



CSIR-CECRI ANNUAL REPORT 2011-2012



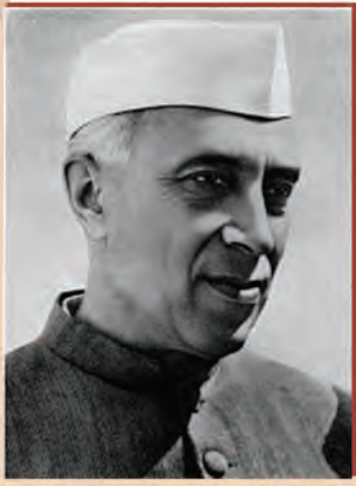
ANNUAL REPORT
2011-2012

CSIR-CECRI

*Where knowledge and
innovation converge for
inclusive development*



सीएसआईआर — केंद्रीय विद्युतरसायन अनुसंधान संस्थान
CSIR-Central Electrochemical Research Institute
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद
Council of Scientific and Industrial Research
कारैकुडी, तमिलनाडु, भारत
Karaikudi, Tamil Nadu, India



"It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, or a rich country inhabited by starving people... Who indeed could afford to ignore science today? At every turn we have to seek its aid... The future belongs to science and those who make friends with science."



"Thinking is progress. Non-thinking is stagnation of the individual, organisation and the country. Thinking leads to action. Knowledge without action is useless and irrelevant. Knowledge with action, converts adversity into prosperity"

- Dr. A.P.J Abdul Kalam



We gratefully acknowledge the support rendered by Shri M.A. Sathish Adithya B.Tech. Final year student for designing and bringing this report in time.

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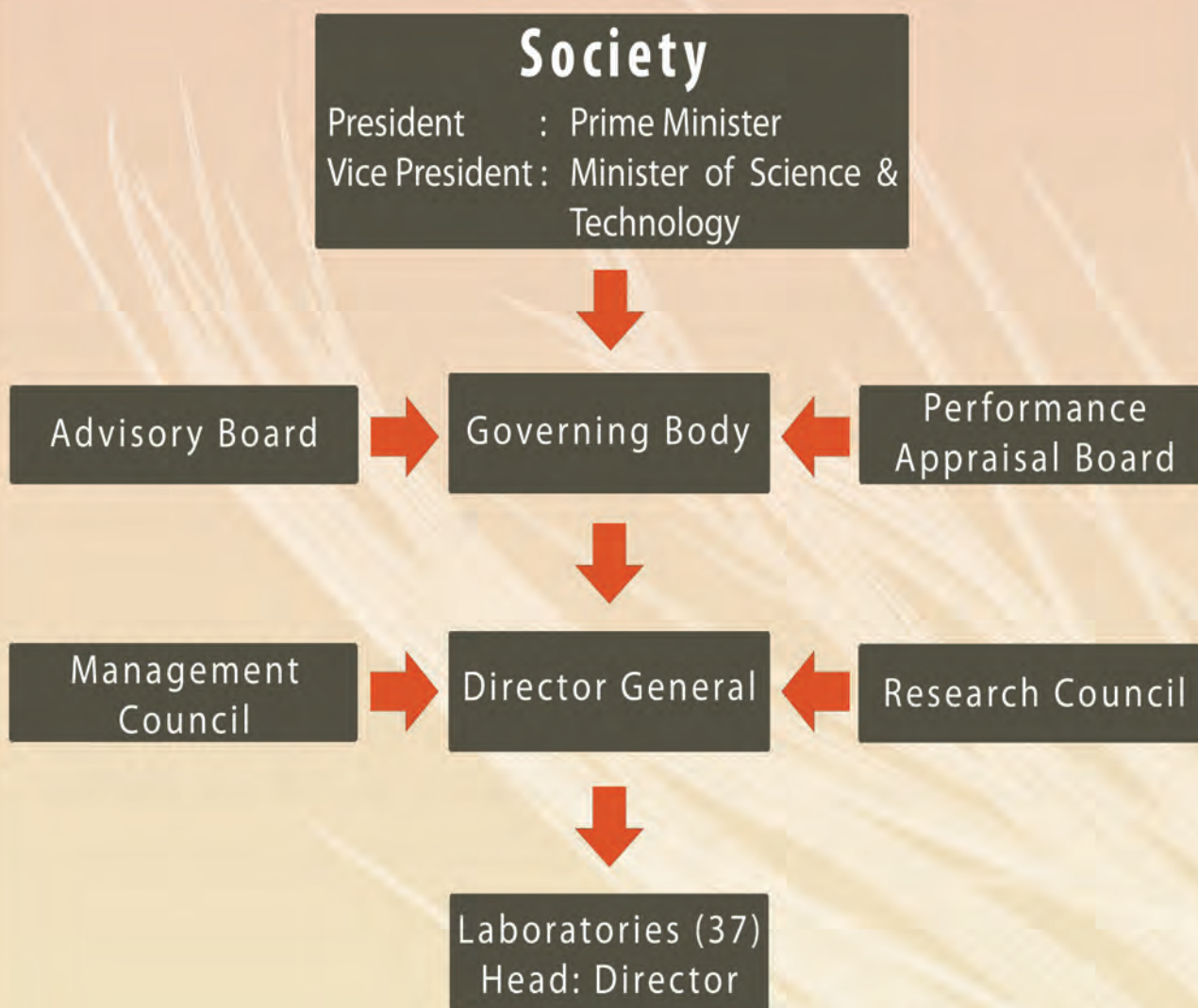
कारैकुडी, तमिलनाडु, भारत
Karaikudi, Tamil Nadu, India



**Director
&
Staff
CSIR - CECRI**



Council of Scientific and Industrial Research Organizational Structure





CSIR-CECRI ANNUAL REPORT 2011-2012

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NMITLI

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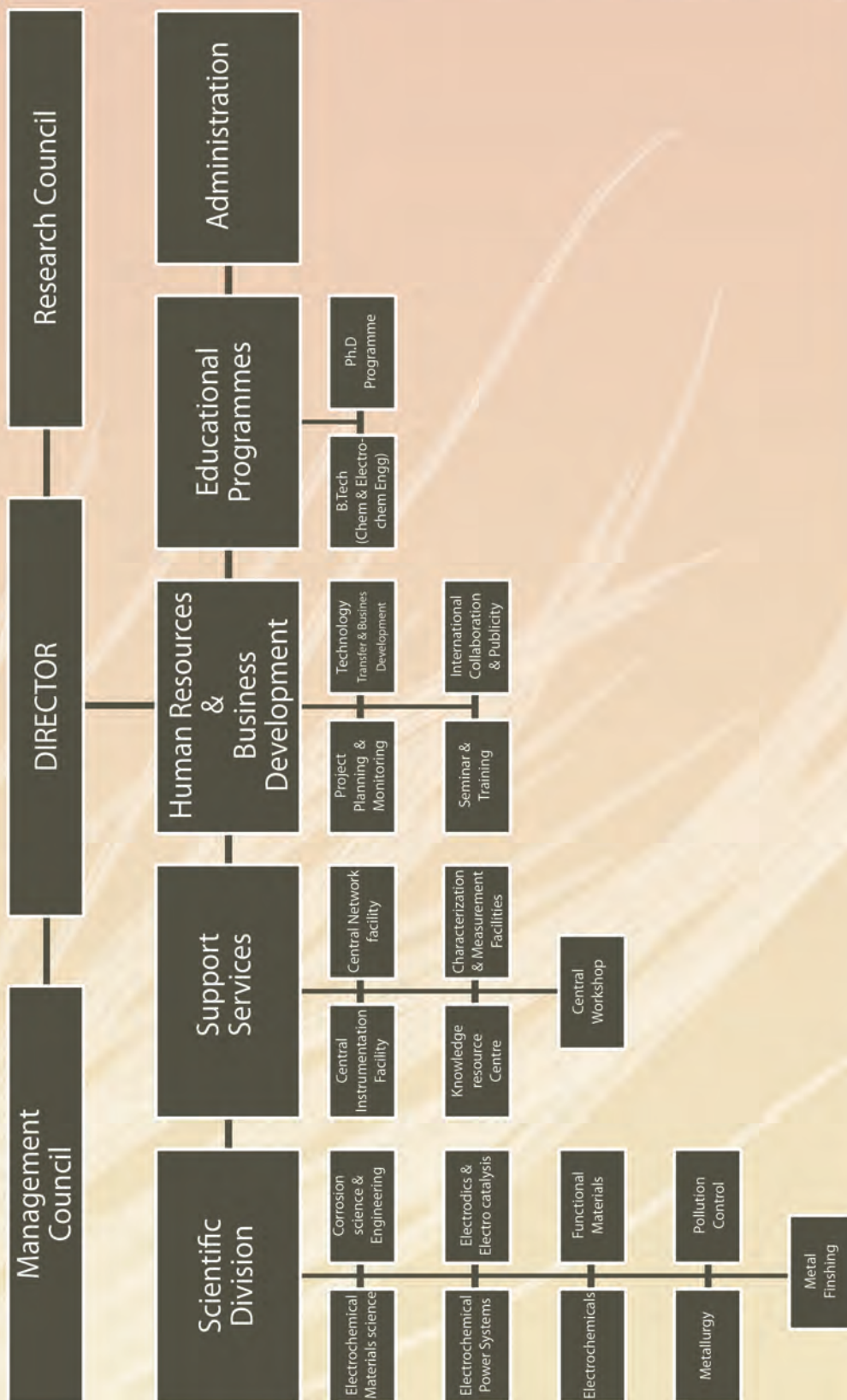
Preamble

CSIR – CECRI is a publically funded organization which strives for scientific excellence and societal benefits. Our vision is to become a global R&D platform for innovation in Electrochemical Science & Technology, leading to inclusive development of our Country. Our Scientists and Engineers blend their passion for excellence in science with societal commitments to develop globally competitive and ecologically benign technologies in energy generation and storage, health diagnostics, corrosion mitigation and material conservation.



CSIR-CECRI ANNUAL REPORT 2011-2012

ORGANIZATIONAL CHART





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निदेशक के डेस्क से



प्रिय मित्रों,

सीएसआईआर-सीईसीआरआई की वर्ष 2011-12 का वार्षिक प्रतिवेदन प्रस्तुत करते हुए मुझे हार्दिक प्रसन्नता हो रही है। सीएसआईआर-सीईसीआरआई ने समाज की आवश्यकता एवं सीएसआईआर की अपेक्षा के अनुरूप कई महत्वपूर्ण कार्य किए हैं। पिछले कुछ समय में सतत उपलब्ध अवसरों एवं उनसे जुड़ी चुनौतियों के अनुरूप, हमने सीएसआईआर-सीईसीआरआई में कई प्रभावी प्रशासनिक परिवर्तन किए हैं जिससे कि सामूहिक निर्णय लेने, व्यवहार में पारदर्शिता लाने तथा मुख्यतः कार्यकुशलता को बढ़ाने में सुविधा हो सके। एक ओर हम सीएसआईआर के सक्रिय समर्थन से मिलकर वैश्विक स्तर पर एक प्रख्यात एवं प्रभावी विश्वस्तरीय वैज्ञानिक अनुसंधान संस्थान के निर्माण में लगे हुये हैं वहीं दूसरी ओर हम मौजूदा तथा भावी तकनीकी समस्याओं का गुणवत्तापूर्ण समाधान प्रदान करते हैं जिससे कि समेकित आर्थिक विकास संभव हो सके। हमारी कार्य-योजना द्वि-पक्षीय है रू सामाजिक अपेक्षाओं को पूरा करने के साथ दूसरा साझेदारों की आवश्यकताओं को पूरा करना। यह सीएसआईआर विजन एंड स्ट्रेटजी 2022 के अनुसार तथा हमारे स्थानीय पर्यावरण की गंभीर यथार्थता को ध्यान में रख कर ही किया जा रहा है। नित-नूतन परिवेश के अनुसार संसाधनों/बिजुनस के निर्माण संबंधी हमारे नवीन प्रयासों (जैसे ईआरपी दृकार्यान्वयन) के अतिरिक्त हम एक मानव संसाधन नीति भी तैयार कर रहे हैं, यह नीति ऐसे युवा शोधकर्ताओं को कार्य करने का अवसर प्रदान करेगी, जो नवीन अनुसंधान-क्षेत्रों के निर्माण तथा उपलब्ध संसाधनों के उपयोग से अभिनव अनुसंधान कार्य करने के लिए प्रतिबद्ध हों।

किसी भी अनुसंधान संस्थान की सफलता प्रयोगशाला-प्रौद्योगिकियों को उद्योग जगत/समाज को हस्तांतरित करने में निहित होती है। इसलिए यह आवश्यक है कि हम अपने दृष्टिकोण में परिवर्तन लाएं तथा ऐसी प्रौद्योगिकियों पर बल दें, जो पर्यावरण सौम्य हों तथा स्पिन ऑफ कंपनियों के निर्माण, बृहद आर्थिक प्रभाव एवं अधिक रॉयल्टी में सहायक हों।

हम ए रसायन और विद्युतरसायन अभियांत्रिकी के स्नातक स्तर के पाठ्यक्रम में सुधार लाने में सक्षम रहे हैं। यह नवीन पाठ्यक्रम गतिशील एवं परिवर्तनीय शैक्षिक वातावरण से सामंजस्य बनाए रखने के हमारे मिशन का ही एक कदम है। यह नवीन कार्यक्रम निश्चित रूप से हमारे विद्यार्थियों को वैश्विक प्रतिस्पर्धात्मक परिस्थितियों में सफल एवं अग्रणी बनाने में सहायक होगा।

वर्ष 2011.2012 वास्तव में हमारे लिए अविस्मरणीय है तथा इसके कई कारण हैं, जैसे कि सीईसीआरआई-वेबमेल का कार्यान्वयन, एसीएसआईआर के माध्यम से सीएसआईआर-अर्हताप्राप्त पीएचडी स्कॉलरों के प्रवेश में वृद्धि तथा प्रशासनिक कोलेजियम का गठन आदि।

तथापि, अब हम अनुसंधान परियोजनाओं, उच्च प्रभाव वाले प्रकाशनों, अंतर्राष्ट्रीय पेटेंट तथा प्रतिष्ठित शैक्षिक संस्थानों और औद्योगिक प्रतिष्ठानों के साथ नई साझेदारी में और विकास के लिए तत्पर हैं। ग्यारहवीं पंचवर्षीय योजना की परियोजनाएं उन्नत अनुसंधान के लिए प्रेरणा का आधार रही हैं। बारहवीं पंचवर्षीय योजना की परियोजनाओं में भी यह उत्साह और अधिक दूरदर्शिता एवं सामाजिक प्रभाव के साथ बना रहना चाहिए। अतीत की असफलताओं का मूल्यांकन कर एवं उनसे सीख लेकर हमें भविष्य के कार्यों की योजना बनानी है। हमें बारहवीं पंचवर्षीय योजना की परियोजनाओं को एक आशावादी नजरिए से देखना चाहिए तथा पूरे जोश एवं सम्पूर्ण समाज के हित के लिए सभी स्तर पर अधिकाधिक योगदान की दृढ़ प्रतिबद्धता के साथ इन परियोजनाओं पर कार्य करना चाहिए।

हम आशा करते हैं कि हमारे अंतर्विषयी दल ए मौलिक विद्युतरसायन अभिकलन और प्रतिरूपण सौर ऊर्जा रूपांतरण प्रकार्यात्मक पदार्थ ए स्मार्ट कोटिंग्स ए पॉलीमर इलेक्ट्रोलाइट फ्यूल सेल्स द्वारा स्वच्छ ऊर्जा उत्पादन ए आदि महत्वपूर्ण क्षेत्रों में संयुक्त रूप से कार्य करेंगे।

संस्थान की पिछली उपलब्धियों का सभी कर्मचारियों और विद्यार्थियों की समग्र प्रसन्नता के साथ मिलान किया जाना चाहिए। हमें ऐसे अभिनव आविष्कारों की आवश्यकता है, जो सीएसआईआर की प्रतिष्ठा में और अधिक वृद्धि करें तथा मुझे विश्वास है कि हमारे दृढ़ संकल्प ए आशावाद एवं दृष्टिकोण के साथ हमें सतत सफलता प्राप्त होगी। वर्ष 2012 की समाप्ति तक सीएसआईआर दृ सीईसीआरआई, सीएसआईआर के एक अग्रणी अनुसंधान संस्थान के रूप में उभरेगा।

मैं, इस वार्षिक प्रतिवेदन के यथासमय प्रकाशन के लिए संस्थान के सभी संबद्ध कर्मचारियों को धन्यवाद देता हूँ तथा यह प्रसन्नता का विषय है कि हमारे पास ऐसा मानव संसाधन है, जो सदैव नए कार्यों/चुनौतियों को समय पर पूरा करने में सहयोग देने के लिए तत्पर रहता है।

मुझे विश्वास है कि भविष्य में आप सभी के सहयोग एवं प्रतिबद्धता के साथ हम और बेहतर कार्य करेंगे तथा आने वाले वर्षों में उल्लेखनीय प्रगति करेंगे।



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From the Director's Desk



Dear friends,

I am delighted to present the annual report of CSIR-CECRI for the year 2011 - 2012.

CSIR-CECRI has taken up several challenges posed by our society at large and CSIR in particular. Commensurate with the increasing opportunities in the recent past and the associated challenges, we at CSIR-CECRI have effected several administrative changes to facilitate collective decision-making, transparency in dealings and above all, improved efficiency. On the one hand, we, with active support from CSIR, yoke all our energy to build a world-class research institute striving for global scientific impact; on the other, we strive to provide quality solutions to existing and emerging technological problems, enabling inclusive economic development. Our strategy is double-edged: to fulfil societal aspirations as well as to meet the demands of stakeholders. It is in complete harmony with CSIR's *Vision and Strategy 2022* and at the same time keeping the sobering realities of our local environment. In addition to new initiatives (such as ERP implementation) for generating resources/business in line with the changing times, we are also poised to launch an HR policy that would enable pumping in a new breed of young researchers, who will have a vision to create new research domains and harness innovative research, tapping all available resources and with no stone unturned.

The success of any research institute lies in transferring bench-scale technologies to the industry/society. This calls for a paradigm shift in our approach, with emphasis laid on technologies that can lead to creation of spin-off companies, greater economic impact, royalty and reduced environmental footprint.

We have been able to bring about reforms in the curriculum of the undergraduate program in Chemical and Electrochemical Engineering. The improved curriculum is a step forward in our mission to keep in tune with the dynamic, changing academic environment. The new program is designed to mould our students into effective leaders in competitive global settings.

The year 2011-2012 was a truly memorable one for us for a number of reasons including the implementation of the CECRI webmail, increased intake of CSIR-qualified Ph.D. scholars through AcSIR and formation of an Administrative Collegium. However, we now look forward to a spurt in research projects, high impact publications, international patents and new partnerships with reputed academic and industrial establishments. The XI FYP projects were springboards for advanced research. The enthusiasm generated by them should dovetail seamlessly into the XII FYP projects with more visibility and societal impact. Past disappointments should be analysed to learn lessons for tasks ahead. We should view the XII FYP projects through rose-colored glasses and pursue them with verve and a dogged commitment for maximizing output at all levels to the benefit of the Indian people. We expect our inter-disciplinary teams to enable collective efforts in cutting edge areas relating to fundamental electrochemistry, computation and modelling, solar energy conversion, functional materials, smart coatings, clean energy generation by polymer electrolyte fuel cells, etc.

The track record of the institute must be matched by overall happiness of all staff and students. We may need more disruptive innovations to create value to CSIR and I am confident that success will continue, strengthening our resolve, optimism and outlook. By the end of 2012, CSIR-CECRI should emerge as one of the flagship research institutes of CSIR. I would like to thank the contributions of every one of our staff who facilitated the publication of this annual report in time.

I am sure that we will do better in future with all your support and commitments to make a big difference in the coming years.



CSIR-CECRI ANNUAL REPORT 2011-2012

CSIR-CECRI

The Central Electrochemical Research Institute (CECRI), founded in 1948, has its roots in the patriotic fervor of Dr. R. M. Alagappa Chettiar, Pandit Jawaharlal Nehru and Dr. Shanthi Swarup Bhatnagar. On January 14, 1953 CECRI became a physical reality when Dr. S. Radhakrishnan dedicated CECRI, the twelfth national laboratory under the CSIR, to the nation. CECRI today is a proud family of 500 employees, 123 of whom are scientists. It represents the largest research establishment for electrochemistry in South Asia. Headquartered at Karaikudi, CECRI has extension centers in Chennai, Mandapam and Tuticorin. Located at latitude of 10.06° and longitude of 78.8°, CECRI, Karaikudi is about 90 km away both from Trichi and Madurai. The ambience at CECRI is quite apt for R&D work. CECRI campus has a unique bird life and is amply green and serene.

In his address on the occasion of laying the foundation stone of the institute, Pandit Nehru said, "... I believe that by such undertakings and by yoking science to public good we can advance the lot of the people of India enormously." In translating those words into action, CECRI has blossomed into a launching pad for a multitude of technologies for the Indian electrochemical industry. Naturally, reflecting on the fact that the inimitable Dr. Alagappa Chettiar donated 300 acres of land and Rs. 15 lakh in cash in 1948 to establish a national laboratory devoted solely to Electrochemistry at a time when Electrochemistry was relegated to the flip-side of Physical Chemistry syllabi in universities, one cannot miss the rare philanthropy and foresightedness of this great visionary.

In living up to its *raison d'être*, the institute works on a gamut of problems covering all facets of electrochemical science and technology like Corrosion Science and Engineering, Materials Electrochemistry, Nanoscale Electrochemistry, Electrochemical Power Sources, Pollution Control, Electrochemicals, Electrocatalysis and Computer Networking and Instrumentation. The institute provides a single and unique canopy under which all aspects of electrochemistry and related areas are deeply investigated for new dimensions. Indeed many CECRI's activities are directed towards the development of new and improved products and processes as well as novel innovations in electrochemical science and technology. Conceptually CECRI runs several projects in collaboration with laboratories from within and outside India.

In 2004, CECRI was selected as one of the nodal laboratories for R&D on hydrogen-based fuel cells under the New Millennium Indian Technology Leadership Initiative. Such an R&D program is seminal for the country since hydrogen has come to be seen as the ultimate fuel for the future. In a short span of two years, CECRI has developed and demonstrated self-sustainable polymer electrolyte fuel cell stacks for portable power applications, clearly establishing its capability to fructify a concept into the product. Based on this noteworthy contribution, prestigious clean energy projects for cutting-edge R&D on hydrogen-based fuel cells and next-generation lithium batteries have been awarded to CECRI during the eleventh five year plan.

CECRI assists the Indian industry by conducting surveys and undertaking consultancy projects. The institute also conducts short term refresher courses for the benefit of the industry and academia. As part of its human resource development programme, CECRI runs Anna University's B Tech course in Chemical & Electrochemical Engineering. Researchers from this part of the country make good use of the excellent library as well as the state-of-the-art analytical and characterization facilities at the institute. CECRI also organizes national and international conferences for dissemination of scientific knowledge. CECRI is alive to societal obligations and participates in such activities as entrepreneur development and CSIR's youth development programme. CECRI is recipient of several technology awards for its telling service to Indian industry. CECRI provides a conducive environment for budding scientists through AcSIR. CECRI offers a platform for young minds and opportunities to use their creativity through its Ph.D. programmes.

To say that the CECRI is the mainstay of electrochemical industry in India is to state the obvious.



Research Divisions

Chlor-Alkali

Corrosion Protection

Corrosion Testing & Evaluation

Electrochemical Materials Science

Electrochemical Power Systems

Electrodics & Electrocatalysis

Electrohydrometallurgy

Electroplating and Metal Finishing Technology

Electropyrometallurgy

Electro-inorganic Chemicals

Electro-organic Chemicals

Electrochemical Pollution Control

Functional Materials

Industrial Metal Finishing

Instrumentation



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Research Council



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INAE Distinguished Professor
Department of Materials Engineering
Indian Institute of Science
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Institute Chair Professor &
Ranjit Singh Endowed Chair Professor,
Department of Chemical Engineering
Indian Institute of Technology
KANPUR – 208 016



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Dept of Chemical Engineering
Indian Institute of Technology
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Sr Principal Scientist
Central Electrochemical Research Institute
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प्रबंधन समिति Management Council



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निदेशक

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Dr. Vijayamohan K Pillai
Director



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रआई, चेन्नै
Dr. A.B. Mandal, Director,
CLRI, Chennai.



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लिक चिकित्सक, प्रधान तकनीकी अधि.
कारी
Dr. ORSL. Sathivathi, FTMO,
Principal Technical Officer



श्री.आर.वी. अलगेसन, प्रमुख, टीटीबीडी
Shri R.V. Alagesan, Head, TTBD



श्री डीपी. मारेट, वित्त एवं लेखा अधि.
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Shri D.P. Marat, FAO



श्री पी. वेंकट राव, वित्त एवं लेखा
अधिकारी
Shri P. Venkat Rao, FAO



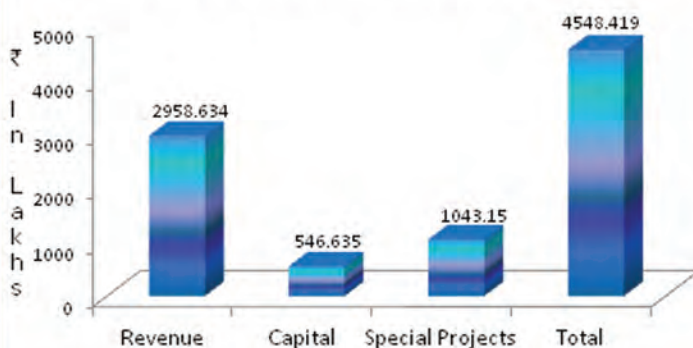
श्री मेन्युल थॉमस, प्रशासन नियंत्रक
Shri Manuel Thomas, COA



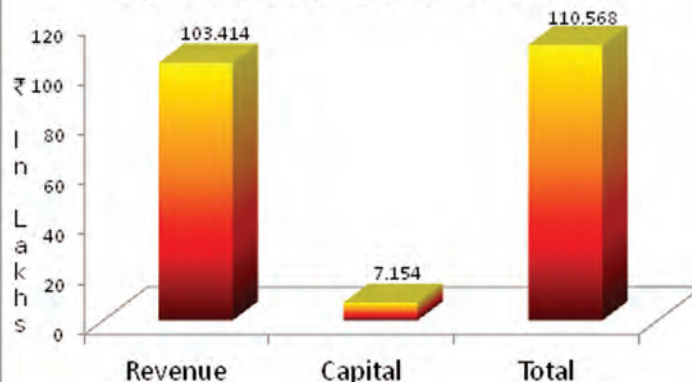
CSIR-CECRI ANNUAL REPORT 2011-2012

Financial Indicators

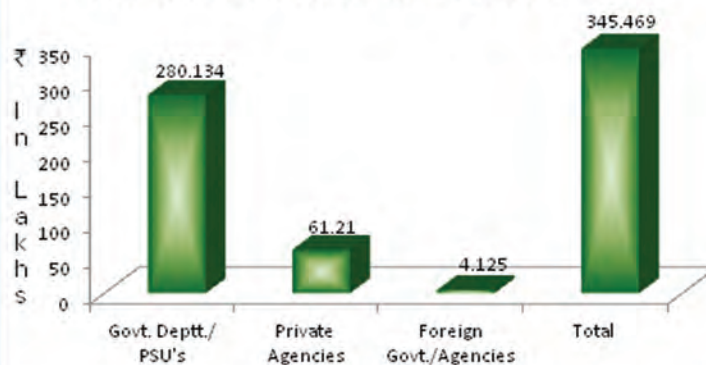
CSIR Resource Input 2011-2012



Expenditure Out of Lab Reserve 2011-2012



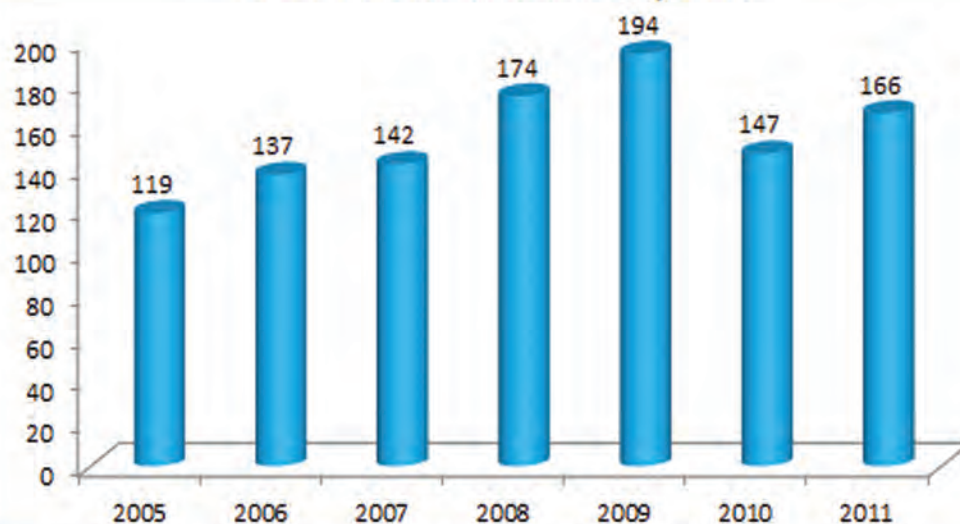
External Cash Flow during 2011 -2012



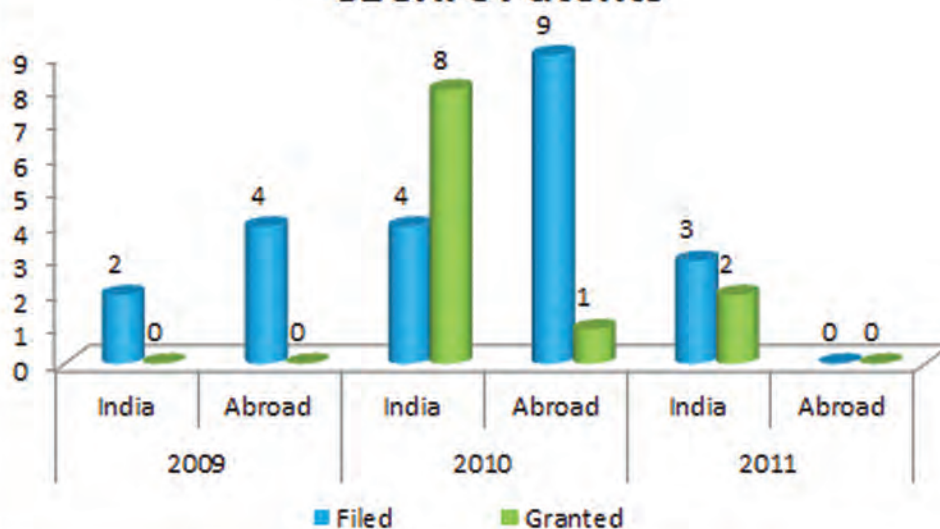


Research Publications & Patents

CECRI's Research Papers



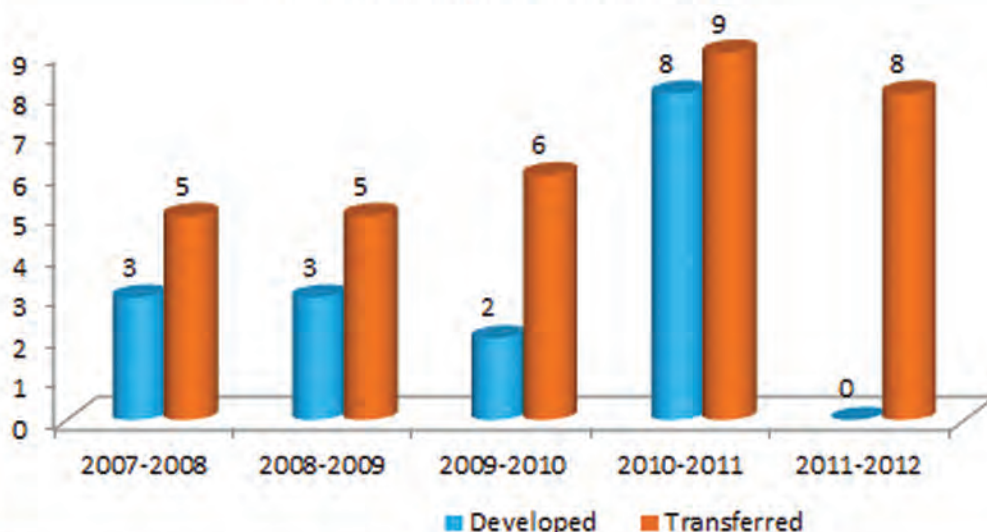
CECRI's Patents



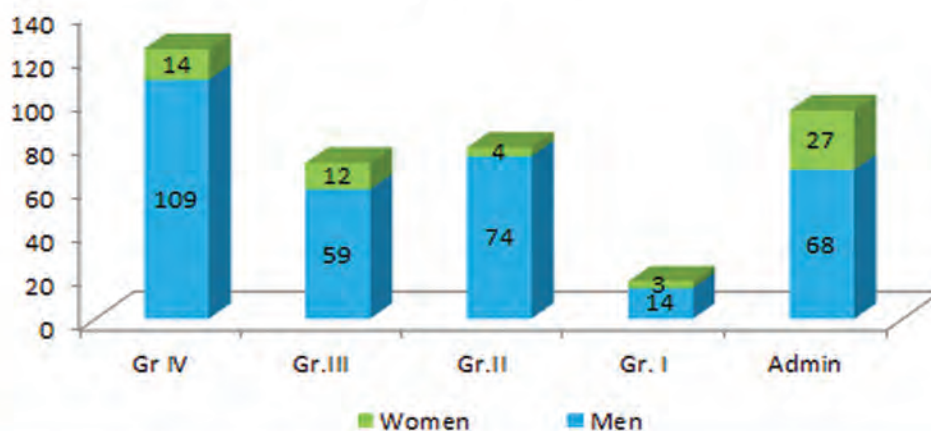


Technologies and Human Resource position

Technologies of CECRI



CECRI's Human Resource As on 31.03.2012





CSIR-CECRI ANNUAL REPORT 2011-2012

Research and Development Reports



IAP-04

Development of lithium-ion batteries for multifarious applications

Principal Investigator : Dr. T. Prem Kumar

Participating industry: Indocel Technologies Pvt. Limited, Bangalore.

Duration 2007-2012.

Objectives

- (a) Optimization of the synthesis of battery-grade materials
- (b) Physico-chemical characterization of the synthesized materials
- (c) Performance evaluation of materials in coin cell configuration
- (d) Assembly and testing of 5-Wh pouch/prismatic cells

Progress highlights

(A) Salient Results & Conclusions

The materials that were to be developed at CSIR-CECRI included, but not limited to, (i) anode materials based on kish graphites, (ii) LiFePO_4 cathode, and (iii) novel conversion electrode materials. CECRI was also expected to provide research support on ionic liquids and polymer membranes. Thus, CECRI's deliverables would include new synthesis methodologies for battery-active materials, formulations for high-performance-electrodes, and 5-Wh pouch/prismatic cells. After initial studies, two anode materials (a graphitic carbon and an intermetallic composite) and two cathode materials (LiFePO_4 and a Li-Co-Ni-Mn layered oxide) were identified as candidate materials for further work. A further fine-tuning led to a kish graphitic anode delivering a capacity of at least 300 mAh/g over 1,000 cycles and a cathode material exhibiting at least 120 mAh/g over 500 cycles were identified. Further objectives were the assembly of a 1-Ah pouch cell that can sustain at least 300 cycles at C/10 rate and safety studies with the active materials.

IAP-04, being the first major funding for a device-directed project with technical inputs from an industrial partner, the project has yielded at least two world-class battery-active materials: kish graphitic anode materials capable of high capacities, even exceeding the theoretical value of 372 mAh/g for graphite, and sustaining hundreds of charge-discharge cycles; and a kish-graphite enveloped fluoride-based LiFePO_4 cathode material that can sustain hundreds of cycles and yet delivering capacities of more than 130 mAh/g. Moreover, a layered $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$ compound, synthesized by a hydroxyl carbonate route yielded more than 180 mAh/g and sustained C/2-C rate discharges required for hill-climbing of a remote-operated toy car.

With large-scale lithium utilization on the anvil, lithium resources are already considered strategic. Much of the world's resources are concentrated in South America, with Bolivia and Chile taking centre stage. It was felt that lithium resources in India were not properly identified. Hence, in the Cluster Meeting held in March 2010, it was proposed to map land-based and ocean-based lithium resources in India with participation of GSI, CSIR-NIO and CSIR-CSMCRI.

(1) Introduction of a new class of high-capacity, long-cycling anode materials based on kish graphites

Kish graphites were produced by precipitating carbon from supersaturated solutions of carbon in steel. The graphitic materials were employed as high-capacity, long-cycling anodes in lithium-ion batteries. The graphitic materials were prepared by two processes.



(a) By conventional technique from inoculated steel melts. In this process, kish graphites with peculiar properties were prepared with inoculants (boron, bismuth, etc.) added to the steel melt from which the graphite was precipitated. The carbon precursors used were cokes, coconut charcoal, etc.

(b) By a filth-to-wealth process in which the carbon precursors were non-biodegradable plastic wastes (PE, PVC, ABS) that litter our surroundings. The new process not only yields kish graphitic materials with different structural and electrochemical characteristics, but also provides a way to convert non-degradable waste into technologically useful products.

Both classes of graphites deliver capacities exceeding 372 mAh/g, the theoretical lithium insertion capacity of perfectly graphitic materials. Typical capacity values hover around 350–430 mAh/g at C/10 rate between 3.000–0.005V. They also exhibit low irreversible capacities, often less than 15%. Another important feature of these graphites is that more than 95% of the capacity is available on a flat plateau below 200 mV vs. Li⁺/Li, which means that devices based on these materials should deliver constant voltages from beginning to end of use.



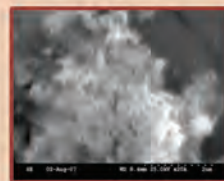
Left: A SEM image of kish graphite showing characteristic flaky morphology.



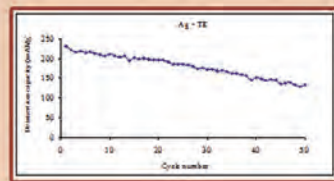
Middle and right: A TEM image of kish graphite showing serpentine carbon nanostructures.

(2) Green routes to nanoscopic intermetallic anodes

A simple, convenient and eco-friendly biological route to the preparation of nanometric intermetallic phases useful as lithium-insertion anode materials. Metals such as silver, lead, cobalt and nickel have been produced by this method. Three approaches were adopted for the preparation such composites: (i) with nitrate-reducing bacteria (e.g., *Pseudomonas*; *Bacillus* sp.); (ii) with enzyme extracts; and (iii) with leaf extracts of plants (e.g., neem; tulsi). Reversible capacities of more than 230 mAh/g (C/10; 1.500–0.005V) have been realized with silver nanoparticles. The leaf extract route is less cumbersome and allows easy purification.



Left: Silver nanoparticles generated with *Pseudomonas*.



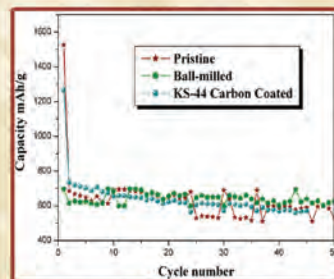
Right: Cycling behavior silver nanoparticles obtained with tulsi leaf extract. Reversible capacities realized: >230 mAh/g (C/10; 1.500–0.005V).

(3) Metal-metal oxide-carbon composite anodes

Because of the large capacities that can be realized with lithium-alloying anodes, much interest continues to be evinced on alloy anodes. To circumvent problems associated with the inordinate volume changes accompanying the lithiation-delithiation processes in such systems, metal-metal oxide-carbon composites have begun to be seriously considered in the recent past. The lithium alloying metals in these composites are generated in situ by mechano-chemical reduction with more reactive metals in a conducting carbon matrix (e.g., generation of Bi from Bi₂O₃ by milling with MgO).

(4) Lithium alloy anodes

The SnSb graphite composites were synthesized using ball milling whereas SnSb (Sn: 46.5 at.%; Sb: 53.5%; average particle size: 100–500 nm). SnSb_{0.5} samples (average particle size: 25–40 nm) were synthesized by a wet chemical method using zinc as a reducing agent. The SnSb particles had a needle-shaped morphology whereas the SnSb_{0.5} particles had a spherical morphology. Thus the composition and method of preparation have a decisive role in particle size and shape in these nano materials. Our results with Ni₃Sn₄ an ternary phases of Sn-Sb-M (M = Ni or Mn) are particularly striking. We also used KS-44 carbon as a matrix for buffering action.



Capacity vs. cycle number for Ni₃Sn₄ (ball-milled, pristine and carbon-coated).

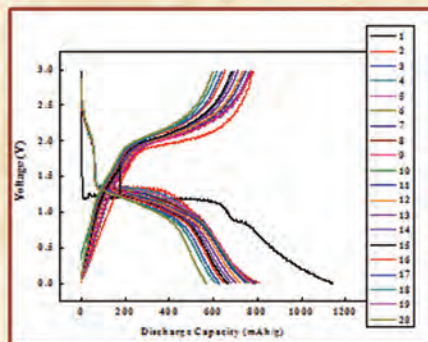


Ball-milled SnSb and ball-milled carbon-coated Ni_3Sn_4 yield stable discharge capacities of more than 600 mAh/g for more than 50 cycles. The Sn-Sb-Mn and the Sn-Sb-Ni ternary intermetallic electrodes provide discharging capacities that average around 650 and 700mAh/g, respectively at a C/10 rate. They are particularly attractive as anode materials especially because of the high intrinsic conductivity of the electrodes and the high capacities.

(5) Conversion electrodes

Macroporous Co_3O_4 consisting of nanocrystals averaging 30 nm in size was prepared with avian egg membrane as a replicating template. Like other forms of Co_3O_4 -based conversion electrodes, this product also undergoes conversion reaction evidenced by a flat potential plateau and a surface polymer film formation reaction in a subsequent sloping potential plateau. At C/10 rate, the material delivered capacities around 800 mAh/g over 20 cycles. Conversion electrodes based on nanoparticulate Co_3O_4 were also synthesized by a combustion process with glycine as a fuel, which ensured that the resulting oxide particles had a coating of carbon on them, and by precipitation followed by mechanical milling with conducting carbon. Cycling studies showed that about 6 lithium per molecule of Co_3O_4 could be reversibly cycled.

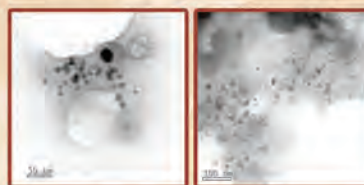
Conversion electrodes based on nanoparticulate Co_3O_4 were also synthesized by a combustion process with glycine as a fuel, which ensured that the resulting oxide particles had a coating of carbon on them, and by precipitation followed by mechanical milling with conducting carbon. Cycling studies showed that about 6 lithium per molecule of Co_3O_4 could be reversibly cycled.



Discharge profiles and cycling behaviour of Co_3O_4 prepared using egg membrane as a template.

(6) Kish graphite-coated LiFePO_4 cathode prepared by a fluoride-assisted synthesis

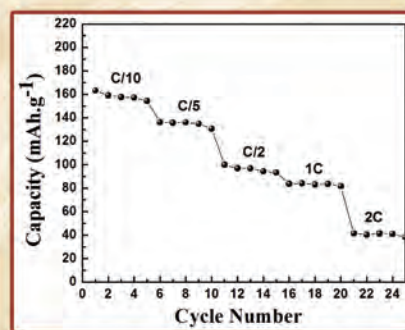
LiFePO_4 is considered the most promising of cathode materials today especially for reasons of safety and economics. Several manufacturers have switched from the conventional LiCoO_2 to LiFePO_4 . Major impediments to the exploitation of this cathode are its low conductivity (10–9 S/cm) and low tolerance to impurities, especially Fe^{3+} . We synthesized LiFePO_4 with an average particle size of less than 40 nm was synthesized by a fluoride-assisted route and ball-milled with PVC-derived kish graphite. The novelty of the material is a network of conducting kish graphite that provides particle-to-particle electronic conductivity, enhancing performance. Capacities exceeding 150 mAh/g (C/10 rate; 3.000–4.000 V) were realized with this method. Under laboratory conditions, the material has sustained more than 500 cycles with lithium as a counter electrode.



TEM images of LiFePO_4 particles (~20 nm) embedded in a graphite matrix.

(7) High-capacity $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$ prepared by a hydroxycarbonate route

Capacities exceeding 160 mAh/g (C/10 rate; 2.5–4.6 V) were realized with this material that was prepared by following a rather unusual methodology. What is significant is that the product gave a capacity of about 80 mAh/g at C rate.



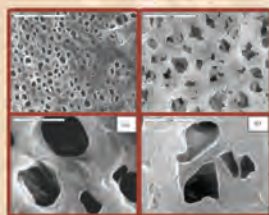
Rate capability performance of $\text{LiNi}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3}\text{O}_2$ calcined at 900°C for 12 h (2.5 to 4.6 V).



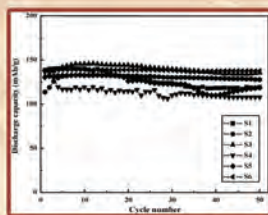
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(8) PVdF-HFP porous membranes for separator application

One of the objectives of the project was to develop a separator membrane or a polymer electrolyte that can be used in lithium-ion batteries. CSIR-CECRI has developed porous membranes of PVdF-HFP (porosity: 48–64%) by phase inversion technique. PEG with volatile solvents such as THF, acetone and DMF were employed for the preparation of such membranes. The membranes had thicknesses between 69 and 79 microns. Electrolyte intakes of 50–115% could be realized with such membranes, promising high electrolyte conductivity. The membranes were found to be compatible with the active materials in their charged and discharged states. The membranes were found to sustain high cyclability in half cells with lithium as the anode and commercial LiCoO_2 and LiFePO_4 as cathodes



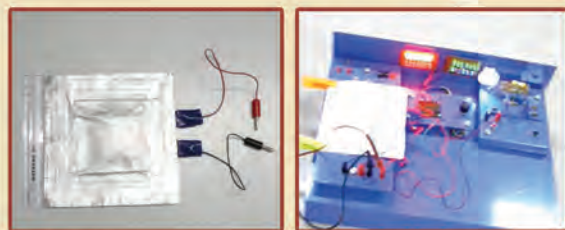
SEM images of PVdF-HFP membranes prepared with acetone as a volatile solvent.



Cycling stability of Li-LiCoO₂ half cells with porous PVdF-HFP membranes prepared by phase inversion technique. Volatile solvents: THF (S1&S2); acetone (S3&S4) and DMF (S5&S6)

(9) CSIR-CECRI's first pouch cells

With the facility established through this project for lithium battery research, pouch cells are now being assembled. A W-weaving (Thuzuri-Ori) style of electrode folding method with a layer of separator in between was used to make the electrode assembly inside the laminated aluminum pouches. A regimen of formation cycles – required for the stabilization of SEI on the electrodes – was arrived at after a number of trials.



A pouch cell. Active materials: graphite and $\text{LiNi}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3}\text{O}_2$; electrolyte: 1M LiPF₆ in 1:1 (v/v) EC-DMC; separator: Celgard 2700; anode weight: 2.1g (260 mAh/g); cathode weight: 3.4g (160–185 mAh/g); electrode area: 5 x 5 cm²; cell capacity: 500 mAh; working voltage: 3.0–4.6 V.

Publications and patents

1. Role of iron dopant and carbon additive in improving the ionic transport and electrochemical properties of $\text{LiFe}_x\text{Mn}_{1-x}\text{PO}_4$ ($x = 0.25$ and 0.75) solid solutions.

D. Bhuvaneswari, Gangulibabu, Chil-Hoon Doh, N. Kalaiselvi.
Int. J. Electrochem. Sci. 6 (2011) 3714–3728

2. Effect of reaction temperature on morphology and electrochemical behavior. A comparative study on hydrothermal and co-precipitation synthesis of LiCoO_2 and LiMn_2O_4 using same set of precursors. K. Sathiyaraj, Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi.
Ionics 17 (2011) 49–59.

3. Modified sol-gel synthesis to prepare nano-crystalline $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$ cathode suitable for rechargeable lithium batteries. N. Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi.
Nanosci. Nanotech. Lett. 3 (2011) 717–722.

4. Solution combustion synthesis of layered $\text{LiNi}_0.5\text{Mn}_0.5\text{O}_2$ and its characterization as cathode material for lithium-ion cells. P. Manikandan, M.V. Ananth, T. Prem Kumar, M. Raju, P. Periasamy, K. Manimaran.
J. Power Sources 196 (2011) 10148–10155.

5. High-capacity potato peel-shaped graphite for lithium-ion batteries. T. Sri Devi Kumari, R. Surya, A. Manuel Stephan, D. Jeyakumar, T. Prem Kumar.
MRS Commun. 1 (2011) 41–44.

6. H_2O_2 -aided one-pot hydrothermal synthesis of nanocrystalline LiMn_2O_4 cathode for lithium batteries. K. Sathiyaraj, Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi, A. John Peter.
IEEE Trans. Nanotech. 11 (2012) 314–320.

Patents

Kish graphitic lithium-insertion anode materials and negative electrodes for lithium-ion batteries prepared therefrom.
Indian (one) + PCT (one): CSIR-IPMD reference No. 173NF2010.



Energy for cleaner and greener environment

Principal Investigator : Dr. P. Sridhar

Duration: 2007-2012.

Objectives

Development, demonstration and commercialization of PEFC stacks operating on hydrogen and air.

Progress highlights

(A) Salient Results & Conclusions

CECRI has been working on the development of functionally superior fuel cell materials e.g. membrane, catalyst and catalyst support materials for performance enhancement and improved durability of PEFC besides system development. This includes development of functionally superior Nafion-inorganic composite membranes for low humidity PEFC applications, membranes for humidifiers, functionally superior electrocatalysts for maximum utilization of Pt nanoparticles with promising electrocatalytic activity toward oxygen reduction reaction and development of mesoporous carbons (MCs) with varying surface area and pore structure as gas diffusion layer for better reactant permeability and water removal.

Some of the materials developed in the context of Polymer Electrolyte Fuel Cells, namely m e m b r a n e have been found to be useful in reducing the crossover of methanol in direct methanol fuel cells. Similarly some of the catalysts like Pt supported on TiO_2 -Carbon composite and Pt-Au alloy catalysts have been found to be selective for oxygen reduction reaction in presence of methanol which would mitigate the crossover problem arising due to methanol.

(B) Publications & Patents

1. Design and development of a self-supported PEFC system with anodic-dead-end operation.
A. Manokaran, A. Jalajakshi, A.K. Sahu, P. Sridhar, S. Pitchumani, A.K. Shukla.
J. Power and Energy, Proc. I Mech.E., Part A, 225 (2011) 175-182.
2. Modified-pore-filled-PVDF-membrane electrolytes for direct methanol fuel cells.
S. Alwin, S.D. Bhat, A.K. Sahu, A. Jalajakshi, P. Sridhar, S. Pitchumani, A.K. Shukla.
J. Electrochem. Soc., 158 (2011) B91-B98.
3. Pt-Au/C cathode with enhanced oxygen-reduction activity in PEFCs.
G. Selvarani, S. Vinod Selvaganesh, P. Sridhar, S. Pitchumani, A.K. Shukla.
Bull. Mater. Sci. 34 (2011) 337-346.
4. A self-supported 40W direct methanol fuel cell system.
A. Manokaran, R. Vijayakumar, T.N. Thomman, P. Sridhar, S. Pitchumani, A.K. Shukla.
J. Chem. Sci. 23 (2011) 343-347.
5. Graphitic Carbon as durable Catcode-catalyst-support for PEFCs.
S. Vinod Selvaganesh, G. Selvarani, P. Sridhar, S. Pitchumani, A.K. Shukla.
Fuel Cells 11(2011) 372-384.
6. Durable electrocatalytic-activity of Pt-Au/C cathode in PEFCs.
S. Vinod Selvaganesh, G. Selvarani, P. Sridhar, S. Pitchumani, A.K. Shukla.
Phys. Chem. Chem. Phys. 13 (2011) 12623-12634.



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7. A DMFC with methanol-tolerant-carbon-supported-Pt-Pd-alloy cathode.

K.G. Nishanth, P. Sridhar, S. Pitchumani, A.K. Shukla.

J. Electrochem. Soc. 158 (2011) B871-B876.

8. Chitosan-polyvinyl alcohol-sulfonated polyether sulfone mixed-matrix membranes as methanol-barrier electrolytes for DMFCs.

S. Meenakshi, S.D. Bhat, A.K. Sahu, P. Sridhar, S. Pitchumani, A.K. Shukla.

J. Appl. Polymer Sci. 124 S1 (2012) E73-82.

9. Bio-composite membrane electrolytes for direct methanol fuel cells.

S. Mohanapriya, A.K. Sahu, S.D. Bhat, S. Pitchumani, P. Sridhar, C. George, N. Chandrakumar, A.K. Shukla.

J. Electrochem. Soc., 158 (2011) B1319-1328.

10. Carbon supported silver as cathode electrocatalyst for alkaline polymer electrolyte membrane fuel cells

S. Maheswari, P. Sridhar, S. Pitchumani.

Electrocatalysis, 3 (2012) 13-21.

11. Experimental analysis of spatio-temporal behavior of anodic dead-end mode operated polymer electrolyte fuel cell.

A. Manokaran, S. Pushpavanam, P. Sridhar, S. Pitchumani,

J. Power Sources 196 (2011) 9931-9938.

12. Durable transition-metal-carbide-supported-Pt-Ru anodes for DMFCs.

K. G. Nishanth, P. Sridhar, S. Pitchumani and A. K. Shukla.

Fuel Cells, 12(2012) 146-152.

13. Catalytic activity of dendrimer encapsulated Pt nanoparticles anchored onto carbon towards oxygen reduction reaction in polymer electrolyte fuel cells.

K. Tintula, A.K. Sahu, S.D. Bhat, S. Pitchumani P. Sridhar.

Appl. Catal. B. Environmental 110 (2011) 178-185.

14. Enhanced methanol electro-oxidation on Pt-Ru decorated self-assembled TiO_2 -Carbon hybrid nanostructure.

K.G. Nishanth, P. Sridhar, S. Pitchumani, A.K. Shukla, ECS Trans., 41 (2011) 1139-1149.

15. Endurance of Nafion-composite membranes in PEFCs operating at elevated temperature under low relative-humidity.

A.K. Sahu, A. Jalajakshi, S. Pitchumani, P. Sridhar, A. K. Shukla.

J. Chem. Sci. 124 (2012) 529-536.

16. Enhanced oxygen reduction reaction activity through spillover effect by Pt- $\text{Y}(\text{OH})_3/\text{C}$ catalyst in direct methanol fuel cells.

K.G. Nishanth, P. Sridhar, S. Pitchumani.

Electrochem. Commun. 13 (2011) 1465-1468.



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FAC-006

CSIR Battery performance evaluation centre

Principal Investigator : Er. S. Ambalavanan

Duration: 2007-2012.

Objectives

- ❖ To build state-of-the-art test facility
- ❖ To assist various industries in quality management.
- ❖ To create simulation and modeling modules for various battery chemistries for varying end uses.

Progress highlights

(A) Salient Results & Conclusions

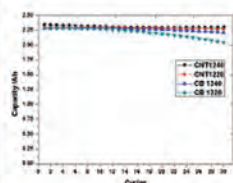
Aim	Completed	ongoing
1. Creation of State-of-the-art test facility for batteries		
a. Electrical Performance	✓	
b. Mechanical performance	✓	
2. Product validation of batteries		✓
a. End users [Indian Railway/BSNL]		✓
b. Manufacturers		✓
3. Simulation and modeling		
a. Back propagation algorithm using ANN technique	✓	

CSIR-CECRI

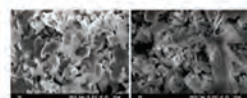
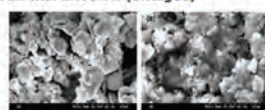
EFYP

(B)

Comparative performance of Carbon black and Multiwall Carbon Nano Tube (MWCNT) additive on Negative of Lead-Acid [2V/2.0Ah]



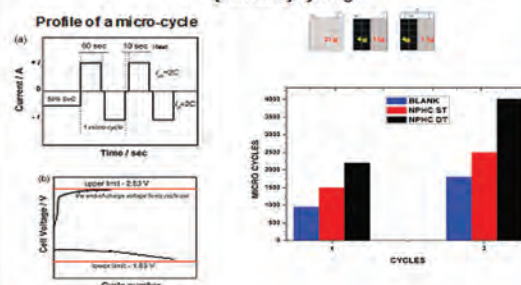
SEM images of charged NAM with 0.25 wt. % CB and MWCNT (SG 1220) after 30 cycle:- (a) NAM with CB, (b) and (c) NAM with MWCNT. (Charged)



SEM images of charged NAM with 0.25 wt. % CB and MWCNT (SG 1240) after 30 cycle: (a) NAM with CB, (b) and (c) NAM with MWCNT. (Charged)

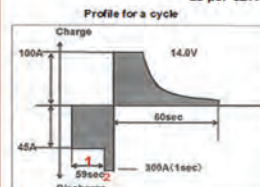
(C)

Performance of half carbon paste in negative plate of lead-acid cells (2V/3.0 Ah) under high-rate partial-state-of-charge [HRPSOC] cycling



(D)

Testing of 12V/43Ah Lead-Acid battery for Idling-Stop hybrid HEVs as per SBA-S-0101-2006



Test Requirement

- Repeat for 3600 cycles
- Rest 48h
- Continue Cycling test till terminal voltage drops below 7.2 V in discharge step 2

Result :

Experimental Time [h]	Prediction time as per ANN [h]
480	5

(E)

Automatic Solar Radiation Monitoring Station (ASRMS) - CSIR-CECRI
Ministry of New and Renewable Energy
Centre for Wind Energy Technology

Identification of potential areas for the deployment and development of solar power stations under Jawahar Lal Nehru National Solar Mission



Parameters monitored

Time
Radiation Direct
Radiation Diffused
Wind speed
Wind direction
Temperature
Relative Humidity
Rain
Atmospheric pressure
Battery voltage



Data is transmitted to the Central receiving station at CVET, Chennai through GPRS transmission from this Station from 24.05.2011 onwards.



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(F)

Sponsored Project Amararaja Batteries limited
Lead foam development PM route

Method : Powder metallurgical route

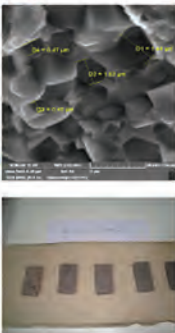
Raw Powder : Pb powder

Blowing agent : TiH_2

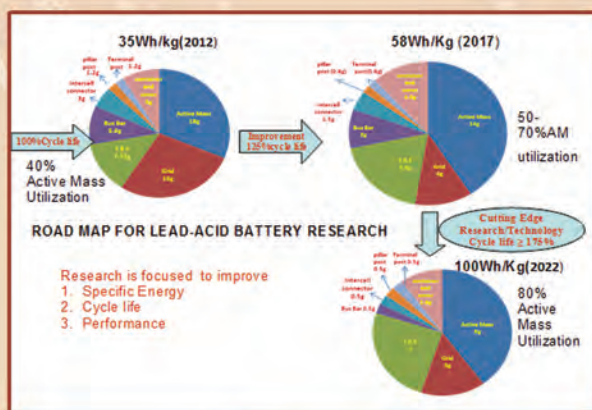
Binder : Carboxymethyl cellulose (2 %)

1. The prepared compacts [12 tons] were subjected to sintering at different temperatures [250,400,600,700,800 deg.C]

2. After heat treatment, compacts were analyzed for further studies



(G)



(H)

Design and Development of Batteries for Solar Photovoltaic Applications - [CLP 01 / 08]. Project completion report was submitted to MNRE.

The report is published in the website:
www.indiaenvironemtportal.org.in

Publications & Patents

1. Failure analysis of cast-on-strap in lead- acid battery subjected to vibration.

M. Saravanan and S. Ambalavanan. Engineering failure Analysis, Available online 29th July 2011.

2. Elecrokintic separation of sulphate and lead from sludge of spent lead acid battery.

Journal of Hazardous materials, 21 July 2011.

S. Maruthamuthu, T. Dhanibabu, A. Veluchamy, S. Palanichamy, P. Subramanian, N. Palaniswamy, IF: 4.144.

3. Patent "Electrode materials for mixed potential" C. Vonu, M. Paramasivam, J. Zosel, M. Berthhold, U.Guth

German Patent Application No:10 201105952.4, dated 29/06/2011.

4. Journal of The Electrochemical Society, 159 (4) A452-A458 (2012)

A Modified Lead - Acid Negative Electrode for High-Rate Partial-State-of-Charge Applications M. Saravanan, M. Ganesan, and S. Ambalavanan



RSP-0005

Development of electrochemical technologies for drinking water upgradation in North East Region

Principal Investigator : Dr. G. Sozhan

Duration: 2008 – 2012.

Objectives

The proposed objective is to develop the following electrochemical units either one or combination of two or more of the processes are expected to benefit the people of the North East region in improving their quality of life by providing safe drinking water and help in fulfilling the mission of the Indian Government. The proposed electrochemical units include

- Electrochemical Defluoridation.
- Electrochemical Arsenic removal.
- Electrochemical Hypochlorite generator utilizing very dilute chloride solutions.
- Solid Polymer Electrolyte (SPE) Ozone generator.

Progress highlights

(A) Salient Results & Conclusions

(i) Development of PEM based electrochemical ozone generator

Ozone is conventionally synthesized by cold corona discharge process, which requires a high voltage and it produces Nitrogen oxide (NO_x) – a harmful gas as a byproduct. An alternative method viz an electrochemical technology which utilize Proton Exchange Membrane Electrolyte (PEME) water electrolysis cells with PbO_2 anode for the in-situ generation of ozone was developed and demonstrated.



Electrochemical cell



PEM ozone generator

(ii) Design and development of integrated electrochemical water treatment system

The integrated system was developed and it consists of electrochemical defluoridator and ozone generator for removal of fluoride from water and disinfection of water respectively.



Integrated electrochemical water treatment system

(B) Publications

- Effects of alternating current in electrocoagulation process on the removal of fluoride from water
S. Vasudevan, B. Sureshkannan, J. Lakshmi, S. Mohanraj, G. Sozhan.
J.Che. Tech.Biotech 86 (2011) 428 – 436.



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(C) Technology Developed / Transferred

(i) Technology on electrochemical defluoridation transferred to M/s. Nagpur Aquatech P Ltd, Nagpur (May 2011)



(ii) Technology on electrochemical defluoridation transferred to M/S Speciality Products P Ltd, Raipur (February 2012)



"Science is the best boon that God has bestowed upon mankind. Science with reasoning becomes the capital of society. . . The convergence of science and technology with spirituality is touted to be the future for both science and technology, and spirituality."

-Dr. A.P.J. Abdul Kalam



Development of speciality inorganic materials for diverse applications

Principal Investigator : Dr. M. Jayachandran

Duration: 2007 - 2012.

Objectives

- ❖ To prepare mixed oxides $\text{SnO}_2\text{-In}_2\text{O}_3$, $\text{SnO}_2\text{-ZnO}$, $\text{MoO}_3\text{-WO}_3$, V_2O_5 , NiO , CeO_2 films and porous silicon (PSi) matrix for gas sensing application.
- ❖ Preparation of Indium Tin Oxide ($\text{In}_2\text{O}_3\text{:SnO}_2$), magnesium indium oxide (MgIn_2O_4), Magnesium tin oxide (Mg_2SnO_4) and magnesium zinc oxide (Mg_2ZnO_4) films by pulsed laser deposition/sputtering/electron beam evaporation (EBE)/spray pyrolysis techniques as transparent conducting oxide (TCO) electrodes for optoelectronic devices.
- ❖ To develop hard coatings of titanium aluminum nitride (TiN-AlN) and TiON by reactive sputtering technique for protective and biomaterial applications.
- ❖ Preparation of nano titanium oxide (TiO_2) and titanium zinc oxide films ($\text{TiO}_2\text{-ZnO}$) by sol-gel & spin coating and spray pyrolysis techniques for dye sensitized solar cell (DSSC).

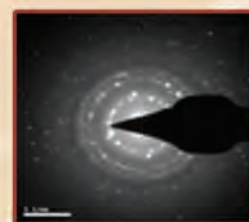
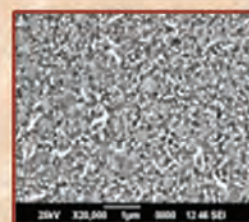
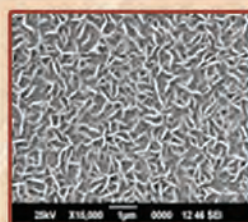
Progress highlights

(A) Salient Results & Conclusions

ITO films by a Jet Nebulizer Spray (JNS) Pyrolysis technique

Nanocrystalline ITO thin films were deposited on glass substrates by a new spray pyrolysis route, Jet nebulizer spray (JNS) pyrolysis technique, at different substrate temperatures varying from 350 to 450°C using a precursor containing indium and tin solution with 90:10 at % concentration. The optical band gap values calculated from the transmittance spectra of all the ITO films showed a blue shift of the absorbance edge from 3.60 to 3.76 eV.

SEM and TEM results showed the nanocrystalline nature with grain size about 12-15 nm. The electrical parameters like the resistivity, mobility and carrier concentration are found as $1.82 \times 10^{-3} \Omega\text{cm}$, $8.94 \text{ cm}^2/\text{Vs}$ and $4.72 \times 10^{20} \text{ cm}^{-3}$, respectively for the ITO film deposited at 400°C.



SEM and TEM images and SAED pattern of ITO film deposited at 400°C.

Nanocrystalline semiconductor oxide films as photoanodes in Dye Sensitized Solar Cells

Nanocrystalline thin films were potentiostatically electrodeposited at -1.0 V (vs Ag/AgCl) on transparent tin oxide conducting glass substrates in the presence of the ionic liquid (IL) 1-butyl-3-methylimidazolium methylsulfate, [bmim][CH_3SO_4] and sodium dodecyl sulphate (SDS). Due to large micellar formations by the complexation of bmim⁺ with SDS anions, the grain size of the deposited ZnO film is reduced from 85 to 28 nm. This is a promising approach to achieve nanocrystalline as well as porous ZnO films with controlled morphology and can be used as nanostructured transparent conducting electrodes for DSSC.



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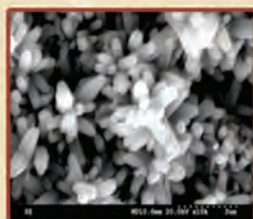
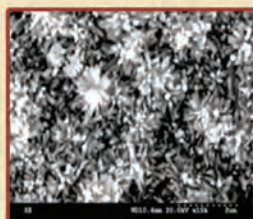
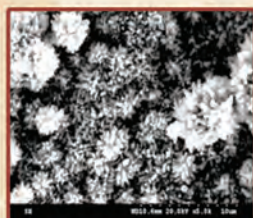
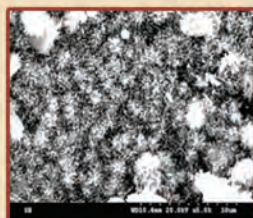


ZnO/dye electrode Counter electrode

Simple fabrication of DSSC

PSi-ZnO by pulse electrodeposition

ZnO thin films were deposited on porous silicon by the pulsed electrodeposition (PED) process, using zinc nitrate as precursors and KNO_3 as supporting electrolyte. The Porous silicon substrates were formed by electrochemical anodization on p-type (100) silicon wafer. The surface morphologies were determined using Scanning electron microscopy and the grain size of the ZnO was around 10 to 30nm. The Optical measurement were made on samples deposited on ITO through the same procedures giving a band gap of 3.3.eV, refractive index of 2.004 and the film was found to have 80% of transmittance in the wavelength range of 400-2000 nm in agreement with the reported values of ZnO.



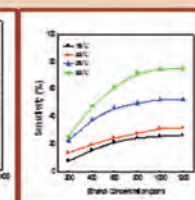
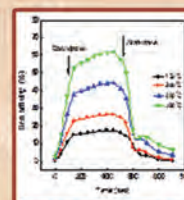
SEM images of the ZnO thin films on PSi by PED

Gas Sensing Properties of SnO_2 Nanoparticles

Fine SnO_2 nanopowders were produced by simple combustion route. As found from XRD line broadening, the crystallite sizes of all powders was in the nanometric range, which is confirmed by TEM. The influence of preparation temperature on gas response of SnO_2 -based ethanol gas sensors is studied.



HRTEM of SnO_2 nanoparticles



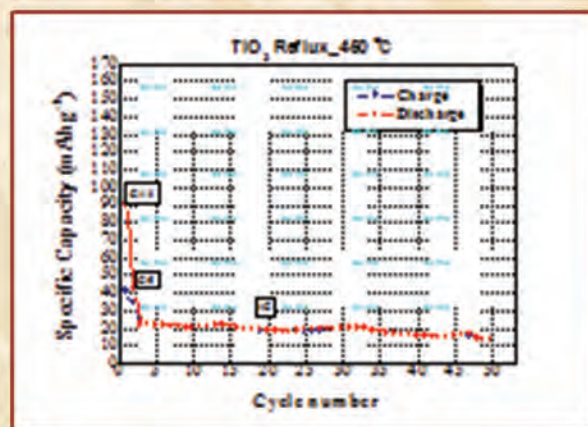
(a)

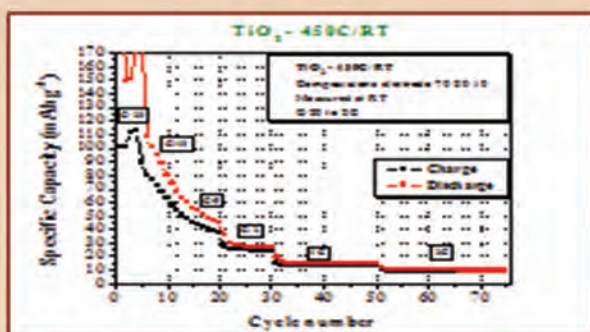
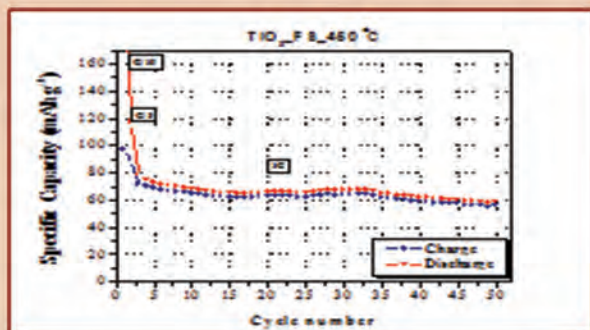
(b)

(a) Transient response curve
(b) sensitivity curve of gas sensor

Next generation TiO_2 -lithium ion batteries

Recently TiO_2 based materials have also been demonstrated as potential anode material in rechargeable lithium ion batteries. In our study, TiO_2 synthesized by hydrothermal method was used to construct TiO_2 -lithium ion batteries



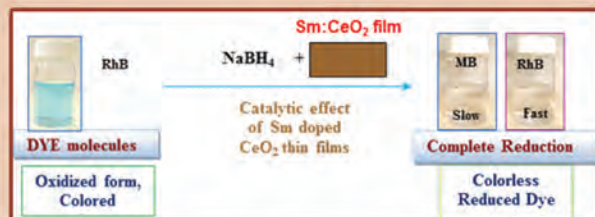


Charge-discharge curves of TiO_2 electrodes at different conditions

The figure above shows the charge-discharge curves of TiO_2 electrodes at C/20, C/10, C/5, C and 2C-rates synthesized at different conditions. The high rate cycling of lithium cells is one of the most important electrochemical characterizations which are required for high power storage applications.

Fabrication of catalytically active nanocrystalline samarium doped cerium oxide (CeO_2) thin films using electron beam evaporation

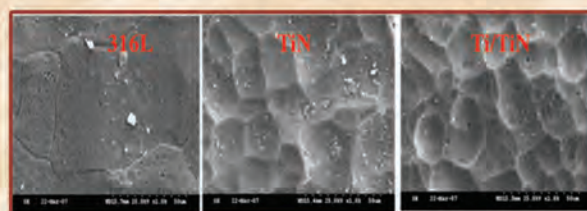
Samarium doped cerium oxide (CeO_2) thin films were fabricated by electron beam evaporation techniques. The synthesized films were deposited either on glass or ITO substrate and studied their nature by annealing at different temperatures. The Samarium doped CeO_2 nanomaterials acts as a re-usable catalyst for the reduction of organic dye molecules in presence of NaBH_4 .



Catalytic application of Sm-doped CeO_2 thin films

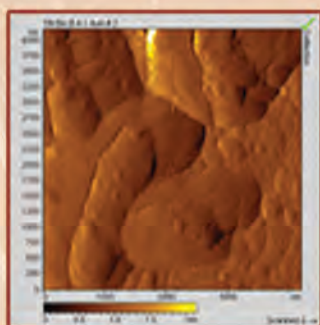
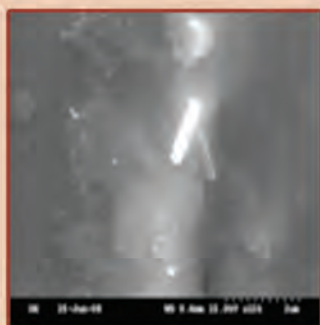
Biosynthesis of calcium hydroxylapatite coating on Sputtered Ti/TiN nanomultilayers and their corrosion behavior in simulated body solution

Titanium/titaniumnitride (Ti/TiN) nanoscale multilayered films were deposited onto 316L stainless steel substrates by reactive magnetron sputtering using a Ti target. Platelet adhesion experiments were carried out to examine the interaction between blood and the materials in vitro.



SEM micrographs of the adherent blood platelets on the 316L substrate, TiN coating, and Ti/TiN coating.

The results indicated that the smoothness and lower isoelectric point contribute to better hemocompatibility of the Ti/TiN nanoscale multilayered coating. The biomediated synthesis of calcium hydroxylapatite was carried out on coated substrates using calcium-depositing bacteria. The observation of low corrosion current density (I_{corr}) for the calcium HA-coated Ti/TiN specimens in simulated body fluid confirmed their highly resistive nature under the testing condition.



SEM & AFM pictures showing bio film formation

(B) Publications & Patents

- Deposition and optoelectronic properties of ITO ($\text{In}_2\text{O}_3:\text{Sn}$) thin films by Jet Nebulizer spray (JNS) pyrolysis Technique.
N. Sethupathi, P. Thirunavukkarasu, V.S. Vidhya, R. Thangamuthu, G.V.M. Kiruthika, K. Perumal, Hari C. Bajaj, M. Jayachandran.
J. Mater. Sci. Electronics 23 (2012) 1087 – 1093.
- Facile Low-Temperature Synthesis of Ceria and Samarium-Doped Ceria Nanoparticles and Catalytic Allylic Oxidation of Cyclohexene.
N. Sutradhar, S. Pahari, Hari C. Bajaj, A. Sinhamahapatra, M. Jayachandran, A.B. Panda, Balasubramanian.
J. Phys. Chem 115 (2011) 7628-7637.
- Allylic and benzylic oxidation over Cr (III) –incorporated mesoporous zirconium phosphate with 100% selectivity.
A. Sinhamahapatra, N. Sutradhar, S.K. Pahari, P. Pal, H.C. Bajaj, M. Jayachandran, A.B. Panda
Chem Cat Chem 3 (2011) 1447-1450.
- Influence of RF power on the growth mechanism, preferential orientation and optoelectronic properties of nanocrystalline ITO films.
T. Balasubramanian, V.S. Vidhya, V. Malathy, V. Saaminathan, C. Sanjeeviraja, M. Jayachandran
Curr. App.Phys. 11 (2011) 286-294.
- Photoluminescent studies on porous silicon/tin oxide heterostructures.
V.S. Vidhya, K.R. Murali, B. Subramanian, P. Manisankar, C. Sanjeeviraja, M. Jayachandran.
J.Alloys.Comp 509 (2011) 2842–2845.
- Development of porous silicon matrix and characteristics of porous silicon/tin oxide structures
V.S. Vidhya, P. Padmavathy, K.R. Murali, C. Sanjeeviraja, P. Manisankar, M. Jayachandran.
J. Non-Crystal. Solids 357 (2011) 1522–1526.
- Electrodeposition and properties of nano crystalline ZnO films prepared in the presence of anionic surfactant SDS and ionic liquid 1-butyl-3-methylimidazolium methylsulfate.
V.S. Vidhya, J. Vatsala Rani, A. Ratheesh Kumar, R. Thangamuthu, K.R. Murali, M. Jayachandran.
J. Mater Sci: Mater Electronics 22 (2011) 1460-1465.
- Synthesisation, characterization and gas sensing properties of SnO_2 nanoparticles.
A. Ayeshamariam, C. Sanjeeviraja, M. Jayachandran.
Int. J Chem. Analy.Sci. 2 (2011) 54-61.
- Thickness dependence of structural, electrical and optical properties of sputter deposited indium tin oxide Films
S. Sivaranjani, V. Malathy, J.J Prince, B. Subramanian, T. Balasubramanian, C. Sanjeeviraja, M. Jayachandran, V. Swaminathan.
Advanced Science Letters 3 (2010) 1–8.
- Defect engineering and opto electronic property modifications by 1.5 MeV Li^+ implantation on nano crystalline MgIn_2O_4 thin films
A.M. Ezhil Raj, T. Som, M. Jayachandran, C. Sanjeeviraja
Radiation effect defects Solids:165 (2010) 265–276.



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11. Structural and optical properties of indium tin oxide (ITO) thin films with different compositions prepared by electron beam evaporation.

V. Senthilkumar, P. Vickraman, M. Jayachandran, C. Sanjeeviraja.

Vacuum 84 (2010) 864–869.

12. Spray deposition and property analysis of anatase phase titania (TiO₂) nanostructures.

A.M. Ezhil Raj, V. Agnes, V. Bena Jothy, C. Ravidhas, Joachim Wollschläger, M. Suendorf, M. Neumann, M. Jayachandran, C. Sanjeeviraja.

Thin Solid Films 519 (2010) 129–135.

Patent:

Filed: 1

Title: A method of depositing corrosion resistant and nano particle strengthened coatings on steel substrates (Ref No. 0031NF2011 Dated 10.02.2012)

(C) Technology Developed / Transferred :

Sputtering of metallic nitrides and metals on synthetic chemical stones for ornamental usage.

(D) Any other important information

Industry Oriented Technology Course:

Surface coatings by physical vapour deposition (PVD), chemical vapour deposition (CVD) and surface analyses.

Duration : 5 days (21.11.2011 to 25.11.2011)



Conducting polymer paints and coatings for corrosion protection of metallic and concrete structures and shielding of concrete structures in strategic areas

Principal Investigator : Dr. S. Sathiyarayanan

Duration: 2007 – 2012.

Objectives

To develop conducting polymer paints and coatings for corrosion protection.

Progress highlights

(A) Salient Results & Conclusions

(i) Corrosion protection of iron by tungstate doped polyaniline containing coatings

Polyaniline containing organic coatings are found to protect steel in acid and neutral media. Since dopants play an important role in the protection ability of polyaniline, a study has been made on the corrosion protection performance of tungstate doped polyaniline containing vinyl coating in 3% NaCl by open circuit potential and impedance measurements. The tungsted doped PANI was synthesized by chemical oxidative polymerization. It has been found by FTIR studies that tungstate doped PANI contains both benzenoid and quinoid moieties. TGA studies indicates that tungstate doped PANI undergoes three staged thermal decomposition. Vinyl coatings were formulated with tungstate doped polyaniline and are found to offer corrosion protection for steel in sodium chloride solutions. The open circuit potential values remain in noble region which indicates the formation of passive film by the redox activity of PANI as confirmed by the FTIR studies. Besides, the formation of iron- tungstate complex has also been found to reinforce the corrosion protection of iron.



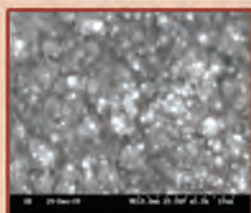
Photograph of tungstate doped PANI incorporated paint coated panels exposed to Salt spray

(ii) Electrosynthesis of PANI-nano TiO_2 composite coatings on steel and its corrosion protection performance

PANI-nano TiO_2 composite coatings on a steel electrode have been electrosynthesized from aniline in aqueous oxalic acid solution containing nano TiO_2 using cyclic voltammetry. Formation of the PANI- TiO_2 coating was found to be strongly dependent on the number of cycles. Smooth and strongly adherent PANI- TiO_2 coatings were obtained during sequential scanning of the potential region between -0.5 to 1.6 V, at a scan rate of 10 mV/s. During the repetitive cyclic voltammetry scans the presence of TiO_2 nanoparticles inhibits the polymer oxidation process. Good adhesion of composite coatings on the steel electrode, with superior electro-active characteristics in comparison with pure poly aniline, was demonstrated. PANI- TiO_2 coatings were characterized by FT-IR, SEM, and XPS techniques. The corrosion behaviour of coated steel was investigated by electrochemical impedance spectroscopy and Tafel studies in 1% NaCl solution and it was found that the PANI- TiO_2 coating was found to be more corrosion resistant than that of pure PANI coating due to compact coating formation.



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SEM micrograph of PANI - nano TiO₂ coating on steel

(B) Publications & Patents

1. Electrosynthesis of polyaniline-molybdate coating on steel and its corrosion protection performance.

V. Karpakam, K. Kamaraj, S. Sathiyarayanan, G. Venkatachari, S. Ramu.
Electrochim Acta, 56(2011) 2165-2173.

2. Synthesis of oxalate doped polyaniline and its corrosion protection performance.

K. Kamaraj, T. Siva, S. Sathiyarayanan, S. Muthukrishnan, G. Venkatachari.
J. Solid State Electrochem., 16 (2012) 465.

3. Synthesis of tungstate doped polyaniline and its usefulness in corrosion protective coatings.

V. Karpakam, K. Kamaraj, S. Sathiyarayanan, S. Syed Azim, G. Venkatachari.
Electrochim Acta 56 (2011) 9262.

4. Electrosynthesis of PANI-nano TiO₂ composite coating on steel and its anti-corrosion performance.

V. Karpakam, K. Kamaraj, S. Sathiyarayanan.
J. Electrochemical Soc., 158 (2011) C416-C423.

Papers presented in conferences

1. Synthesis of poly-o-phenylene diamine nano capsules Using β -cyclodextrin and its anticorrosion performance.

T. Siva, S. Sathiyarayanan.
CORCON2011, 28-30 Sept. 2011, Mumbai.

2. Electrosynthesis of PANI-nano SiO₂ composite coating on steel and its anti-corrosion performance.

V. Karpakam, K. Kamaraj, S. Sathiyarayanan.
CORCON 2011, 28-30 September 2011, Mumbai.

3. Corrosion protection performance of PANI nano Fibers.

V. Karpakam, K. Kamaraj, T. Siva, S. Sathiyarayanan.
International Symposium on surface Protective Coatings during 7- 9 Dec 2011.

4. Self healing hardener free coating containing PANI.

T. Siva, K. Kamaraj, V. Karpakam, S. Sathiyarayanan.
International Symposium on surface Protective Coatings, 7- 9 Dec 2011.

5. Template-free synthesis of hollow sphere of conducting-polymer and its anticorrosion performance.

T. Siva, K. Kamaraj, V. Karpakam, S. Sathiyarayanan.
Presented at the Conference on Engineering coatings ENGGCOAT-2012, IIT Mumbai, Feb 9-11, 2012.

6. Electrodeposition of poly (2-ethylaniline) and poly (aniline-co-2-ethylaniline), polyaniline on steel surfaces and their corrosion protection performance on steel surfaces and their corrosion protection performance.

V. Karpakam, K. Kamaraj, T. Siva, S. Sathiyarayanan.
Conference on Engineering coatings ENGGCOAT-2012, IIT Mumbai during Feb 9-11, 2012.

(C) Technology Developed / Transferred

High performance PAP system for steel structures has been licensed to M/s Krishnaconchem Pvt. Ltd., Mumbai

(E) Honours/ Recognition of the Project Staff

Dr. S. Sathiyarayanan, Senior Principal Scientist was awarded the Third AKZO NOBEL Excellence Award for Coating Research & Promotion 2011-12 by the Society for Surface Protective Coatings India during the International Symposium on surface Protective Coatings (7- 9 Dec 2011).



Hydrogen Energy: Overcoming materials challenges for the Generation, storage and conversion of hydrogen using fuel cells

Principal Investigator : Dr. G. Sozhan

Duration : 2008 – 2012.

Objectives

Development and demonstration of 25 kW (5Nm³/hr Hydrogen) PEM based water electrolyser.

Progress highlights

(A) Salient Results & Conclusions

(i) *Development of suitable flow field design for reactant feed and their performance evaluation*

A serpentine flow channel has been designed, CFD analysis was carried out and the simulation has also been done. The CFD model is verified by comparing the simulation results with the reference results (Jianhu, 2010). The resultant pressure drop value of the simulations for different flow rates are nearly coinciding with the reference data with a negligible (+/-) error. The simulation data is compared the reference data.

(ii) *Development of suitable alternate material for bipolar plates and their surface modification for water electrolysis*

Titanium is chosen as the material for making bipolar plates since it is highly corrosion resistant in the water electrolysis environment, strength to weight ratio is higher than other metal/alloys. But the passivation is problem, which gives rise to increase in electrical resistance which reflects in the cell voltage. Hence the surface of the titanium is coated with platinum by reduction method and sintered in the furnace. The coating on the titanium improves the performance of the electrolyser. Aluminium is one of the metals having a very good electrical conductivity, light weight cheaper than titanium but passivation would be the problem again. Gold coating has been given to avoid passivation. When assembled the plate bends. Structural stability is the problem. Performance of the electrolyser reduced while operating continuously.

(iii) *Development of new coating method for cathode catalysts for hydrogen evolution reaction*

Platinum catalyst prepared by reduction of hexachloroplatinic acid with sodium borohydride in the presence of non-ionic surfactant (polyethylene glycol tert-octyl phenyl ether) and in the absence of surfactant.. Tri-distilled water is used in this work to prepare lyotropic liquid crystal. The concentration of surfactant used was 30% by wt. For the templates to deposit platinum, the water phase is substituted by 5% by wt. H₂PtCl₆ aqueous solutions. Equilibration of the samples is accomplished by repeatedly stirring. The specific surface area is determined from the charge associated with the hydrogen adsorption and desorption process. The specific surface area was found to be 1.5 m²/g for Pt prepared in the absence of surfactant medium and 38 m²/g for Pt prepared in the presence of surfactant medium.

(iv) *Development of 25 kW PEM electrolyser*

Cell hardware were fabricated, the cell stack was assembled and operated for evaluation.





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(B) Publications

1. Sulfonated Poly (Ether Ether ketone) Based Composite Proton - Exchange Membrane for Energy Production.

S. Seetharaman, G. Sozhan, S. Ravichandran, S. Vasudevan, D.J. Davidson.
Inte.J.Polym.Mater 60 (2011) 742-753.

2. Polyvinyl alcohol based membrane as separator for alkaline water electrolyser

S. Seetharaman, S. Ravichandran, D.J. Davidson, S. Vasudevan, G. Sozhan.
Separ. Sci. Tech 46 (2011) 1563-1570.

3. Sulfonated Polystyrene - block - (ethylene - ran - butylene)-block-polystyrene (SPSEBS) membrane for sea water electrolysis to generate hydrogen

S. Ravichandran, R. Balaji, B. Suresh Kannan, S. Elamathi, D. Sangeetha, J. Lakshmi, S. Vasudevan, G. Sozhan
ECS Trans 33(27)157-166 (2011).

4. Development and performance evaluation of proton exchange membrane (PEM) based hydrogen generator for portable applications.

R. Balaji, N. Senthil, S. Vasudevan, S. Ravichandran, S. Mohan, G. Sozhan, S. Madhu, J. Kennedy, S. Pushpavanam, M. Pushpavanam.
Int. J. Hydrogen Energy 36 (2011) 1399-1403

(C) Technology Developed / Transferred



Technology on PEM based hydrogen generator was transferred to M/S Eastern Electrolyser P Ltd New Delhi (May 2011)



Cecri Foundation day Lecture delivered Dr.S. Sundarrajan, Director, NIT Trichy.



Fabrication of LED Devices and Systems for Solid State Lighting Applications

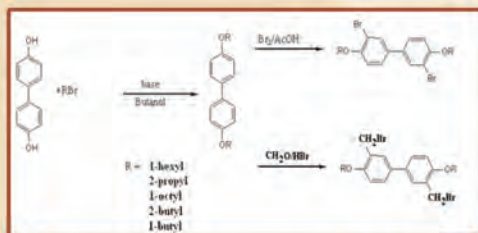
Principal Investigator : Dr D. Jeyakumar
Duration : 2007 – 2012.

Objectives

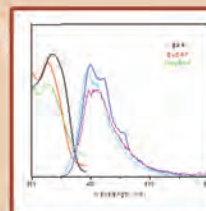
- ❖ Preparation of functional monomers based on benzene, biphenyl, diphenyl methane and other aromatic moieties.
- ❖ Preparation of alternate block copolymers .
- ❖ Random co-polymerisation of the functional monomers.
- ❖ The chemical spectral characterisation of these polymers by GPC, optical absorption & emission spectral methods.

Progress highlights

- ❖ Polymers having PL from blue to green region have been synthesized. The materials have the molecular weight in the range of 8000 to 18000 Daltons. The PL studies on the film of these materials were also carried out and indicated that these materials can be used as the photoemissive layer for PLED.
- ❖ Synthesis of functionalized monomers using phenyl, biphenyl, fluorene, naphthalene derivatives were carried out (image below). The functional monomers were characterized using FTIR and NMR spectral data.



- ❖ Synthesis of polymers from these functionalized monomers were carried out using Wittig's reaction, Suzuki coupling reaction and Heck coupling reactions. These polymers were characterized using gel permeation chromatography (GPC), Optical absorption and emission spectroscopy, FTIR, ¹H NMR spectral methods. The quantum yields of emission of these polymers in solution were calculated using quinine sulphate as the standard and found to be 0.80.

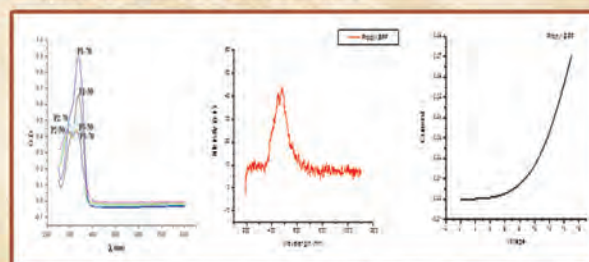


Synthesis of functionalized graphene (FG) and solution processable graphene (SPG)

Compound	$\lambda_{abs}(soln.)$	$\lambda_{emis}(soln.)$	Φ	$\lambda_{abs}(film)$	$\lambda_{emis}(film)$
P1	325 nm	385 nm	0.78	340 nm	400 nm 424 nm 456 nm
P2	325 nm	387 nm	0.75	327 nm	394 nm 415 nm
P3	325 nm	390 nm	0.65	327 nm	404 nm

Optical absorption and emission data of polymers

- ❖ These polymers in the form of thin films were studied for their absorption characteristics. The alkyl chains attached to the biphenyl group seem to have significant variation on annealing of the films. For octyl side chains there was an increase in the optical absorbance values indicating that there is decrease in the path length and branched chains increase did not have significant change in the optical absorbance values on annealing.
- ❖ The EL of one set of polymers (poly (dialkoxybiphenyl fluorene system with varying alkyl group side chain)) have been attempted. Poly(4,4'-(2-propoxy biphenyl) fluorene was found to emit in the blue region. The i-V characteristic of the PLED was also studied. However, it is worthy to note that the system is not highly efficient. The other polymers of the series showed feeble EL, in spite of similar i-V behaviour.



Optical absorption spectra of poly (EL and i-V characteristics of thin film of dialkoxybiphenyl fluorene) P1=Octyl, Poly(2,2'-(4,4'-propoxy biphenyl)-2,7-(9,9-dihexyl fluorene) P2=1-butyl and P3=2-butyl derivatives.

(B) Publication

Synthesis, characterization and optical properties of poly (4,4'dioctyloxy-3,3'-biphenylene vinylene) copolymer
V. Sannasi, B.G. Sundararaj, S. Meenakshi, D. Jeyakumar. Iran. Polym. J. 20 (2011) 633-644.



NWP-0035

Nanomaterials and nanodevices for application in health and disease

Principal Investigator : Dr. Sheela Berchmans

Duration: 2008 - 2012.

Objectives

- ❖ Synthesis of Au, Pt nanoparticles and design of electrochemical sensors based on these nanomaterials for glucose, lactate, nitric oxide and ethanol.
- ❖ Bio-assisted preparation of metal nanoparticles (Au and Ag) and investigations of their bio-conjugation properties for cell tracking and as biomarkers.
- ❖ Design of nitric oxide releasing materials- Molecular nanoreactors such as zeolites PAMAM dendrimers will be evaluated for the preparation.

Progress highlights

(A) Salient Results & Conclusions

1. Preparation of Au nanoparticles through chemical method

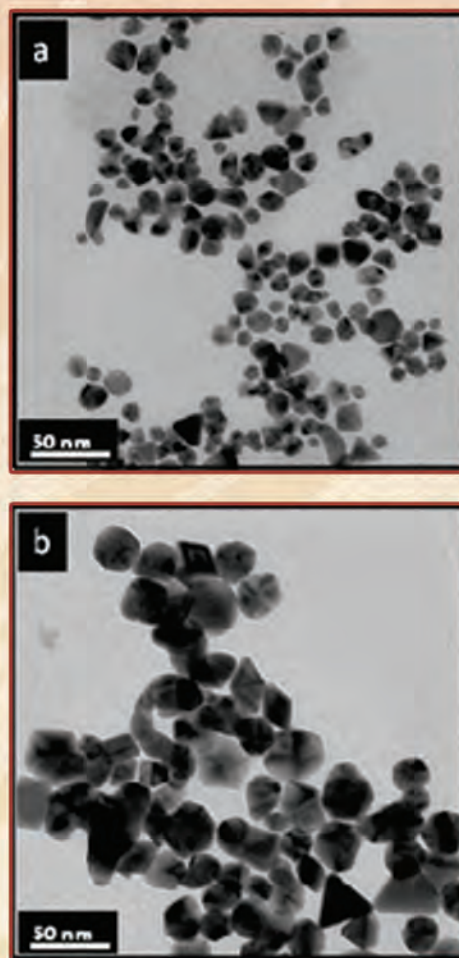
Gold nanoparticles stabilized by histidine (3 nm), 2-mercapto-5-nitro benzimidazole (10 nm) chitosan (50 nm) and citrate (20 nm) are prepared by chemical method using and are characterized by TEM. The different gold nanoparticles are used for different applications

- a) Au-histidine- Building unit for modification, signal amplification
- b) Au-2-mercapto-5-nitro benzimidazole – Nitric oxide release
- c) Au-chitosan and Au-citrate - for controlled nitric oxide release from nitrosothiols

Synthesis of Shape Specific Gold Nanoparticles

Gold nanoparticles (GNPs) synthesis was carried out using amino acids such as aspartic acid, cysteine, glutamic acid, histidine etc. It is well known that amino acids can bind with many heavy and transition metals. Hence, we wanted to explore the possibility of developing electrochemical heavy metal ion sensing using amino acid functionalized GNPs.

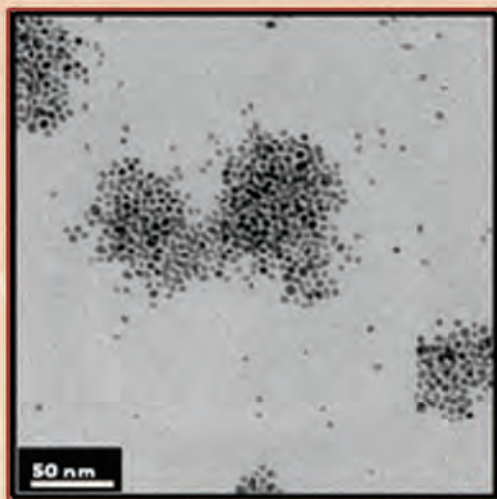
Shape specific (triangle or hexagonal) GNPs were obtained when glutamic acid or aspartic acid was used as a capping agent evident from transmission electron micrographs.



Transmission electron micrographs of gold nanoparticles stabilized by a) glutamic acid b) aspartic acid



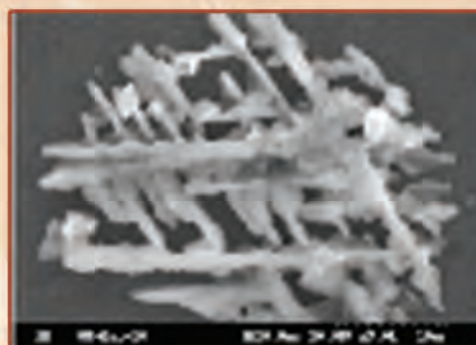
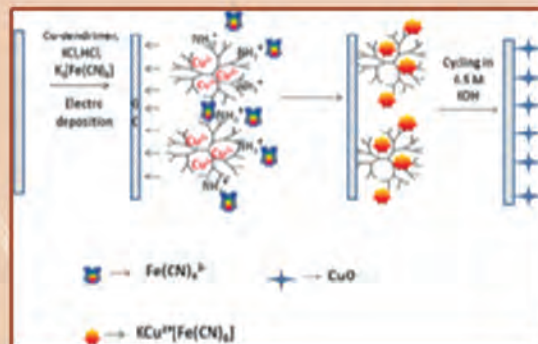
Spherical GNPs with relatively uniform size were obtained when histidine was used as a stabilizer. Electrochemical sensing and fine tuning of synthetic protocol are in progress to obtain a particular, instead of irregular shaped particles, shape GNPs.



Transmission electron micrographs of gold nanoparticles stabilized by histidine

2. Copper oxide-modified glassy carbon electrode prepared through copper hexacyanoferrate–G5-PAMAM dendrimer templates as electrocatalyst for carbohydrate and alcohol oxidation

Modification of glassy carbon electrode by electro-deposition of copper hexacyanoferrate (CuHCF) in the presence of an amine-terminated dendrimer (PAMAM) as a template is described here. The electrode containing the CuHCF template was cycled in alkaline solution to generate a layer of cupric oxide (CuO). Scanning electron microscopy reveals that the CuO prepared by this method has a meso-porous grid-like appearance. The ability of the CuO film towards the electrocatalytic oxidation of carbohydrates and alcohols was detected using cyclic voltammetry. Simple methodology has been adopted in this work for the preparation of the catalytically active electrode, and this work also explains the structure directing effect of dendrimer and its influence on the electrocatalytic oxidation of analytes.



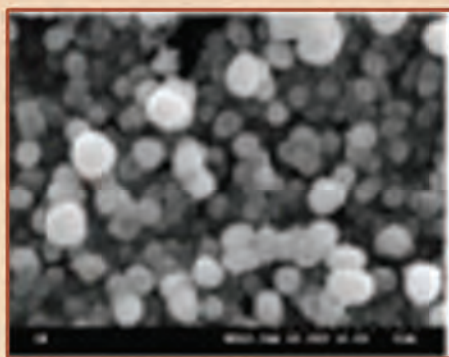
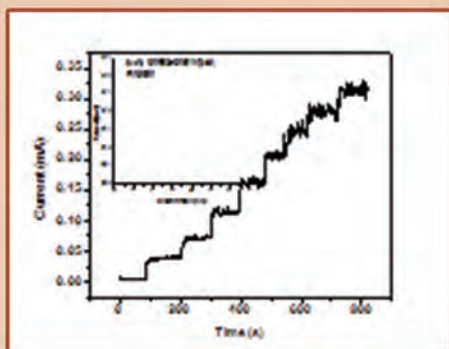
3. CuO Microspheres Modified Glassy Carbon Electrodes as Sensor Materials and Fuel Cell Catalysts

This work describes the electrocatalytic oxidation of glucose on CuO microspheres prepared by initially depositing copper galvanostatically from an optimized sulfate bath on glassy carbon (GC) surface and subsequently subjecting the Cu deposits to potential cycling in 0.1 M KOH. The electrochemical behaviour and electro catalytic activity of the electrode were characterized using cyclic voltammetry (CV) and chronoamperometry. Anodic oxidation current density was found to be 0.0496 mA cm⁻² for 1 mM of glucose. Modified electrode was validated as a sensing matrix by carrying out invitro analysis of glucose in human blood serum and in the anolyte of the microbial fuel cell (MFC).

The CuO/GC electrode shows very good sensitivity (709 mA M⁻¹ cm⁻²) and excellent linearity (R = 0.998). Our results present the scope of using CuO modified GC substrate as non-enzymatic glucose sensor for invitro analysis and as an electrocatalyst for fuel cell application.

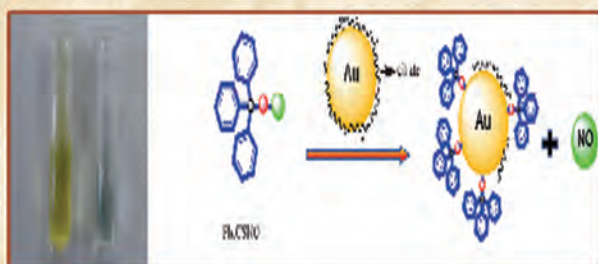


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4. Naked eye detection of nitric oxide release from nitrosothiols aided by gold nanoparticles

In this work we have demonstrated that nitric oxide can be monitored spectrophotometrically using cyclodextrin encapsulated ferrocene. The detection course showed the colour change from yellow to blue which can be detected with the naked eye. Also we describe the catalytic effect of gold nanoparticles in enhancing nitric oxide release from S-nitrosothiols.



(B) Publications

1. Naked eye detection of nitric oxide release from nitrosothiols aided by gold Nanoparticles.
S. Priya, T. Kaviyarasan, Sheela Berchmans.
Analyst, 2012, 137,1541 (IF=3.9).
2. Highly sensitive detection of proteins using voltammetric assay in the presence of Silver nanostructures.
L. Bhavani Devi, Sheela Berchmans, A.B. Mandal.
J. Electroanal. Chem. 665 (2012) 20–25.
3. CuO microspheres modified glassy carbon electrodes as sensor materials and fuel cell Catalysts.
S. Priya and Sheela Berchmans,
J. Electrochem. Soc. (2012) 16,1527-1535.
4. Copper oxide-modified glassy carbon electrode prepared through copper hexacyano ferrate– G5-PAMAM dendrimer templates as electrocatalyst for carbohydrate and alcohol oxidation.
S. Priya, Sheela Berchmans.
J Solid State Electrochem, 16 (2012) 1527-1535 (IF=1.822).

Patent filed

1. A method of detection of nitric oxide(NO) by electrochemical reducio and the development of NO monitor by Sheela Berchmans, S.Vincent, S.Varatharajan and V.Yegnaraman (Reference no 0117NF2011)



NWP-054

Development of low cost, large area fabrication of solar cell by simple coating technique on steel / plastic substrate [Organic Photo-voltaics (OPV) - Solar Paint (SP)]

Principal Investigator : Dr. M. Selvaraj

Duration : 2011- 2017.

Objectives

The main objective of the project is to develop cost effective OPV paint, DSSP and QDSSP. The conjugated polymer, p-n type semiconductors and dye will be characterized by various techniques like FTIR, UV-VIS, SEM, TEM, AFM, porosity measurements, etc. The formulated photovoltaic paint will be tested for its physical characteristics like density, viscosity, fineness of dispersion etc. The performance of the developed photovoltaic paint will be evaluated by Solar simulator.

Progress highlights

(A) Salient Results & Conclusions

Graphene based materials for Transparent Conductive films (TCFs)

Indium tin oxide (ITO) is used as anode for organic solar cells. High quality ITO is expensive. The cost of ITO is almost 30% of the total cost of solar cells. ITO also suffers from drawbacks like brittleness, sensitivity to acids and bases during processing.

Graphene films have been proposed as the new generation of multifunctional, transparent, and conducting electrodes. The attractiveness of graphene arises from its low cost, transparency, high electrical conductivity, chemical resistance and flexibility. Graphene may be used as anode instead of ITO for organic solar cells. Solution based graphene was prepared and coated on PET/PU substrate by spray coating method and characterized.

Synthesis of functionalized graphene (FG) and solution processable graphene (SPG)

Graphite oxide (GO) was synthesized by Hummer's method.

Sulphonation:

GO, prepared by Hummers method, was redispersed in distilled water and sonication was carried out to obtain brown dispersion. The sulfonation process was carried out to obtain S-rGO in three steps as given below:

- Pre-reduction of GO with sodium borohydride (reducing agent).
- Sulfonation of rGO with diazonium sulphonate salt and
- Post reduction with hydrazine hydrate solution.

Then S-rGO was dispersed in distilled water and reduced by hydrazine hydrate (N_2H_4) to remove the remaining oxygen moieties.



CSIR-CECRI ANNUAL REPORT 2011-2012

NWP-056 (TAPSUN)

Innovative Solutions for Solar Energy Storage

Principal Coordinator : Dr. S. Gopukumar

Duration: 2011 – 2017.

CSIR – CECRI Team:

Dr. D. Velayutham,
Er. S. Ambalavanan,
Dr. I. Arul Raj,
Dr. S. Dheenadayalan,
Er. M. Ramakrishnan,
Dr. P. Periasamy,
Dr. A. Sivashanmugam,
Dr. M.V. Ananth,
Dr. M. Raju,
Dr. T. Prem Kumar,
Dr. M. Ganesan,
Dr. N. Kalaiselvi,
Dr. A.M. Stephan,
Dr. V. Suryanarayana,
Dr. M.V.T. Dhananjayan,
Dr. D. Kalpana,
Dr. A.S. Prakash,
Dr. K. Ramesha,
Dr. M. Anbukulandainathan,
Dr. C. Sivakumar,
Dr. R. Thirunakaran.

Objectives

Short Term Deliverables

New Patentable Materials for SPV Energy Storage
Maintenance Free SPV Lead Acid Battery

Mid Term Deliverables

Efficient light weight lead-acid battery
Lithium-ion battery for LED lights in farmers cap
Super-capacitor

Long Term Deliverables

Zinc Bromine Battery
Electrode Materials for Lithium Air Battery
Electrode Materials for Lithium Microbattery



Visit of Science Enthusiasts during CECRI-Open Day



Development & Demonstration of PEFC Stacks for Stationary Applications

Principal Investigator : Dr. S. Pitchumani

Sponsor : CSIR - New Millennium Indian Technology Leadership Initiative scheme (NMITLI).

Duration: 2010 - 2012.

Objectives

- ❖ Development of kW level PEFC stacks using in-house components.
- ❖ Cost reduction and material optimization for achieving reduction in weight and volume for customized applications ensuring high performance.
- ❖ Evaluation of durability characteristics of the MEAs and failure mode analysis; examine critical parameters which cause performance degradation under simulated operating environments.

Progress highlights

(A) Salient Results & Conclusions

Performance of PEFC stack comprising MEAs with catalyst coated membrane using Decal process

A 16-cell PEFC stack (NAF-3) comprising of NCL-MEAs with catalyst coated onto the membrane by decal process is assembled and tested using hydrogen and oxygen at 60 °C and ambient pressure. Durability test is carried out at a constant current of 50 A for 50 h. The power and voltage output during the period of testing is fairly constant.

Reproducibility in performance of NAF-1 and NAF-3 stacks

Reproducibility in performance of a single cell to that in a multi-cell stack and reproducibility in performance of multi-cell stacks with hydrogen and oxygen/air are evaluated. The performance is reproducible. Scale-up of single cell to multi-cell has not affected the performance.

The average cell voltage and the power density for H₂-O₂ and H₂-air, respectively are 0.655 and 0.6 V, and 290 and 240 mW/cm², for NAF-1 and NAF-3 stacks. Durability study on NAF-1 stack is performed for 500 h with hydrogen and air at a constant current of 35A. The cell voltage of all the cells is fairly constant during the course of the durability test.

Durability study on NAF-2 stack with 20 ppm CO containing H₂ and Air

Single cell performance study was conducted on MEA comprising catalyst layer, containing Pt-Ru on the anode, coated on the membrane by decal process. This MEA is subjected to performance evaluation with hydrogen containing 20 ppm CO and air. Air bleed experiments are conducted by varying the concentration of air fed along with 20ppm CO containing hydrogen into the anode for varying flow rates. The optimum concentrations of air in the air bleed experiments are 1.6% and 2.0% for flow rates of 0.5 and 1.0 slpm, respectively.

A 20-cell PEFC stack comprising of MEAs with Pt-Ru and Pt catalyst coated onto the anode and cathode side of the membrane, respectively by decal process is assembled and tested using hydrogen and oxygen/air at 55 °C and ambient pressure. Durability test of 20-cell NAF-2 PEFC stack comprising MEAs with Pt-Ru and Pt catalyst coated onto the anode and cathode side of the membrane, respectively by decal process is carried out at a constant current of 35 A for 50 h in air bleed mode on the 20ppm CO containing hydrogen side. Air bleed is kept at 2% of the anode flow rate. The power and voltage output during the period of testing is fairly constant.



Design & supply of 5 kW polymer electrolyte membrane fuel cell stack operating on hydrogen and air

Principal Investigator : Dr. S. Pitchumani

Sponsor : TVS Motor Co. Ltd., Hosur.

Duration: 2010 - 2012.

Objectives

To configure and deliver 1 no. of 5 kW polymer electrolyte membrane fuel cell stack operating on hydrogen and air along with balance of plant.

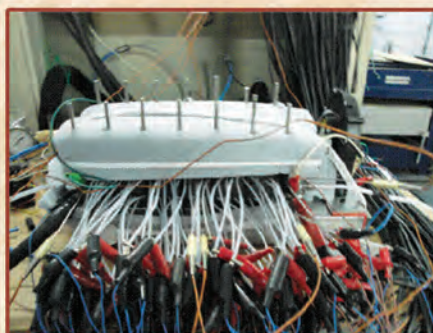
Progress highlights

(A) Salient Results & Conclusions

A 78-cell 1 kW HT PEFC stack of dimension 46 cm x 11 cm x 13 cm with an active single cell electrode area of 45 cm² was configured and tested. The salient feature of the stack is that the flow field for oxidant and coolant are one and the same. Single cell gives an output of ~18 W (0.5 V & 36 A). Stack is operated under bleed mode on hydrogen and blower is used to supply the oxidant. The cell temperature is maintained around 160 °C. The stack is initially heated to 120 °C using 2 nos. of 100W silicone rubber heaters affixed on both the sides of the stack. Silicone based insulation material is used for thermal insulation of the stack. Pressure regulator is used to supply hydrogen at a pressure of 3 psig. A semi-automatic technique is used to cut gaskets for assembly. Photos of the stack are included.



1 kW HTPEFC stack



Testing of 1 kW HT PEFC Stack is in progress



CLP-13-10

Development of GMR materials by electrodeposition technique

Principal Investigator : Dr. S. Mohan

Sponsor : Board of Research in Nuclear Science.

Duration: 2009 - 2012.

Objectives

- ❖ To prepare Co-Ag, Ni-Fe/Cu and Ni-Fe/Ag alloys and multilayer by using Direct current and Pulse Current.
- ❖ To optimize various parameters like current density, On time, Off time and Total time to get the desired Magnetic properties for DC and Pulse Current methods.
- ❖ To deposit alloys to a thickness of 1 micron with each sub layer thickness is in the range 5 nm --- 100 nm.
- ❖ To view the multilayer deposits by using cross sectional SEM and TEM.
- ❖ To study the structure and microstructure using XRD and AFM.
- ❖ To Study the Giant magneto resistance (GMR) for Co-Ag, Ni-Fe/Cu and Ni-Fe/Ag by four probe method.
- ❖ The value of MR ratio aimed will be 4 to 8 %.
- ❖ Correlation between Thickness , annealing and MR ratio will be established
- ❖ An understanding of percentage Composition on the magnetic properties will be investigated thoroughly

Progress highlights

(A) Salient Results & Conclusions

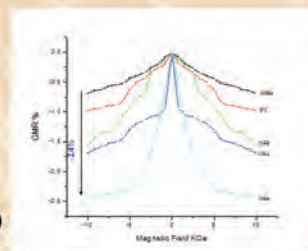
Electrodeposition of Co-Ag alloys by using DC and Pulse plating techniques

Co-Ag alloy films exhibiting GMR properties have been prepared on indium tin oxide coated glass substrate using perchlorate electrolytes solution. In this study, the deposition processes were done using both direct current (DC) and Pulse current (PC) techniques. We have attempted to find correlation between the deposit properties and pulse conditions were made.

The basic electrochemical mechanism of the electrolyte was studied with Cyclic Voltammetry (CV). The structural information of the deposits were investigated using X-ray diffraction technique. The morphology and composition analyses were observed with the help of SEM with EDAX. The ferromagnetic characteristics of the deposits were analyzed using both FMR and VSM studies. The magnetoresistance studies were observed with four probe technique.

Electrolyte composition and conditions

AgClO₄ - 0.01M
Co(ClO₄)₂ - 0.1M
H₃BO₃ - 0.3M
NaClO₄ - 0.1M
C₆H₁₁NaO₇ - 0.1M
Electrolyte pH - 4
Working Electrode- ITO
Counter Electrode - Pt
Current density - 8 mA/cm²
Reference Electrode - SCE



Magnetoresistance values of the deposits varies with frequency. The GMR values are first increased from DC to 10Hz frequency and the values reach maximum when the frequency is increased to 50 Hz. Further increase of frequency from 50 Hz to 100Hz reduces the GMR value. The maximum GMR value -2.4 % is observed at 50Hz deposits. The GMR value depends on the crystallite size as well as magnetic coercivity of the deposits. There is a optimum size for favoring high GMR value. if it comes to lower size GMR % decreases.. The smaller size particles favor the super-paramagnetism which is the killer phase for GMR. So, the reduction in the size due to the frequency change , leads to the deposits from ferromagnetic to super-paramagnetic behavior.



Conclusion

- The Co-Ag electrodeposits exhibit maximum GMR value when the current is pulsed at 100Hz frequency
- The preliminary information's of the electrolytes were observed from the CV studies.
- The X-Ray diffraction spectrum confirms the formation of alloy phase
- Deposits at DC has lowest GMR value due to its higher grain size as well as high coercivity value
- The grain size and crystallite size gets reduced by applying the pulse current.
- Morphological differences affects the GMR behavior

(B) Publications

1. Electrodeposition of Co-Ag alloy films for giant magnetoresistance applications using both DC and pulse techniques,

N. Rajasekaran, S. Mohan, G. Ravikumar, Workshop on Electrochemical Techniques for Nano-Scale Surface Engineering 2012, BARC, Mumbai.



"Nothing is too wonderful to be true if it be consistent with the laws of nature."

- Michael Faraday



CLP-10-11

Energy conversion reactions: fine tuning of electrocatalytic activity through surface manipulation guided by in-situ spectroscopic and microscopic studies

Principal Investigator : Dr. KLN. Phani

Sponsor : Australia-India Strategic Research Fund - Round Five 2010/11 [DST].

Duration : 2011 - 2014.

Objectives

To study the nanoscale electrocatalysis of

(a)Electrochemically generated atomic gold clusters.

(b)Surface electrochemistry of single gold nanocrystals.

(c)Nanoscale segregation on bimetallic electrocatalytic surfaces using both high resolution in-situ spectroscopic and microscopic techniques and highly sophisticated electrochemical techniques.

Progress highlights

(A) Salient Results & Conclusions

i). Copper atomic clusters, which exhibit fluorescent and EPR properties and catalytic activity towards oxygen reduction, have been generated electrochemically. Studies are underway to use this copper cluster –immobilized graphene surfaces for the reduction of CO₂.

ii). Observation of surface segregation of Au-Ag alloy nanoparticles under chemical/electrochemical reduction conditions.

(B) Publications and Patents

[1] Study of methanol-tolerant oxygen reduction reaction at Pt-Bi/C bimetallic nanostructured Catalysts.

A.M. Remona, K.L.N. Phani.

Fuel Cells 11 (2011) 385-393 .

[2] Methanol-tolerant oxygen reduction at Pt-Pd/C alloy nanocatalysts.

A.Mary Remona, K.L.N. Phani.

J.Fuel Cell Sci. & Technol., 2011, 8, Article No.11001.

(E) Honours/ Recognition of the Project Staff

Sl. No	Name	Honor	Institute	Duration
1	C. Jeyabharathi (CSIR-SRF)	DAAD Sandwich Doctoral fellowship	Max-Planck Institute for Iron Research, Dusseldorf, Germany	14 months from June 2011

International collaboration:

"Energy Conversion Reactions: Fine Tuning of Electrocatalytic Activity through Surface Manipulation guided by in-situ spectroscopic and microscopic studies", submitted to *Australia-India Strategic Research Fund (AISRF)* – Round Five 2010/11 (with Prof.Alan M.Bond, Monash University, Australia)



CLP - DST-DAAD Indo German Project

Mechanochemical synthesis and electrochemical characterization of nanostructured ferrite materials

Principal Investigator : Dr. L. John Berchmans

Sponsor : DST-DAAD.

Duration: 2010 - 2012.

Objectives

The main objective of the project is to develop an efficient method for the preparation of nanostructured ferrite materials and their applications in electrochemical technology.

Progress highlights

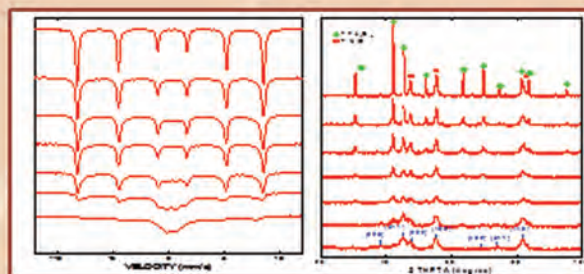
(A) Salient Results & Conclusions

Ferrite materials have been prepared by mechanochemical synthesis and their physicochemical characterization was performed using XRD, Mössbauer spectroscopy and Transmission Electron Microscopy. The preparation of nano materials was performed at the Institute of Physical and Theoretical Chemistry, Braunschweig University of Technology, Braunschweig. The Electrochemical studies were carried out at Electro Pyrometallurgy Division, CSIR-CECRI, Karaikudi.

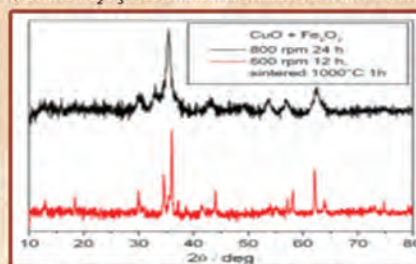
From the above studies, it has been concluded that the synthesized ferrite materials have found potential applications in electro-catalysis.

From the above collaborative research programme, the CECRI Scientists have gained knowledge on the Mechano synthesis of nano structured ferrite materials and their characterization using advanced techniques. German scientists had visited our institute delivered lectures and learnt the Electrochemical characterization of materials at CECRI, Karaikudi.

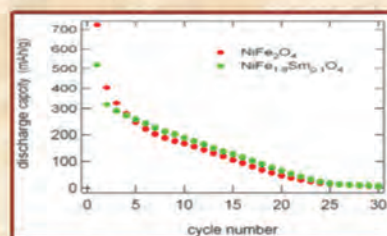
Based on the collaborative research programme, two research papers have been published in reputed foreign journals. The project has been successfully completed in 2011. The output of the collaborative research was fruitful in terms of publications and interactions among the scientists of both Institutes.



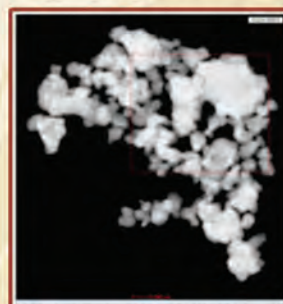
Room-temperature ^{57}Fe Mossbauer spectra (left) and XRD patterns (right) of the $\text{Fe}_2\text{O}_3/\text{NiO}$ mixtures milled for various times



XRD patterns of (top) mechano synthesized CuFe_2O_4 and (bottom) CuFe_2O_4 followed by thermal treatment at 1000°C for 1 h



Specific discharge capacities of NiFe_2O_4 and $\text{NiFe}_{1.9}\text{Sm}_{0.1}\text{O}_4$ as a function of cycle number



TEM image of mechano synthesized NiFe_2O_4 with the average crystallite size of about 10 nm



CSIR-CECRI ANNUAL REPORT 2011-2012



Visit of German Scientists to our Institute on DST-DAAD
INDO-GERMAN JOINT RESEARCH PROGRAM -2009 to 2011

(B) Publications

1. Low-temperature synthesis of lithium manganese oxide using $\text{LiCl-Li}_2\text{CO}_3$ and manganese acetate eutectic mixture,
M. Helan, L. John Berchmans. *Mater. Manuf. Proc.*, 99999, 1, (2011) 1-14.
2. Molten salt synthesis of $\text{LiGd}_{0.01}\text{Mn}_{1.99}\text{O}_4$ using chloride-carbonate melt,
M. Helan, L. John Berchmans, V.S Syamala Kumari, R. Ravi Sankar, V.M Shanmugam,
Mater. Res. Innov. 15, (2011) 130-134.
3. Electrolytic preparation of CaB_6 by molten salt technique,
S. Angappan, M. Helan, A. Visuvasam, L. John Berchmans, V. Ananth,
Ionics, 17 (2011) 527-533.
4. Electrosynthesis of cerium hexaboride using lithium tetra borate melt,
K. Amalajyothi, L. John Berchmans, A. Visuvasam, S. Angappan,
Mater. Manuf. processes, 26 5 (2011) 792-795.
5. Mechanochemical synthesis and electrochemical characterization of nano crystalline calcium ferrite
L. John Berchmans, K. Karthikeyan, M. Helan, Sheela Berchmans, V. Šepelák, K.D. Becker,
Catalysis Letters , 141, (2011) 1451-1457.
6. Non equilibrium Stannates M_2SnO_4 ($\text{M}=\text{Ca}, \text{Zn}$) and their electrochemical behavior,
V. Sepelak, S.M. Becker, S. Indris, H. Halin, L.J. Berchmans, P. Heitjans, K.D. Becker.
7. Synthesis and characterisation of nanocrystalline nickel ferrite using hexamine as a fuel,
R. Parthasarathi, L. John Berchmans, R. Preetha, G. Senguttuvan, G. Umapathy,
Self propa. High Temp Synth. 20, (2011),4.
8. Synthesis of lanthanum nickelate and praseodymium substituted compounds by molten salt technique,
S. Ignatius Arockiam, L. John Berchmans, S. Angappan, A. Visuvasam, V. Mani ,
Mater. Sci Forum. 699 (2012) 167-183.
9. A theoretical estimation of the charge density distribution in the diluted magnetic semiconductors of $\text{Si}_{1-x}\text{M}_x$ and $\text{Ge}_{1-x}\text{M}_x$ ($\text{M}=\text{V}, \text{Mn}, \text{Co}$),
R. A. J. R. Sheeba, R. Saravanan and L. John Berchmans,
Mater. Sci. Forum 699 (2012) 167-183.
10. Structural, optical and magnetic properties of MgFe_2O_4 Synthesised with addition of copper,
S. Angappan, L. John Berchmans,
Synthesis and reactivity in Inorganic, Metal-Organic, and Nano-Metal Chemistry 42 (2012) 121-127.



CLP: Indo-Taiwan Exchange programme

Synthesis and applications of room temperature ionic liquids as quasi electrolytes for DSSCs

Principal Investigator : Dr. V. Suryanarayanan

Sponsor : DST, New Delhi and NSC, Taiwan.

Duration: 2009 - 2012.

Objectives

- ❖ Synthesis of different fluoro organic based ionic liquids containing various anions and cations and their characterization by chemical and electrochemical techniques.
- ❖ Their application as the electrolyte for dye sensitized solar cells (DSSCs).

Progress highlights

(A) Salient Results & Conclusions

Different alkyl substituted imidazolium anions based ionic liquids have been synthesized and characterized at CECRI and the suitability of these ionic liquids had been tested as quasi electrolytes for DSSCs at National Taiwan University, Taiwan.

Among these ionic liquids, 1-ethyl-3-methyl imidazolium nonaflate ionic liquid shows maximum conversion efficiency of 4.63% with VOC of 0.6V and JSC value of 11 mA cm⁻² with fill factor of 0.7 on TiO₂ anode having N719 as dye material and sputtered Pt as the counter electrode under the illumination of 100 mW cm⁻². Other studies related to EIS and electron life times of the injected electrons are in progress.

Indo German

Solution combustion synthesis of high performing Li-ion battery electrode materials and their performance evaluation using pouch cells

Principal Investigator : Dr. A. S. Prakash

Sponsor : Indo German (CSIR-BMBF) Joint project.

Duration: 2011 - 2013.

Objectives

- ❖ To develop and use novel solution combustion synthetic method for the preparation of high performing Li-ion battery electrode materials,
- ❖ In specific cathode materials (i) LiMn₂O₄ (LMO) (ii) LiMn_{1-x}Ni_{1-x}O₂ (MNO) (iii) LiCo_{1/3}Ni_{1/3}Mn_{1/3}O₂ (LNMC) possessing improved performance will be synthesized using simple and cost effective solution combustion method.
- ❖ The anode materials, Li₄Ti₅O₁₂ (LTO) and anatase phase of TiO₂ will also be prepared by solution combustion technique
- ❖ Finally to fabricate and demonstrate the pouch cells using high performing cathode and anode materials

Progress highlights

(A) Salient Results & Conclusions

The cathode material with composition (i) LiMn₂O₄ (LMO) (ii) LiMn_{1-x}Ni_{1-x}O₂ (MNO) (iii) LiCo_{1/3}Ni_{1/3}Mn_{1/3}O₂ (LNMC) possessing desired structure and nano metric size are prepared by modified solution combustion synthesis. The synthesized cathodes materials exhibited improved performance in terms of rate capability and capacity stability.



GAP-25/07

Development of electroanalytical sensors for pesticides analysis

Principal Investigator : Dr. M. Chandrasekaran

Sponsor : Department of Science and Technology, , New Delhi.

Duration: 2008 - 2011.

Objectives

- ❖ Development of electroanalytical sensor for pesticides.
- ❖ Development of portable amperometric sensing instrument for pesticides sensing.

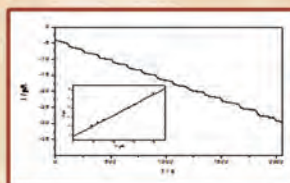
Progress highlights

(A) Salient Results & Conclusions

Sensing of pesticides is very important for environmental protection. Electroanalytical sensors are fast, sensitive, selective and cost effective when compared to other sensors. Methyl parathion, parathion, fenitrothion, imidacloprid, thiamethoxam, malathion, lindane, chlorpyrifos and paraoxon were taken for electrochemical sensing. The major problem associated with the electrochemical analysis is fouling of electrode by adsorption of larger pesticides molecules/products. This problem was overcome by the use of chemically modified electrodes to get reproducible electrochemical responses. The chemically modified electrodes also offer higher sensing current. The following modified glassy carbon electrodes were developed for the analysis of pesticides.

- (1) Nanosilver /nafion composite modified glassy carbon electrode
- (2) NanoTiO₂/nafion modified glassy carbon electrode
- (3) Nanosilver/nafion/TiO₂/nafion modified glassy carbon electrode
- (4) Nanosilver/SDS modified glassy carbon electrode
- (5) Cellulose acetate/TiO₂ modified glassy carbon electrode
- (6) Cellulose acetate modified glassy carbon electrode

These modified electrodes showed excellent electrocatalytic properties in the analysis of the above pesticides. Analytical parameters such as LOD, LOQ and linear dynamic range were estimated by cyclic voltammetry, differential pulse voltammetry and amperometry. Recovery rates for spiked water samples were also estimated. The performance of the above sensing electrodes was also assessed with the analysis of the commercial samples. The electroanalytical method was validated by HPLC. An amperometric sensing instrument was designed, fabricated and tested.



Amperometric response of lindane for the constant addition of 15.4 μ M
Inset shows the calibration graph



Amperometric instrument

(B) Publications

1. A biocompatible nanoTiO₂/nafion composite modified glassy carbon electrode for the detection of fenitrothion.

A. Kumaravel, M. Chandrasekaran.
J.Electroanal.Chem 650 (2011) 163.

2. Electrochemical determination of imidacloprid using nanosilver nafion/ nano TiO₂/nafion composite modified glassy carbon electrode.

A. Kumaravel, M. Chandrasekaran.
Sensors.Actuators. B 158 (2011) 319.



Addressing novel applications of current generation using microorganisms

Principal Investigator : Dr. Sheela Berchmans

Sponsor : Department of Bio-Technology, New Delhi.

Duration: 2009 - 2012.

Objectives

- ❖ Screening and choosing microorganisms highly efficient for the sugar industry effluents, beer waste and corn waste.
- ❖ Selection of suitable anode materials for channeling electrons generated during biodegradation and identification of proper cathode reactions and cathode materials.
- ❖ Construction of a prototype MFC:
 - a) Lab-scale model of biofuel cell for waste water treatment - batch and flow type,
 - b) Miniaturized biofuel cells for biomedical and domestic applications

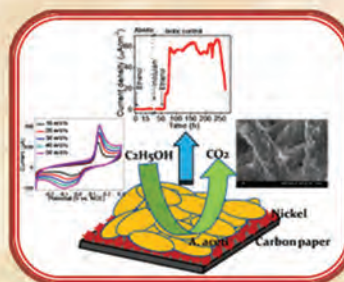
Progress highlights

(A) Salient Results & Conclusions

We have developed a novel anode for microbial fuel cell (MFC) which exhibits effective direct electron transfer with *Acetobacter aceti*. A high surface area nickel electrode was obtained using a simple process of template electrodeposition and it significantly improved the bioelectrocatalytic activity of *Acetobacter aceti* towards the oxidation of ethanol and glucose. Electrodeposition of Ni on carbon paper was carried out in the absence and presence of a soft template which served as the substrate for direct electron transfer. The soft template consists of a two component mixture of Triton X-100 and water. The structural and morphological characterizations of these modified electrodes were carried out using scanning electron microscopy (SEM). The redox properties of the biofilm formed on Ni coated carbon electrodes were investigated using cyclic voltammetry (CV) and chronoamperometry (CA). The formation of redox peaks during CV studies suggests the immobilization of a membrane bound redox protein (PQQ) present within these microbes on the modified electrodes

Investigation on the scan rate dependence reveals that the proteins are surface confined and anchored. From CA studies, we found that the oxidation current density corresponding to glucose and ethanol was more for the template deposited nickel (TNiCP) when compared to the one without the template.

The oxidation current density of ethanol was found to be higher ($68 \mu\text{A}/\text{cm}^2$) on comparison to glucose ($42 \mu\text{A}/\text{cm}^2$). For comparison, we have also carried out all these studies using a bare carbon paper (CP). Our results clearly demonstrate the direct electron transfer between *Acetobacter aceti* and high surface area nickel electrodes through the membrane bound redox enzyme which presumably contributes to the higher oxidation current density for ethanol and glucose and could be used as an



(B) Publications

1. Bio-electrocatalysis of *Acetobacter aceti* through direct electron transfer using a Template deposited nickel,
R. Karthikeyan, V. Ganesh, Sheela Berchmans,
Catal. Sci. tech. 2 (2012) 1234-1241.



GAP-29/07

Quality assurance of electrodeposited coatings for reactor and reprocessing applications

Principal Investigator : Dr. P. Veeramani

Sponsor : IGCAR, Kalpakkam.

Duration: 2010 - 2012.

Objectives

Fast breeder reactor fuel reprocessing plants handle fuels with higher concentration of Pu in high burn up and nitric acid solutions at high concentrations up to 11.5 N. Corrosion and materials reliability are major issues in avoiding failure of components, and thus materials selection and fabrication is of paramount importance. Various corrosion protection coatings could be used for protecting the equipments from failure. Thus AISI type stainless steel -SS 304L, SS 316L and titanium components in aqueous reprocessing plants based on nitric acid can be achieved by developing suitable coatings with high corrosion resistance.

Most of the Nuclear reactors and Fast breeder reactors are made up of structural materials of SS 316L or SS 304L grade. These are exposed severely corrosion environment and operational sequences. To safeguard these structural materials, various types of metals & alloy coatings of nickel, copper and its alloys are to be applied on the surface. Hence it is of important to prepare the standard test procedure on the above mentioned deposits on different substrates like SS 316L, SS 304L and steel. So it is proposed to prepare different thickness of 10, 25, 50 and 75 micron thick deposits on above substrates each of 5 samples.

All these electroplated materials are to be evaluated on various tests at IGCAR, Kalpakkam or any other destination desired by IGCAR and Data Bank is to be generated on Electrodeposited various alloy coatings of nickel, copper and their alloys like nickel-tungsten, nickel-copper prepared by electrodeposition route for Nuclear

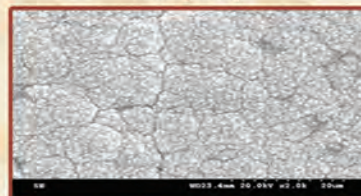
Progress highlights

(A) Salient Results & Conclusions

The following metals and alloys were coated by electrodeposition technique of different thickness on base metals like SS316L SS304L and steel Nickel of 25, 50 100, 250 and 1000micron thickness were coated on the above said substrate (40Nos). For the above work various pre-treatments were tried for SS plates and optimized the conditions. Further the nickel coating of higher thickness was provided by continuous shift works (1000 micron thick). These above coated SS specimens will undergo thermography tests to suit the nuclear compatibility.



Plating set up



SS316L SS304L and steel Nickel of 25, 50 100, 250 and 1000micron thickness coated specimens (40 Nos.) were delivered to IGCAR for further evaluation at Kalpakkam.

Nickel-tungsten alloy coatings were coated on the above substrates (15Nos) of various thickness like 10, 25, 75 and 100micron thickness and the report was also submitted to QAD, IGCAR.



GAP-06/08

Exploration of metal cyano-complex gels to tailor-make bimetallic alloys/mixed oxides for application in electrocatalysis of fuel cell reactions

Principal Investigator : Dr. James Joseph

Sponsor : Department Of Science & Technology, New Delhi.

Duration: 2008 – 2011.

Objectives

Bimetallic alloys/mixed oxides for application in electrocatalysis

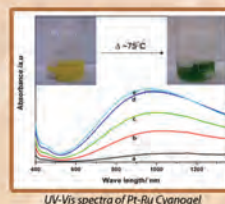
Progress highlights

(A) Salient Results & Conclusions

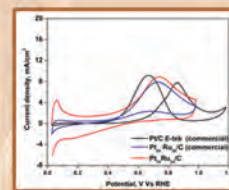
System: I

Chloroplatinic acid and potassium hexacyanoruthenate (II) solutions form opaque green-colored gels on heating upto 80°C. The formation of gels was investigated by UV-Vis spectral and cyclic voltammetric studies before and after gelling. These gels, upon thermal decomposition in inert atmosphere form Pt-Ru alloy. Vulcan carbon, as a porous support for Pt-Ru particles was added to the gelling solution to obtain carbon-supported nanoparticles for studying electrocatalytic oxidation of methanol. The Pt₇₀Ru₃₀/C were found to be highly catalytic towards methanol oxidation without any CO poisoning effect.

Palladium chloride and potassium ferricyanide form cyanogels that show various colours ranging from green to red depending upon the molar ratio of PdCl₂ and potassium ferrocyanide. The formation of gels was studied by CV and UV-Vis spectra. Upon thermal decomposition, PdFe alloy particles supported on carbon were obtained. The order of electrocatalytic activity of these alloy particles towards oxygen reduction was found to be: Pd₃Fe/C > Pd₂Fe/C > PdFe/C.



UV-Vis spectra of Pt-Ru Cyanogel



Cyclic voltammogram shows the methanol oxidation at the scan rate of 50mV/s in 0.5 M H₂SO₄

(B) Publications

1. Role of pH on aminosilane stabilized colloidal gold/silver and their alloy sols – application in catalysis (S. Harish, R.Sabarinathan, James Joseph*, K.L.N. Phani) Mat.Chem.Phys 127 (2011) 203-207.
2. Interaction between gold chloride and hexacyanoferrate (II/III) ion - Does it lead to gold analogue of Prussian blue? (S. Harish, James Joseph* and K.L.N.Phani), Electrochim. Acta 56, 2011, 5717-5721.
3. Ni_x-Fe_(1-x)Fe(CN)₆ hybrid thin films electro deposited on glassy carbon: Effect of tuning of redox potentials on the electrocatalysis of hydrogen peroxide A.V. NarendraKumar, S. Harish, James Joseph*, K.L.N. Phani). J. Electroanal. Chem. 659 (2011) 128-133.
4. Microwave assisted polyol method for the preparation of Pt/C, Ru/C and PtRu/C nanoparticles and its application in electrooxidation of methanol. Srinivasan Harish, Steve Baranton, Christophe Coutanceau, James Joseph J. Power Sources, 214, 15 (2012) 33-39

(A) Honours/ Recognition of the Project Staff:

Mr.S.Harish, SRF was awarded Sandwich Ph.D fellowship offered by French Embassy and visited France for 6 months.



GAP12/08

Development of high performing electrode materials for lithium ion batteries to be used in information and communication equipments

Principal Investigator : Dr. S. Gopukumar

Sponsor : DST (India) - JST (Japan).

Duration: 2008 – 2012.

Objectives

The development of lithium-ion rechargeable batteries of high energy density has relied on the successful development of high energy density intercalation compounds. Now a day's lithium transition metal oxides and phosphates are mainly used as the cathode materials for commercially used lithium rechargeable batteries. However, these materials suffer from cycle-dependent degradation and a reduction in capacity at high temperature which is attributed to structural rearrangements caused during extraction and reinsertion. Recent attempts to improve the performance of these materials by means of doping or coating have shown promising results for obtaining higher capacity with enhanced stability of the cathode materials. Therefore, bulk doping and surface modification have been the strategies to improve the electrochemical performance of the cathode materials. At the same time, commercially used rechargeable batteries uses graphite as anode materials however, it suffers from severe volume expansion results poor capacity retention. Therefore, an attempt has been made as metal and alloy based anode materials can be used as alternative to these carbon based materials.

Progress highlights

(A) Salient Results & Conclusions

1. Synthesized high performing oxide based cathode materials and alloy, metal/ $\text{Li}_4\text{Ti}_5\text{O}_{12}$ composite anode material and investigated its electrochemical performance.
2. High voltage cycling (4.9V) $\text{LiNi}_x\text{Co}_y\text{Mn}_{1-x-y}\text{O}_2$ cathode material delivered the capacity of 200 mAhg⁻¹ at C/10 rate. This is the first work reported at high voltage (4.9V) regions.

3. Mg doped $\text{LiNi}_{0.5}\text{Mn}_{0.5}\text{O}_2$ cathode material synthesized by sol-gel method using succinic acid as a chelating agent. These materials delivered the discharge capacity of 170 mAhg⁻¹ at C/10 rate and retains 85% capacity retention after 50 cycles when cycled upto 4.8V. Higher content Mg leads to poor capacity retention which is due to cation mixing in the synthesized materials.

4. $\text{LiMg}_x\text{Ni}_y\text{Co}_{1-x-y}\text{O}_2$ cathode materials were successfully synthesized by microwave-assisted solution technique. This material delivered the discharge capacity of 160 mAhg⁻¹ and retains 85% capacity after 20 cycles when cycled upto 4.3V.

5. $\text{Li}_4\text{Ti}_5\text{O}_{12}/\text{Sn}$ composite were successfully synthesized by ball mill technique. Developed composite anode material delivered a capacity of 220 mAh/g in the voltage range 0.01 to 2.5V).

(B) Publications

1. "Synthesis of high voltage (4.9 V) cycling $\text{LiNi}_x\text{Co}_y\text{Mn}_{1-x-y}\text{O}_2$ cathode materials for lithium rechargeable batteries".
C. Nithya, R. Thirunakaran, A. Sivashanmugam, S. Gopukumar.
Phys. Chem. Chem. Phys 13 (2011) 6125.
2. "Novel $\text{Li}_4\text{Ti}_5\text{O}_{12}/\text{Sn}$ composites as anode material for lithium rechargeable batteries".
A. Sivashanmugam, S. Gopukumar, R. Thirunakaran, C. Nithya, S. Shanmuga Prema.
Mater. Res. Bull. 40 (2011) 492.
3. Effect of Mg dopant on the electrochemical performance of $\text{LiNi}_{0.5}\text{Mn}_{0.5}\text{O}_2$ cathode materials for lithium rechargeable batteries.
C. Nithya, R. Lakshmi, S. Gopukumar.
J. Electrochem. Soc. 159 (2012) A1335-A1340.



GAP-16/08

HydroFluoroEthers (HFEs) as third generation substitute for CFCs – Synthesis and characterization by chemical and electrochemical methods

Principal Investigator : Dr. D. Velayutham

Sponsor : Ministry of Environment & Forests, Govt. of India.

Duration: 2008 - 2011.

Objectives

HFEs are considered as ozone friendly substitute for CFCs. Hence, synthesis and characterization of HydroFluoroEthers (C6-C8) by chemical and electrochemical methods were considered for this project.

Progress highlights

(A) Salient Results & Conclusions

Synthesis and characterization of methoxyperfluoro octylether was carried out from perfluorooctanoyl fluoride. The product was mostly ester rather than ether. Electro-decarboxylation of octanoic acid, butyric acid, perfluorooctanoic acid, and perfluorobutyric acid. Dimer was the product in the case of octanoic acid. Mixture of nucleophilic substituted product was obtained from butyric acid. Completion report will be sent soon.

(B) Publications

1. Anodic oxidation of alkane carboxylates and perfluoroalkane carboxylates at platinum and graphite anodes: Product selectivity and mechanistic aspects.

M. Rangarajan, M. Noel, D. Velayutham.
Ionics. 17 (2011) 827-833.

"Imagination is more important than knowledge."

- Albert Einstein



GAP-18/08

Development of microsensors for biomedical, food and environmental applications

Principal Investigators :Dr. K.L.N. Phani [CECRI] / Dr. V.K. Khanna [CEERI]

Sponsor : Aeronautical Development Agency (ADA), Bangalore [NPMAS].

Duration: 2009 - 2013.

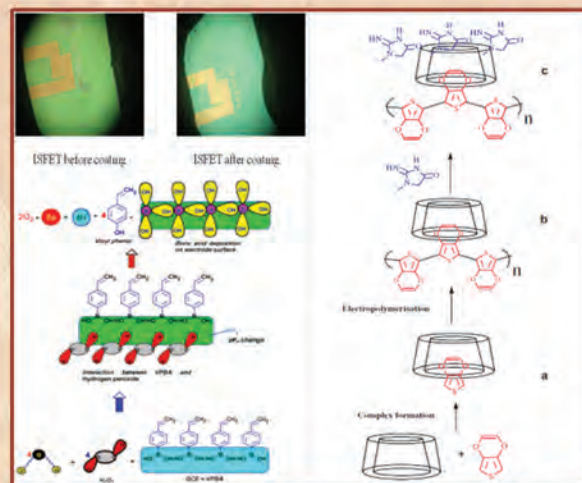
Objectives

To develop sensor membrane coatings on ISFET structures for the detection of (i) creatinine, urea and hydrogen peroxide for biomedical; (b) ammonia and nitric oxide for environmental applications.

Progress highlights

(A) Salient Results & Conclusions

- (1) ISFET structures fabricated by CEERI-Pilani were evaluated for their response to different pH conditions
- (2) Main purpose being the detection of creatinine and urea, appropriate membrane coatings incorporating the relevant enzymes were placed on the gate platforms of the ISFETs.
- (3) Stability and sensitivity of the coatings [Point (2)] were ensured for detection at the micromolar levels
- (4) Creatinine (Urea) could be detected against interferences like glucose, ascorbic acid and urea (creatinine).
- (5) In related fundamental investigations, new enzyme-less potentiometric schemes (i) using conducting polymer-cyclodextrin composite coatings were prepared and used for sensing of creatinine; (ii) phenylboronic acid (PBA)-nafion composite coatings for hydrogen peroxide sensing was shown to yield reliable results in the analysis of textile process waste waters (environmental application).



Schematic representations of pKa changes

Schematic of (a) EDOT/BCD inclusion complex formation, (b) electropolymerization of EDOT/β CD inclusion complex, and (c) β CD/creatinine interactions.

(B) Publication

- 1) Enzymeless creatinine estimation using β-cyclodextrin-poly (3,4-ethylenedioxythiophene) T. Naresh Kumar, A. Ananthi, J. Mathiyarasu. James Joseph, K.L.N. Phani, V. Yegnaraman. J. Electroanal. Chem. 661 (2011) 303-308.
- 2) A novel potentiometric hydrogen peroxide sensor based on pKa changes of Vinylphenylboronic acid membranes. A. Ananthi, T. Naresh Kumar, J. Mathiyarasu, James Joseph, K.L.N. Phani, V. Yegnaraman. Mater. Lett. 65 (2011) 3563-3565.



GAP-19/08

Development of nanoscale multilayered and nano composite super hard coatings by reactive magnetron sputtering for biomedical applications

Principal Investigator : Dr B.Subramanian

Sponsor : Deoartment of Science and technology, New Delhi.

Duration: 2009 -2012.

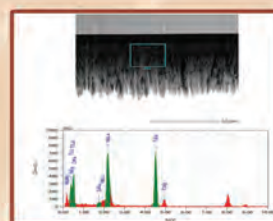
Objectives

- ❖ To develop nanoscale multilayers and nanocomposite super hard coatings.
- ❖ Structural analyses by XRD.
- ❖ Micro-structural analyses by SEM, AFM and TEM
- ❖ To study the corrosion resistance of these coatings using potentiostatic polarization studies and impedance measurements and in situ corrosion by SVET.
- ❖ To test the mechanical properties such as adhesion, hardness and wear resistance.
- ❖ To study the bio compatibility of the coatings by cell adhesion tests and dynamic clotting time measurement.

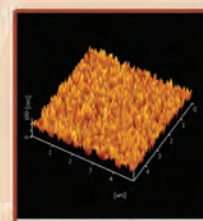
Progress highlights

(A) Salient Results & Conclusions

The structural, mechanical, corrosion properties and biocompatibility of TiN/TiAlN, TiN/NbN, TiN/VN multilayer and Ti-Si-N nanocomposite coatings prepared by reactive dc magnetron sputtering in an Ar-N₂ gas mixture are studied in this work. X-ray diffraction analysis reveals that the films are polycrystalline in nature. The presence of chemical composition on the surface of TiN/TiAlN, TiN/NbN, TiN/VN and Ti-Si-N coatings was identified by XPS analyses. TiN/NbN, TiN/VN and Ti-Si-N multilayer coatings. A morphological study shows uniform coatings with columnar surface morphology.

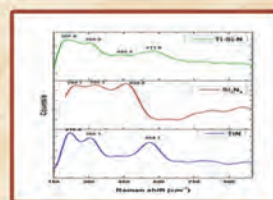


HRTEM image with EDS pattern for the TiN / NbN multilayers

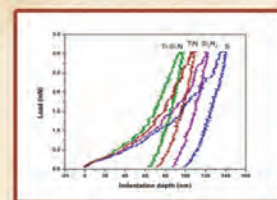


AFM 3D image of TiN/NbN multilayers

The characteristic peaks were observed from Laser Raman spectrum of Ti-Si-N. The lower friction coefficient and wear rate observed for the multilayer coated sample indicated that the better wear resistance.



Laser Raman spectra of nanocomposite coatings (a) TiN, (b) Si₃N₄ and (c) Ti-Si-N



Typical load vs. displacement curves for the Ti-Si-N nano composite coatings at 3 mN load

A comparison of the load-indentation depth curves for the steel substrate, single-layer TiN, Si₃N₄ and Ti-Si-N nanocomposite coatings shows a maximum hardness value of 39GPa for Ti-Si-N. Multilayer coatings. They also had better hemocompatibility than single layer and bare AISI 316LSS substrates. The attachment of bacteria on multilayer coatings was found to be very minimum and without colonization.



The multilayer coated 316L surfaces showed a significant reduction of the presence of bacteria, and this fact could probably be important in the decrease of the inflammation of the peri-implant soft tissues. The increase in charge transfer resistance (R_{ct}) and decrease in double layer capacitance (C_{dl}) value shows the better corrosion resistance for the coated sample. Potentiodynamic polarization curves showed that the positive shift in E_{corr} and decrease in I_{corr} values for multilayer coating signifies that it exhibits higher corrosion resistance than single layer and bare substrate in simulated body fluid. It is concluded that by using the transition metal nitride based multilayer coated 316L SS as a human body implant, improvement of corrosion resistance as an indication of biocompatibility could be obtained. To improve the osseo integration between the implant surface and tissue, a top layer of hydroxyapatite will be coated and further evaluation of biocompatibility will be done

(B) Publications & Patents

1. Bio synthesis of calcium hydroxyl apatite coating on sputtered Ti/TiN nano multilayers and their corrosion behavior in simulated bodily solution.
B. Subramanian, P. Dhandapani, S. Maruthamuthu, M. Jayachandran.
J. Biomater. Appl. 26 (2012) 22-33.
2. Surface modification of 316L stainless steel with magnetron sputtered TiN/VN nanoscale multilayers for bio implant applications.
B. Subramanian, R. Ananthakumar, Akira Kobayashi, M. Jayachandran.
J. Mater. Sci. Materials in Medicine, 205 (2012) 5014-5020.
3. Nanocomposite Ti-Si-N coatings deposited by reactive dc magnetron sputtering for biomedical applications.
B. Subramanian, R. Ananthakumar, Akira Kobayashi, M. Jayachandran.
J. Am. Ceram. Soc. 205 (2012) 5014-5020.
4. Electrochemical corrosion and materials properties of reactively sputtered TiN/TiAlN multilayer coatings,
R. Ananthakumar, B. Subramanian, Akira Kobayashi, M. Jayachandran,
Ceram. Int. 38 (1) (2012) 477-485.
5. A comparative study of titanium nitride (TiN), titanium oxy nitride (TiON) and titaniumaluminum nitride (TiAlN), as surface coatings for bio implants.
B. Subramanian, C.V. Muraleedharan, R. Ananthakumar, M. Jayachandran.
Surf. Coat. Techn. 205 (2011) 5014-5020.
6. Effect of substrate temperature on the properties of reactively sputtered TiN/NbN multilayers.
B. Subramanian, R. Ananthakumar, M. Jayachandran.
Cryst. Res. Technol. 46, (2011) 1273 – 1282.
7. Structural and electrochemical impedance spectroscopic studies on reactive magnetron sputtered titanium oxynitride (TiON) thin films.
P. Padmavathy, R. Ananthakumar, B. Subramanian, C. Ravidhas, M. Jayachandran.
J. Appl. Electrochem. 41 (2011) 751
8. Structural and tribological properties of DC reactive magnetron sputtered titanium/titanium nitride (Ti/TiN) multilayered coatings.
B. Subramanian, R. Ananthakumar, M. Jayachandran.
Surf. Coat. Tech. 205 (2011) 3485-3492.
9. Influence of substrate temperature on the materials properties of reactive DC magnetron sputtered Ti/TiN multilayered thin films.
B. Subramanian, R. Ananthakumar, V.S. Vidhya, M. Jayachandran.
Mater. Sci. Eng. B, 176 (2011) 1-7.



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10. Effect of nitrogen ion implantation on structural and microstructural properties of reactive magnetron sputtered TiN thin films.

B. Subramanian, R. Ananthakumar, Akira Kobayashi, M. Jayachandran.

Trans. Inst. Met. Finish. 89 (2011) 28-32.

11. Microstructural, mechanical and electrochemical corrosion properties of sputtered titanium – aluminum – nitride films for bio implants.

B. Subramanian, R. Ananthakumar, M. Jayachandran.

Vacuum 85 (2010) 601-609.

(C) Technology Developed / Transferred

Consultancy Project (CNP 05/11):

Advice on Sputter Coating of Titanium Nitride onto Nickel or Chrome plated Stainless steel Needles to M/S Nano Marker's Trichy.



TiN coatings on needles



TiN coatings on blades

(D) Any other important information

Industry Oriented Technology Course:

Surface coatings by physical vapour deposition (PVD), chemical vapour deposition (CVD) and surface analyses.

Duration : 5 days (21.11.2011 to 25.11.2011)

(E) Honours/ Recognition of the Project Staff

Honours / Recognition	Awardee
Received FY2011 JSPS Long term fellowship and availed the same in Osaka University, Japan from May 01, 2011- Feb 29, 2012.	Dr. B.Subramanian, Senior Scientist
Received Paper award for the paper on "Materials Properties of TiN/ TiOxNy multilayers prepared by plasma ion beam sputtering on 316 LSS for bio medical implants" in the 8 th International Symposium on Applied Plasma Science held during September 26-30, 2011 at Hakone, Japan.	Dr. B.Subramanian, R. Ananthakumar, S. yugeswaran, M. Jayachandran and Akira Kobayashi.



Electrochemical process for the synthesis of C3 and C4 perfluoroalkanoyl fluoride

Principal Investigator : Dr. D. Velayutham

Sponsor : Defense Research and Development Organization.

Duration: 2008 - 2012.

Objectives

The main objective of the proposal is to develop an electrochemical process for the synthesis of perfluoropropionyl fluoride and perfluorobutyryl fluoride from the corresponding alkanoyl chloride.

Perfluorobutyryl fluoride and Perfluoro propionyl fluoride are useful for the synthesis of perfluoroketone such as dodecafluoro-2-methylpentane-3-one which find application as ozone friendly fire extinguisher.

Progress highlights

(A) Salient Results & Conclusions

Electrochemical fluorination of propanoyl chloride (PC) was carried out in a 1000ml capacity cell under optimized conditions. Electrolysis was carried out for about 10 days and 1430 g of PC was fluorinated. About 1500 g of crude sodium perfluoropropionate was obtained. Material yield and current efficiency of the product were 51.5% and 50.5% respectively. About 1000 g of product was sent to CFEEs, DRDO for further studies.

(B) Publications

1. Phosphonium salts; Novel ionic liquids and the first phosphonium-based organic ionic plastic crystals.
V. Armel, D. Velayutham, J. Sun, P. C. Howlett, M. Forsyth, D. R. MacFarlane, J. M. Pringle.
J. Mater. Chem. 21 (2011) 7640-7650.

2). Anodic oxidation of alkane carboxylates and perfluoroalkane carboxylates at Platinum and graphite anodes: product selectivity and mechanistic aspects.

T. M. Rangarajan, D. Velayutham, M.Noel.
Ionics. 17 (2011) 827-833.

3). Voltammetric investigations on the transition between dissolution, passivation and deposition characteristics of Ni, Cu and their alloys in fluorine based ionic liquid.

S. Sathyamoorthy, D. Velayutham, V. Suryanarayanan, M. Noel.
Electrochim Acta. 56 (2011) 7012.



GAP-22/08

Signal amplification by gold nanoparticles in bioelectrocatalysis and sensing

Principal Investigator : Dr. Sheela Berchmans

Sponsor : Department of Bio-Technology, New Delhi.

Duration: 2009 - 2012.

Objectives

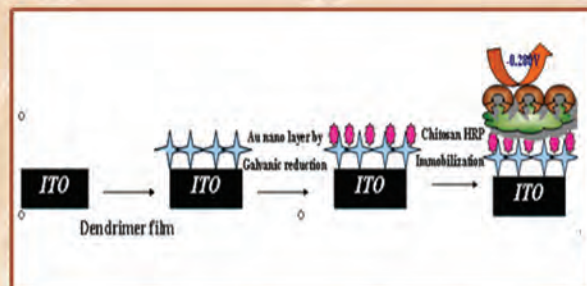
- ❖ Synthesis of nano-building blocks such as monolayer protected metal nanoclusters, gold nano shells, dendimer encapsulated nanoclusters, polymer-Au nanocomposites.
- ❖ Evolving new strategies for fabrication of novel platforms for the fabrication of electrochemical transduction of H_2O_2 and NADH.
- ❖ Evaluation of nano-structured assemblies for biosensor applications (e.g. Phosphate ion sensor)

Progress highlights

(A) Salient Results & Conclusions

An enhanced amperometric signal output for the enzymatic detection of peroxide was obtained using gold nanoparticles dispersed in a film of fourth generation PAMAM-OS-trimethoxysilyl dendrimer self assembled on indium tin oxide (ITO) electrode. An overlayer of chitosan formed on the gold nanoparticles modified ITO electrode, was used for the immobilization of the enzyme horseradish peroxidase. The strategy used for the modification resulted in a new third generation amperometric biosensor for hydrogen peroxide (H_2O_2). Different steps corresponding to the modification strategy employed in this work were characterized using microscopic (SEM & AFM) and electrochemical techniques. The resulting biosensor exhibited excellent sensing to H_2O_2 in neutral phosphate buffer. The influence of gold nanoparticles in increasing the loading of active enzyme molecules and the amplification of catalytic activity was observed. The lowest detection limit was determined to be 165 μM with a sensitivity of 0.3151 $\mu A/mM$ (for 3-layers) and 0.07614 $\mu A/mM$ (for a single layer).

The apparent Michaelis – Menten rate constant was calculated to be 0.1194 mM. The enzyme turn-over was estimated to be 4.873 s^{-1} . This biosensor provides a wide response range towards H_2O_2 detection with excellent reproducibility.



(B) Publication

1. Direct electron transfer of horseradish peroxidase immobilized on ITO substrates facilitated by signal amplification exhibited by gold nanoparticles. S. Farzana, V. Ganesh, Sheela Berchmans communicated to Analytical methods.



GAP-04/09

Exploration of sonochemical methodologies for control of size/shape of metal nanoparticles for electrochemical reaction

Principal Investigator : Dr. S.Senthilkumar

Sponsor : Department of Science and Technology, New Delhi.

Duration: 2009 - 2012.

Objectives

- ❖ To develop a novel synthetic route for preparing shape controlled noble metals (Pt, Au, Ag & Cu) and its alloy (Au-Pt, Au-Ag, and Au-Cu) nanoparticles by sono chemical and sonoelectrochemical methods.
- ❖ To elucidate the mechanism of the formation and the morphology of these nanoparticles aided by characterization using TEM, AFM, SEM, XRD, XPS, UV-Vis, FT-IR and electrochemical techniques. (in addition to the structure-sensitive under potential deposition reactions-cyclic voltammetry and impedance analysis).
- ❖ To study the structure sensitive electrochemical reactions like oxygen reduction reaction, methanol oxidation, etc.

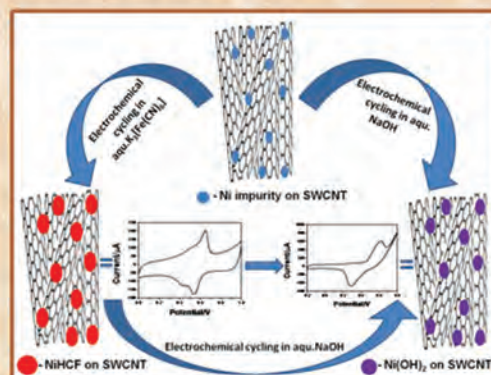
Progress highlights

(A) Salient Results & Conclusions

System:I

We observed metal impurities present in SWCNTs forms their corresponding metal hexacyanoferrate by simple electrochemical cycling with ferricyanide solution in the presence of excess potassium salt. In the first time, we explored the formation of Nickel hexacyanoferrate (NiHCF) on SWCNT and its typical redox behaviour can be used as an electrochemical probe to get qualitative and quantitative information of metal impurity in SWCNTs. These interesting features of NiHCF modified SWCNTs, further modified by electrochemical cycling in alkali solution to arrive their corresponding metal oxide on SWCNT. Finally modified Ni(OH)₂-SWCNT electrodes used to study enzymeless glucose oxidation and their pseudo capacitance behavior in alkaline condition.

The observed better electrochemical behavior is mainly due to the intimate contact between the metal oxide and SWCNT. This approach may be extended the interest to intentionally introduce favorable metal as a catalyst like impurities in CNT growth stage itself & control the minimum loading of favorable metal impurities in the CNT for the catalysis, sensing, energy storage and energy conversion applications.



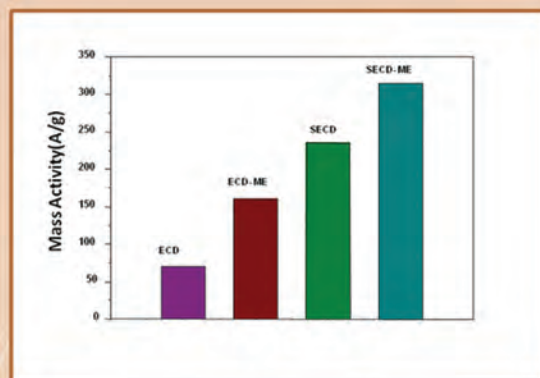
System:II

Prussian blue (PB) modified glassy carbon electrode(GCE) was prepared by potentiostatically in presence/absence of ultrasound and with/without micro-emulsion(ME) conditions. In micro-emulsion formation, 0.1M KCl +0.1M HCl solution was mixed with x% of toluene (x=1%, 2% to 5%) and this mixture was sonicated for about 1 minute to form emulsions. The electrochemical properties of modified electrode were studied by cyclic voltammetry and atomic force microscopy. Our results emphasized that the electrochemical properties of the modified electrode were very much dependent on the emulsification.



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Electrochemical reduction of hydrogen peroxide on various conditioned PB modified GCE was examined in 0.1MKCl +0.1MHCl solutions using cyclic voltammetry and amperometry techniques. The mass activity of various conditioned PB was compared and found that sonoelectrochemical with microemulsion conditioned PB shows good catalytic activity and stability towards H₂O₂ detection applications.



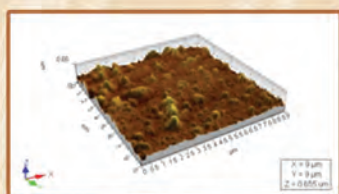
Comparison of Mass activity of various conditioned PB deposited GCE electrode for hydrogen peroxide reduction.



A: PB/GCE-(ECD)



B: PB/GCE-(ECD-ME)



C: PB/GCE-(SECD)



D: PB/GCE-(SECD-ME)

AFM images of PB deposited glassy carbon electrode.



GAP -13/09

Electrogenerated free radicals on boron doped diamond electrode for anodic substitution reaction

Principal Investigator : Dr. V. Suryanarayanan

Sponsor : Department of Science and Technology, New Delhi .

Duration: 2009 - 2012.

Objectives

- ❖ Studies on the electrochemical characteristics of BDD and GC electrodes in different aqueous and non-aqueous media.
- ❖ Synthesis of few important organic intermediates via the anodic substitution reaction on both these electrodes.

Progress highlights

(A) Salient Results & Conclusions

Deactivation behavior of boron-doped diamond (BDD) had been extensively studied for the first time in three room temperature ionic liquids (RTILs) namely 1-ethyl-3-methyl imidazolium nonaflate (EMIN), triethylmethylammonium methyl sulphate (TEMAMS) and N-hexyl-N,N,N-triethylammonium bis(trifluoromethanesulfonyl)imide (N2226TFSI) along with glassy carbon (GC) and platinum (Pt) electrodes on the anodic oxidation of 2,6-dimethylphenol (2,6-DMP), 2,4-dimethylphenol (2,4-DMP) and 3,4-methylenedioxyphenol (3,4-MDP). Cyclic voltammetric studies reveal that the anodic potential limit of the electrodes decreases in the order GC>BDD>Pt in these media and EMIN shows the highest anodic limit among the three RTILs. The phenolic compounds get oxidised at higher potential on the BDD electrode followed by Pt and GC electrodes and their oxidation potential in the three media increases in the order: TEMAMS < EMIN < N2226TFSI. Anodic polarisation studies in presence of phenols suggests that the Pt and GC do not show any serious electrode fouling; however, the BDD gets deactivated severely, as noted from the I_{pa4}/I_{pa1} values.

Passivation of the BDD electrode in the EMIN medium containing the 2,6-DMP was investigated by Scanning Electron Microscopy and Atomic Force Microscopy. The addition of CH_3CN in large amounts to this medium increases the activation of the BDD electrode surface.

(B) Publication

1. Voltammetric investigations on the relative deactivation of boron-doped diamond, glassy carbon and platinum electrodes during the anodic oxidation of substituted phenols in room temperature ionic liquids (RTILs).

K.R. Saravanan, S. Sathyamoorthy, D. Velayutham, V. Suryanarayanan.

Electrochim Acta 69 (2012) 71.



GAP-16/09

Lab-on-a-chip based hybrid sensor system for environmental monitoring

Principal Investigator : Dr. J. Mathiyarasu

Sponsor : Department of Biotechnology, New Delhi.

Duration: 2010 - 2012.

Objectives

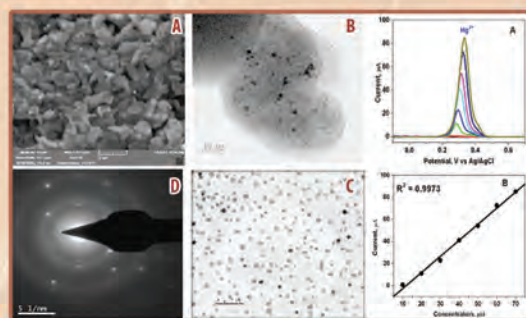
To develop "Hybrid sensor systems" for heavy metals and organophosphorous pesticide detection employing electrochemical stripping technique in a μ -total analytical systems incorporated Lab-on-a-chip device or with disposable type screen printed modified carbon electrodes.

Progress highlights

(A) Salient Results & Conclusions

Exploiting the interaction chemistry between the gold and mercury, the determination of mercury was attempted using linear sweep anodic stripping voltammetry technique [Analytical Methods, 4(8), 2012, 2486-2489]. Mercury could be detected between the concentration ranges 10-70 μ M with a minimum detectable concentration of 5 μ M.

Gold-poly(3,4-)ethylenedioxythiophene (Au-PEDOT) was synthesized using novel interfacial synthetic route. Using Au-PEDOT, carbon paste electrodes were fabricated and mercury detection was attempted exploiting gold-mercury interaction chemistry. Anodic stripping voltammetric analysis showed excellent sensitivity of micromolar level detection of mercury (LOD = 5 μ M). In an amperometric detection of mercury, electrode fouling is being a major problem since the memory effect couldn't be removed easily. Hence, colorimetric / fluorescence techniques are mostly dominating the field using gold nanoparticles probe for the detection of mercury. Au-PEDOT carbon composite film electrodes showed excellent repeatable measurements avoiding the memory effect while detecting the mercury using anodic stripping voltammetry. As a preliminary investigation, the present carbon composite has been successfully demonstrated for mercury detection in tap water.



(i) Microscopic images of Au-PEDOT powder

(A) SEM

(B) TEM

(C) Higher magnification of TEM and

(D) SAED pattern; (ii) SWASV of Hg^{2+} (10-70 μ M) in 0.1 M acetate buffer (pH 4.5) solution using Au-PEDOT modified carbon paste electrode (A), corresponding calibration plot (B).



GAP-03/10

Modelling for service life prediction of reinforced concrete structures

Principal Investigator : Dr. R. Vedalakshmi

Sponsor : Board of Research in Nuclear Sciences, Mumbai.

Duration: 2010-2013

Objectives

The main objective of the project is evolving a suitable methodology for the estimation of service life of concrete structures in a non-destructive way. The reliable model for life prediction will be evolved with the collection of data. The validity of the model will be checked on naturally corroded beam as well as the beam exposed under sea water at NITK, Suratkal

Progress highlights

(A) Salient Results & Conclusions

1. $D_{eff, EIS}$ determined using Nernst-Einstein relation from the resistance of concrete is the sum of gradients created due to moisture, chloride, diffusion potential and their interaction effect. The effect of micro structure of concrete (such as porosity and percolation effect) on chloride ingress is also included in $D_{eff, EIS}$. The D_{eff} arrived using other reported analytical, empirical models and chloride profile method are measured only one of the above three effects.
2. When the concrete subjected to repeated wetting and drying cycles, the influence of diffusion potential contributed by the movement of other ionic species present in the pore solution through an electrical coupling on chloride ingress is much more than that of diffusivity of moisture and chloride.
3. The maximum D_{eff} value of $21.9 \times 10^{-12} \text{ m}^2/\text{sec}$ is obtained at 90/30 RH/temp condition and seems that it is the threshold level at which D_{eff} attained its maximum value. A pure Arrhenius trend could not be found between D_{eff} and temperature because of other effects developed when temperature is changed.
4. The result concludes the resistivity of concrete is the parameter that more comprehensively represents the diffusion process of moisture and chloride and their combined effect during the initiation period in the service life estimation.
5. The methodology evolved in the present study can

5. The methodology evolved in the present study can be able to predict the time-dependent characteristics of D_{eff} of chloride under 1D and 2D flow of chloride in actual field structures non-destructively.



Field exposure study at Mandapam



Chloride sensor in RCC beam exposed to naturally corroding condition at NIT, Suratkal

(B) Publications & Patents

1. R. Vedalakshmi, K. Rajagopal, N. Palaniswamy Durability performance of rebar embedded in chloride admixed blended cement concretes, *Corr.Eng.Sci.Techn.* 46 (2011), 256-270.
2. R. Vedalakshmi, K. Thangavel, Reliability of electrochemical techniques to predict the corrosion rate of steel in concrete structures, *Arab.J.Sci.Eng.* 36 (2011), 769-783.
3. R. Vedalakshmi, V. Saraswathy, A.K Yong, Performance of blended cement concrete under MgSO_4 attack, *Mag. Concr. Res.* 63(2011), 669-681.
4. R. Vedalakshmi, Prediction of service life of concrete structures using corrosion rate model, *Struc. Build.* 165, (2012), 95-108.

(C) Technology Developed / Transferred

Cement polymer composite coating for corrosion protection of reinforcing and prestressing steel (renewal)- Mahavir Chemicals, Mumbai.



GAP-08-10

Ionic liquid as solvent for electrodeposition of chromium, nickel, zinc and aluminium

Principal Investigator : Dr S Mohan

Sponsor : Department of Science and Technology, New delhi.

Duration : 2009 - 2012.

Objectives

- ❖ To deposit chromium, zinc and aluminium from ionic liquids.
- ❖ To study the nucleation of these metals on various substrate.
- ❖ To optimize various parameters like current density, temperature, pH and bath chemistry to get a good deposit.
- ❖ A comparative study will be done using DC and pulse current.
- ❖ To get deposit to the maximum thickness of 10 microns.

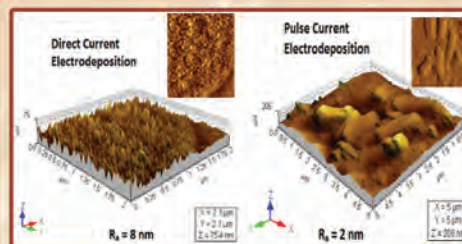
Progress highlights

(A) Salient Results & Conclusions

Conductivities were studied by variation of Ni^{2+} ion concentration with 1:2 molar ratios of choline chloride and ethylene glycol (ethaline) and variation of temperature. Among the conductivity values 1:2 molar ratio of choline chloride, nickel (II) chloride mixture is having higher value. We have optimized the current density ($50 \mu\text{A}/\text{cm}^2$), pH (~ 4), temperature ($40-60^\circ\text{C}$) and pulse parameters for Nickel deposition. low pulse frequency region (10 Hz) is not suitable for electro deposition. Other frequencies have somewhat better results. UV and FTIR studies show that the intensity of quaternary ammonium chloride ion-bending peak is 957 cm^{-1} and the peak diminishes in both ethylene glycol and mixture. The reason behind this is chloride ion concentration is transferred to the solvent and NiCl_2 mixture. At 2360 cm^{-1} chloride-ion's stretching peak is also denied in DES. This is due to the formation of complex known as ethaline. Hardness of DCD coated nickel is 250 – 300 HV, whereas in PCD the hardness is 280 – 375 HV. And we compared the Nickel deposition from ordinary watt bath and choline chloride and ethylene glycol deep eutectic solvent.

PED Ni is having very small crystalline size of 23.23 nm, which is smaller than the Ni obtained by DCD (37.06 nm) techniques. Crystalline size and texture coefficient were also calculated.

2θ		FWHM (2θ)		Crystalline size (Å)		Texture coefficient (%)	
DCD	PED	DCD	PED	DCD	PED	DCD	PED
44.634	44.800	0.2175	0.2342	40.27	38.62	51.55	63.26
52.024	52.014	0.3680	0.5022	35.37	21.48	24.27	12.03
76.625	76.820	0.2856	1.1424	35.53	9.58	24.17	24.70



AFM image of deposited nickel in direct current density of 0.2 mA cm^{-2} and time 180 seconds is given above, its approximate average grain size is 200 - 350 nm and SEM image of deposited nickel in pulse method (average current density 0.2 mA cm^{-2} , Duty cycle 10, time 180 seconds) is also given above and approximate average grain size is 100-230 nm. Both DCD and PED method has fine nano crystalline sized nickel deposits with less roughness. The Ecorr and Icorr values have been calculated using the Tafel extrapolation method, there is an appreciable increase in corrosion resistance for the PCD plated and DCD deposited nickel than that of bare mild steel substrate. The increased R_{ct} values and decreased C_{dl} values for nickel deposits clearly confirm the better corrosion resistance of these PC and DC deposition systems compared to bare mild steel substrates. The PC plating has maximum corrosion resistance than DC deposition, which is more corrosion resistance than mild steel as observed from the high frequency region of the impedance spectra.



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We have estimated the porosity of the Ni-deposited from PED and DC current and results indicate that PED Nickel is having 0.0056% and Ni-(DCD) is having 0.0666%. From this value we concluded that the PED nickel coating system is having ten times lower porosity than the DCD nickel system.

Sample	E_{corr} (mV)	i_{corr} (mA)	Corrosion rate (mpy)	R_{ct} $\Omega \text{ cm}^2$	C_{dl} mF cm^2	Porosity
Mild steel	-702	850	39.00	63	14.84	---
DCD (0.2mA)	-481	183	10.74	930	0.822	0.0666
PED (0.2mA)	-418	20.84	8.94	2881	0.613	0.0056

(B) Publications

1. Electro deposition of Fe-Ni-Cr alloy from deep eutectic system containing choline chloride and ethylene glycol.

G. Saravanan, S. Mohan.

Int.J.Electrochem.Sci. 6 (2011) 1468 – 1478.

2. choline chloride – ethylene glycol mixtures as green electrolyte for nano crystalline Nickel electrodeposits, Communicated to J.electroanaly. chem.



A Glimpse of ERP Training Programme at CECRI



GAP-09/10

Development of portable voltammetric probe for online monitoring of trace metals in fresh water.

Principal Investigator : Dr. R.Srinivasan

Sponsor : Ministry of Environment and Forests Govt. of India, New Delhi.

Duration: 2010 - 2013 .

Objectives

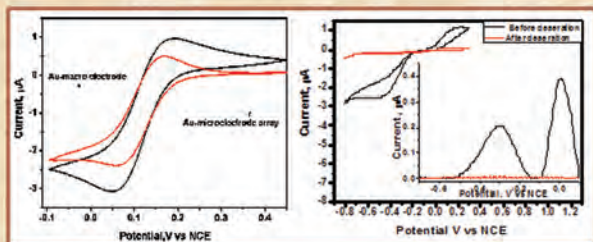
Fabrication of a Voltammetric probe for use in online determination of Pb, Cd, Cu and Zn in fresh water by SWASV on Bi-Coated Au-MEA

Progress highlights

(A) Salient Results & Conclusions

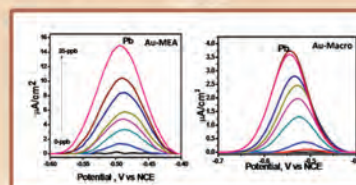
❖ Au – micro electrode array of 18 μm diameter, 60 μm inter electrode distance and 0.01cm² electrode area towards sensing of Pb, Cd, and Zn in 0.1M acetate buffer of pH 4.5 through SWASV.

❖ To make a distinction electrode behavior from macro to micro electrode electrochemical characterization are performed by potential cycling in ferri cyanide containing solution for these Au-MEA, which gives a almost same response like Au- macro electrode.



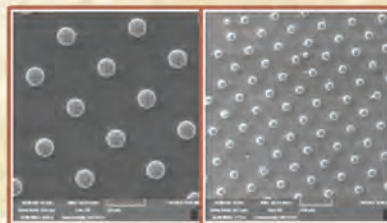
❖ Further, we found from our analysis that, these Au-MEA are more sensitive towards oxygen environment. Electrochemical sensitivity of these electrodes are highly dependent. On performing the SWASV for these micro electrode arrays in both conditions the SWASV signal are different from deaeration solutions.

❖ Sensing ability of Pb²⁺ has been compared with the current densities of both Au-MEA and Au macro electrodes, From the SWASV output Au- MEA shows superior response in terms of sensing when compared to that of Au-macro electrode on heavy metal sensing.



SEM analysis

The used Gold micro electrode array (Au-MEA) having 18 μm diameter, 60 μm of inter electrode distance and electrode area of 0.01 cm². These electrodes have been characterized through (SEM) to graph the dimension and confirm the area. The whole chip was encapsulated on silicon nitride layer. Silicon nitride is a polymer, which serves as an insulating material. SEM images shown were captured at various spots of electrode surface to confirm the uniformity and quality of the electrode. The spherical objects represent the metal of single microelectrodes, the darker region is the insulating silicon nitride layer



Detail SEM images of gold ultra micro electrode arrays at different resolutions and view fields



GAP-14/10

Conducting polymer carbon composite sensor for the determination of Na:K ratio in blood serum samples

Principal Investigator : Dr. J. Mathiyarasu

Sponsor : Department of Science and Technology, New Delhi.

Duration : 2010 - 2013.

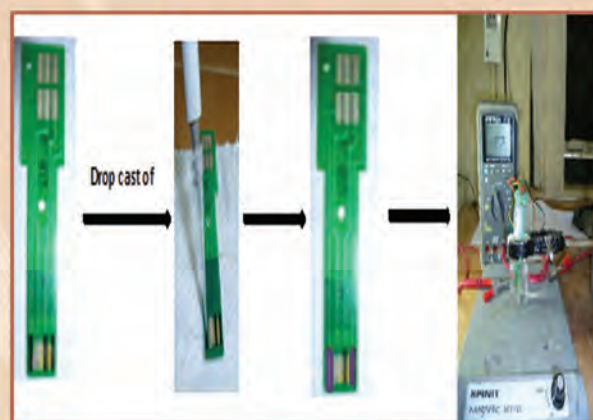
Objectives

To develop Na:K sensor strips which directly read out the Na:K ratio from the blood samples without sample preparation.

Potentiometric determination of sodium and potassium ions using respective membranes incorporated in a screen printed electrode

(A) Salient Results & Conclusions

After experimenting Na/K estimation in a conventional glassy carbon electrode and carbon paste electrodes, further evaluation in a disposable type screen printed carbon electrode was attempted. In a typical screen printed electrode (as shown in the Figure) configuration, both Na and K sensing inks were drop cast ($2\mu\text{l}$) on the carbon leg. The potentiometric responses of the respective ions were monitored in terms of potential where both sodium and potassium are added together in the solution. Sodium ion responded a slope value of 37.8 mV/decade concentration of Na whereas potassium ion showed a slope value of 24.0 mV/decade concentration of K, for a decade concentration of 1×10^{-6} – $1 \times 10^{-2}\text{ M}$. Thus, the screen printed electrode exhibited a comparable performance with Vulcan carbon paste electrode. Since, the normal range of blood sodium level is 135 to 145 milliequivalents per liter and potassium is 3.5 to 5 milliequivalents per liter, the sodium / potassium ink modified screen printed electrodes are evaluated in these concentration ranges. Sodium ink modified electrode showed a slope Value of 129.3 mV/mm of sodium concentration ($R^2 = 0.98$) and potassium ink modified electrodes showed a slope Value 105.9 mV/mm of potassium concentration ($R^2 = 0.98$). Further optimization and interference studies are in progress now.



Potentiometric setup for the determination of sodium and potassium ion in sample solutions based on screen printed electrodes.



Nanostructures of metal chalcogenides for catalytic and electrochemical applications – First principle approach

Principal Investigator : Dr. P. Murugan

Sponsor : Department of Science & Technology, New Delhi.

Duration: 2010 - 2013.

Objectives

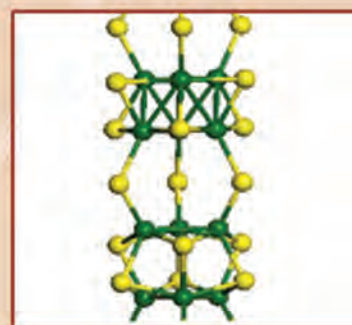
- ❖ Nanowires assembly for high performance electrode for Li-Ion battery applications
- ❖ Stability of nanosized triangular platelets
- ❖ Magnetism in platelets and polyhedral clusters
- ❖ Electronic conductivity and mechanical stability of Mo-S-I nanowires
- ❖ Triangular platelets and polyhedral MoS_{2+x} clusters for hydrodesulfurization process

Progress highlights

(A) Salient Results & Conclusions

This project is concerned with the first principles study of various nanostructures of metal chalcogenide compounds, especially molybdenum sulfides (MoS_x). It is well known that there exists various nanostructures of Mo-S that can be classified as 0D (platelets and polyhedral clusters), 1D (nanowire and nanoribbons), and 2D (nanosheets) compounds. Our focus lies on the MoS based nanowires like $\text{Mo}_6\text{S}_{9-x}\text{I}_x$ which is considered an alternative to CNT as the former can have unique electronic properties during bulk synthesis. Moreover improved electronic and optical properties were reported for single layer MoS_2 compound (similar to graphene). Thus our emphasis is on various MoS_x nanostructures.

The $\text{Mo}_6\text{S}_{9-x}\text{I}_x$ nanowire (NW) comprises of stacked octahedron which is decorated by anions (either S or I atom) and these stacks are in turn bridged by a combination of anions. Besides each octahedron is rotated by 60 with respect to the other and results in formation of a prism at the bridging site. Here the presence of I plays an important role which led us to vary its concentration from $x = 0 - 9$ and understand its corresponding properties. Note that the addition of iodine atoms increases the number of electrons that are available for metal-metal bonding in the network.



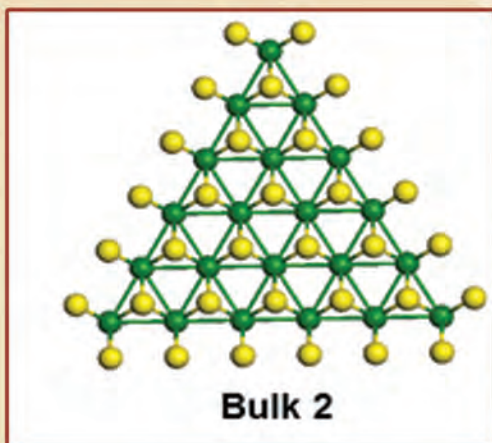
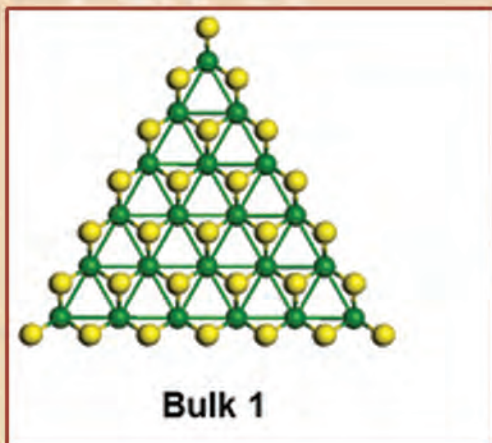
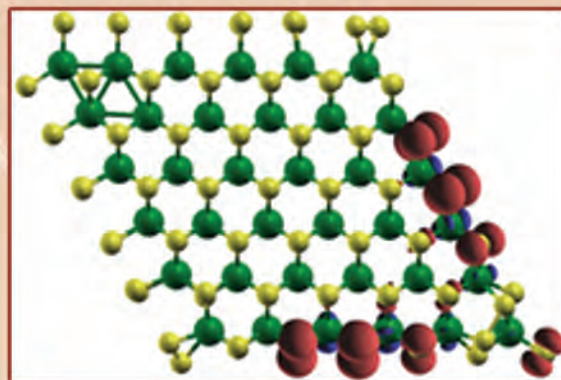
MoS_2 Platelets:

Similar to MoS NW, MoS_2 platelet is also a promising nanostructured material for battery electrodes, in petroleum oil purification (desulfurization), and water splitting for H_2 production. Experimental synthesis of these triangular and other shaped platelets with different dimensions on substrates like gold, TiO_2 , and quartz are reported (Nature Nanotech. 2006) and the platelets are found to exist in triangular or parallelogram geometry. However a molecular level study at the DFT level is still lacking.. Thus we study triangular platelets (both bulk1 and bulk2) and parallelogram platelets with different dimensions. Note that bulk2 has rich sulfur content in edge of platelets and in bulk1 platelet, sulfur atoms are connected in edge of two Mo atoms, hence, its having less sulfur content than in bulk2 case. Some cases, we studied platelets on the Au(111) substrate to understand the growth of platelets. We showed from our calculations that the BE of bulk1 platelets is more that of bulk2. However, for high sulfur environment, bulk2 platelet could be formed. Our calculation on role substrate on growth of this cluster is showed that it plays less role. Further, we also studied some of 3D Mo-S polyhedral clusters (not shown here).



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This cluster has more BE than 2D Mo-S platelets, but such cluster could be formed when sulfur content is less MoS₂ stoichiometry. The parallelogram shaped platelets can be perceived to comprise of two triangular platelets (Bulk1 and Bulk2). We studied these platelets of different dimension m and n where m and n are number of Mo atom along each axis. In this system we mainly focus on structural stability and magnetic properties. Later property can be expected as the presence of partially occupied d-electrons in Mo atoms. It is interesting that for larger sized platelets (above 1.0 x 1.0 nm²), the magnetism is observed. We understood that the magnetism in the platelets is originated from some of under-coordinated sulfur atoms which are located at edge of its bulk1 side, rather than bulk2 side (refer figure). We concluded that the magnetism is quenched due to presence of sulfur dimer.





Exploring modified semiconductor electrodes as sensors and catalysts

Principal Investigator : Dr.V. Ganesh

Sponsor : Department of Science and Technology (Fast Track Scheme for Young Scientists).

Duration: 2009 - 2012.

Objectives

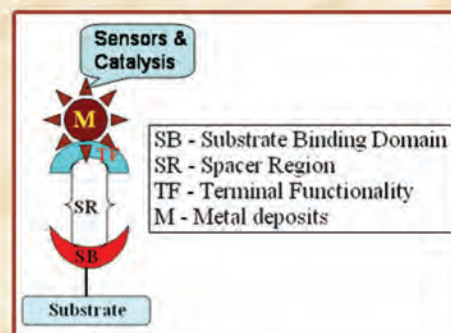
- ❖ To prepare and characterize the formation of stable, reproducible and ordered self-assembled monolayer (SAM) films on semiconductor electrodes. Molecules with various terminal functionalities such as amino, carboxyl and thiolate terminated alkyl siloxanes will be studied.
- ❖ To immobilize nanoparticles (Au, Pt and Ni) on SAM coated electrodes.
- ❖ To incorporate enzymes and study their functional activities on with and without nanoparticles modified electrodes. Several enzymes like Glucose oxidase (GO_x), Alcohol dehydrogenase (ADH), Pyruvate oxidase and Horseradish peroxidase (HRP) will be investigated.
- ❖ To carry out the corresponding enzymatic reactions such as oxidation of glucose and alcohols, sensing phosphates and hydrogen peroxide reduction on these enzymes immobilized semiconductor electrodes.

Progress highlights

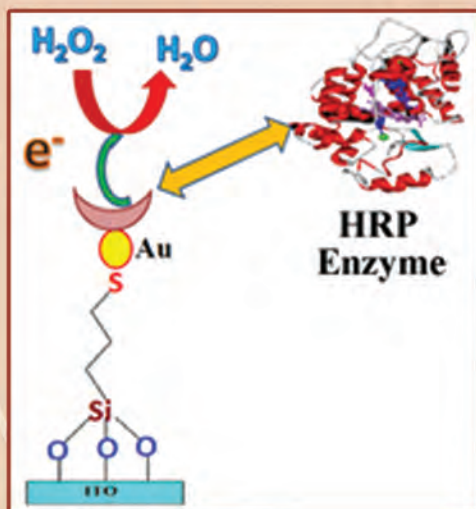
(A) Salient Results & Conclusions

Self-assembled monolayer films of various molecules on metallic surfaces such as Au, Ag and Cu are well explored, while the monolayer studies on semiconductor electrodes are fairly limited. Semiconductor electrodes such as ITO, silica (SiO_2) and TiO_2 have interesting physical and chemical properties like optical transparency, semi-conducting behaviour, chemical stability and high surface area. These electrodes are proposed to be modified with self-assembled monolayer films. Molecules having different structural components (as shown in scheme 1) such as substrate binding (SB) domain, spacer (electron transport) region (SR) and terminal functionality (TF) will be utilized for SAM formation (Scheme 1).

These functionalities will further be exploited for enzyme (EZ) immobilization. Several well-known interactions viz. electrostatic, hydrophobic, covalent bonding and anchoring of nanoparticles will be explored for enzyme immobilization and its activity on these modified surfaces is to be investigated (Scheme 2). The present work is to establish the methodology and to understand the mechanism of action on silane modified semiconductor electrodes. We propose to form a stable and ordered monolayer films on these electrodes using amine, carboxyl and thiolate terminated alkylsiloxane compounds. These modified electrodes will be used later to immobilize the biologically active molecules (enzymes). Several important reactions such as oxygen reduction, hydrogen peroxide reduction, glucose oxidation and ethanol oxidation will be performed using enzymes incorporated semiconductor electrodes. It could also be mentioned that these transparent metal. oxide platforms can also be used for optical sensing, although this is not a part of proposed work.



Scheme 1: Pictorial representation of the proposed methodology for systematic modification of semiconductor electrodes to develop sensors and catalysts.



Scheme 2: Schematic representation of the proposed methodology for HRP immobilization on SAM modified ITO electrode

(B) Publications

1. Electrochemical characterization of self-assembled monolayers (SAMs) of silanes on indium tin oxide (ITO) electrodes – Tuning electron transfer behaviour across electrode – electrolyte interface
A. Muthurasu, V. GANESH*.
J. Colloid Interface Sci. 374 (2012) 241-249. (IF: 3.066).
2. Strategies for an enzyme immobilization on electrodes: Structural and electrochemical characterizations.
A. Muthurasu, V. GANESH*.
J. Phy. Conf. Ser. 358 (2012) 012003.

*"Science Leads to development of technologies.
Availability of technologies Leads to products."*

- Dr. A.P.J Abdul Kalam



Soft chemical strategies for the synthesis of indium-free nanocrystalline transparent conducting oxides

Principal Investigator : Dr. N. Lakshminarasimhan

Sponsor : Department of Science and Technology (Fast Track Scheme for Young Scientists).

Duration: 2011 - 2014.

Objectives

The objective of the project is to synthesize indium-free nanocrystalline transparent conducting oxides (TCOs) as an alternate to ITO through soft chemical approaches. The proposed work envisage ZnO:Al and $\text{TiO}_2\text{:Nb}$ as alternate materials to ITO. Sol-gel and hydrothermal methods are proposed for the synthesis, and spin coating and dip coating processes are to be utilized for coating the TCO materials over glass substrates.

Progress highlights

(A) Salient Results & Conclusions

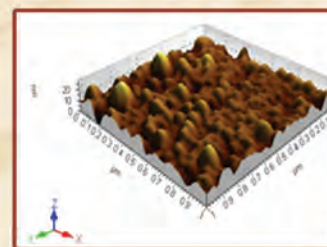
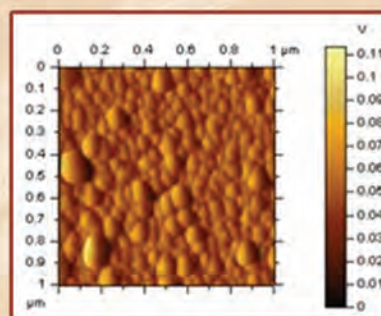
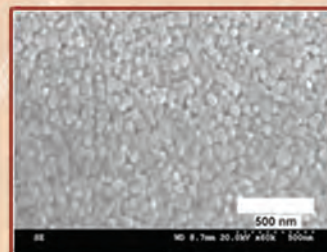
Optimization of synthesis conditions and coating processes have been carried out with ZnO:Al and $\text{TiO}_2\text{:Nb}$ thin films. Transparent thin films were obtained by spin coating method. Work is going on to improve the conductivity of these thin films by modifying the synthesis conditions and dopants and their concentrations.



Photograph of bare glass and, ZnO and ZnO:Al coated glass plates revealing the transparent nature of the films.



Images showing the increase in water contact angle (WCA) over glass, ZnO and ZnO:Ti coated glass.



SEM and AFM images of ZnO:Al coated glass.



GAP-04/11

Development of rapid detection kit for MRSA diagnosis

Principal Investigator : Dr. J. Mathiyarasu

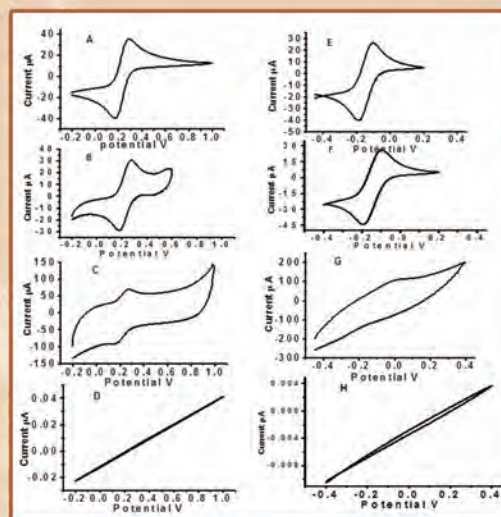
Sponsor : National Hub for healthcare Instrumentation Development (NHHID).

Duration: 2011 - 2014.

Fabrication and evaluation of immuno platforms

In this project, it is aimed to develop an electrochemical immunoassay method for swift testing of MRSA bacterium cells using cultured samples at the first instance that may subsequently develop into a single step electrochemical immunoassay avoiding the culturing step. In this approach, as a preliminary step, it is attempted to fabricate and evaluate carbon based immuno sensing platforms. The activity of carbon materials such as Vulcan, activated, acetylenic, nanotubes and nitrogen doped carbon were evaluated for its electrochemical performance with the bench mark redox systems, with the intention of taking the optimized electro-active carbon material for further immuno biosensor fabrication and evaluation. Among the different materials tested, Vulcan carbon behaves almost in a better way of electron transfer kinetics observed by the delta Ep values, which is found to be 117 ± 5 mV. Voltammetric studies revealed that only vulcan carbon and carbon nanotube show well defined voltammetric behaviour with clear peak-to-peak separation close to the Nernstian behaviour. Acetylene and activated carbon does not exhibit the expected electroactivity.

In the next stage, the Vulcan carbon platform was evaluated for its immuno-sensing characteristic, by the way of immobilizing glucose oxidase enzyme along with chitosan to perform glucose oxidation reaction. Here, the electron transfer is observed directly from glucose to the electrode via the active site of the enzyme without involving the redox mediator. This is the first of its kind to observe such behaviour in a carbon matrix. This direct electron transfer help us to understand intrinsic behaviour of enzyme and this observation may lead to the development of mediatorless glucose biosensor and the work is in progress.



Cyclic voltammogram of carbonaceous materials in 0.01 M $[\text{Fe}(\text{CN})_6]^{3-/4-}$ + 0.1 M KNO_3

(A) Vulcan carbon

(B) SWCNT

(C) Acetylene carbon

(D) Activated carbon & in 0.01 M $[\text{Ru}(\text{NH}_3)_6]^{3+/2+}$ + 0.1 M KNO_3

(E) Vulcan carbon

(F) SWCNT

(G) Acetylene carbon

(H) Activated carbon; $\gamma = 50 \text{ mVs}^{-1}$



GAP-11/11

Development of customized organic coatings for corrosion protection of special mining equipments at Neyveli lignite mines

Principal Investigator : Dr. S. Muthukrishnan

Sponsor : Neyveli Lignite Corporation

Duration: 2011 - 2014.

Objectives

To develop customized organic coatings for corrosion protection of special mining equipments at Neyveli lignite mines

Progress highlights

(A) Salient Results & Conclusions

Nano particles TiO_2 , SiO_2 and conducting polymer Polypyrrole were synthesized and the particle size was characterised was done by SEM and TEM instruments. The particle size was in the range of 70-110 nano meter. The paints were formulated with nano pigment of TiO_2 and conducting polymer Polypyrrole. The evaluations of the coatings are under progress.



National Technology Day celebrations at CECRI



GAP-13/11

First principles study on local atomic structure, magnetic ordering and interface effects in exchange coupled multilayer systems

Principal Investigator : Dr. P. Murugan

Sponsor : Defence Research and Development Organisation.

Duration: 3 Years .

Objectives

- ❖ First principles calculations will be employed to understand the role of hard and soft magnetic phases in $\text{SmCo}_5/\text{Fe-Co}$ multilayer system by varying the thickness of respective magnetic layers.
- ❖ Role of interface to improve the magnetic energy product will be understood with help of electronic density of states.

Progress highlights

(A) Salient Results & Conclusions

We performed first principles density functional calculations to understand the structural stability, electronic and magnetic properties of SmCo_5 (0001) surface with three different surface terminations ;

- 1) stoichiometric slab (SmCo_2 layer at one surface and Co_3 layer on another surface),
- 2) Co_3 layer termination on both surfaces, and
- 3) SmCo_2 layer termination on both surfaces.

Latter two surface slabs are having mirror symmetry with respect to central surface layer. Calculations, within the limit of GGA+U, were performed for various thick layers from 1L to 10L (1L = combination of SmCo_2 and Co_3 layers). Preliminary results show that Co_3 terminated surface slab has more energetically stable than that of other two cases. We also observed that in surface slabs terminated with SmCo_2 layer that layer is expected to peel-off from its surface slabs.

"The idea is to try to give all the information to help others to judge the value of your contribution; not just the information that leads to judgment in one particular direction or another."

- Richard P. Feynman



GAP -14/11

An explorative attempt on the validation of dual electrode behavior of certain LiMXO_4 compounds [X= P, Sn]

Principal Investigator : Dr. N. Kalaiselvi

Sponsor : Department of Science and Technology, New Delhi.

Duration: 2009 - 2012.

Objectives

- ❖ Synthesis and characterization of select category LiMPO_4 and LiMSnO_4 compounds.
- ❖ Validation of their cathode and anode behavior against Li/Li⁺ half cell assembly.
Recommendation on better performing cathode
- ❖ and/or anode from the select electrode materials.

Progress highlights

(A) Salient Results & Conclusions

Few lithium metal stannates have been synthesized using novel solution assisted methods and their electrochemical validation for lithium intercalation and de-intercalation is in progress



School toppers foretasting the scientific research during CPYLS programme at CECRI



CNP-07/10

Feasibility studies for recycling of water from rinse/wash water from zinc barrel plating unit

Principal Investigator : Dr. S. Udaya Bhanu

Sponsor : Sundaram fasteners, Aviyur, Virudhunagar District.

Duration: 2010 - 2011.

Objectives

- ❖ To remove the Zn^{2+} from barrel Plating wash-waters by electrochemical methods and compare with chemical methods.
- ❖ Optimization of conditions at which maximum zinc can be removed and water recovered by electrocoagulation.

Progress highlights

(A) Salient Results & Conclusions

Zn removal from barrel plating rinse waters by modified electro-coagulation methods (MECM) under optimized conditions like pH, current density, time, anode materials, type of electrolysis etc.

In the current work, electrochemical methods yielded better results compared to traditional chemical coagulation methods. The extent of Zn removal ranged between 22 to 60% by chemical methods (lime, lye, sulfite and sulfate precipitation) compared to MECM methods where in the maximum extent of zinc removal is ~87%. Besides Zinc, other pollutants present in the original rinse waste-waters vis-a-vis K, Mn, SO_4^{2-} , etc were observed to be removed to a greater extent as confirmed by EDAX. Also the quanta of sludge formed by chemical methods are 2 to 7.5 times more compared to MECM. The MECM method decontaminated original 'polluted water' to a water of medium quality'. This work was carried out as a part of CNP 07/10 project (feasibility study) and further work is in progress.

Composition of post-electrolysis waste-concentrate from waste rinse water

Elements	Electrolysis Scheme 1 Weight %	Electrolysis Scheme 2 Weight %
O	15.39	28.93
Na	15.72	10.92
S	0.14	—
Mn	0.29	—
Cl	15.43	26.33
K	2.51	5.94
Zn	19.31	14.84
Other elements	31.21	13.05
Total	100%	100%

(B) Publications

1. Treatment of dye effluent by electrochemical and biological processes.
B. Ramesh Babu, A.K. Parande, S. Arun Kumar, S. Udaya Bhanu.
J. Safety Sci. Tech. 1 (2011),12-18.
(doi:10.4236/ojsst.2011.11002).
2. Removal of pesticides from wastewater by electrochemical methods- A comparative approach.
B. Ramesh Babu, K. Seeni Meera, P. Venkatesan.
Sustain. Environ. Res., 21(2011), 401-406.
3. Treatment of engine oil effluent by electro-oxidation and aerobic biological degradation.
B. Ramesh Babu, S. Sasi, K. R. Saravanan, N. Vadivel Murugan.
Sustain. Environ. Res. 21(2011), 109-116.



Advise on hard anodizing of aluminium alloys

Principal Investigator : Dr. S. Mohan

Sponsor : Wabco, TVS.

Duration: Six months.

Objectives

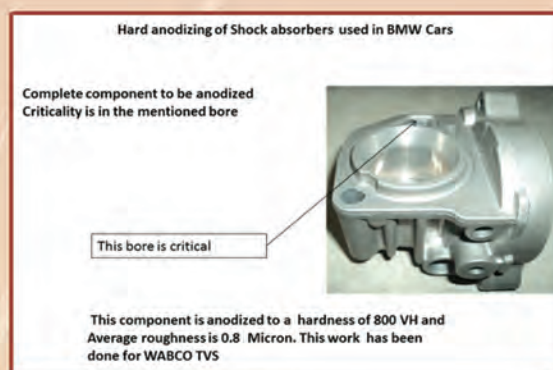
To hard anodize aluminium alloys.

Progress highlights

(A) Salient Results & Conclusions

The shock absorber used in BMW cars was anodized as per the specification given by Wabco TVS. TVS Wabco, is using our formulation for hard anodizing of aluminium alloys.

Aluminium alloy is hard anodized to thickness of 20 microns with a Roughness value 0.8 Microns. We have optimized the process to get a hardness of 800 VH.



"The edifice of science not only requires material, but also a plan. Without the material, the plan alone is but a castle in the air - a mere possibility; whilst the material without a plan is but useless matter."

- Dmitry Ivanovich Mendeleev



CNP-04/11

Designing, fabricating and Installing a 2 kA rating pilot electrolyser suitable for the electrolytic production of caustic soda - chlorine-hydrogen at Grasim Industries

Principal Investigator : Dr. K. Subramanian

Sponsor : Grasim Industries (Aditya Birla Group), Madhya Pradesh.

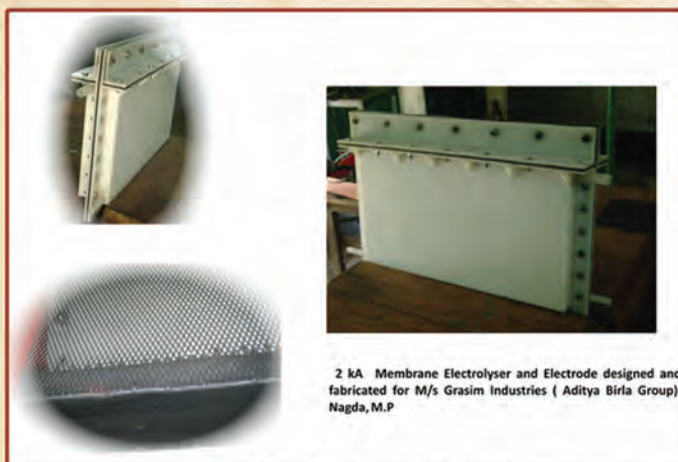
Duration: Four Months.

Objectives

To design, fabricate and install a 2 kA rating Pilot membrane electrolyser for the production of caustic soda-chlorine-hydrogen.

Progress highlights

2 kA rating (active area: 0.50 m²) membrane electrolyser with catalytic anode with an active coating on titanium and coated cathode with active catalytic coating on nickel were designed. The electrolyser body was made up of polypropylene polymer material. Anode and cathodes were having expanded mesh structural configuration. The anode and cathode compartments were separated by bilayer composite perfluoro sulphonic/carboxylate layer membrane (nafion 961). The electrolyser is to be used to study various process parameters at the commercial plant site.



2 kA Membrane Electrolyser and Electrode designed and fabricated for M/s Grasim Industries (Aditya Birla Group), Nagda, M.P

2 kA membrane electrolyser, Electrode designed and fabricated at CECRI for Grasim Industries



CNP-06/11

Corrosion control for brazed joints on copper tubes

Principal Investigator : Dr. G.T. Parthiban

Sponsor : Faiveley Transport India Limited, Hosur.

Duration: Six months.

Objectives

To advice on the corrosion behaviour of brazed joints on copper tubes and to advice on the corrosion control measures for the brazed joints.

Progress highlights

(A) Salient Results & Conclusions

The corrosion of copper tubing of HVAC system in Delhi Metro Rail was investigated. The corrosion was determined to be caused by the deposits. Suitable remedial measures were recommended.



Metro Rail Cooling system: Testing of brazed joints on Copper tubes



CSIR-CECRI ANNUAL REPORT 2011-2012

CNP-07/11

Suggesting suitable coating to protect the steel components of radial gates and other parts and monitoring the application of the protective coating on radial gate and other steel components as per CECRI specification for Sardar Sarovar dam, Dam Gujarat ,Phase – II

Principal Investigator : Dr. M. Selvaraj

Sponsor : Sardar Sarovar Narmada Nigam Ltd, Vadodara.

Duration: 2012 - 2013.

Objectives

To suggest suitable coating system to protect the steel components of radial gates and other parts and supervise the painting work at the time of implementation.

Progress highlights

(A) Salient Results & Conclusions

On the spot inspection of the radial gate components were made and the corrosion product was collected for analysis. The suitable protective coating system and the surface preparation were recommended and will supervise the painting work at the time of implementation.



Faraday Medal 2011 awarded to
Jean Marie Tarascon at CECRI



SSP-07/05

Corrosion monitoring of pre-stressed strands in kudankulam nuclear reactor

Principal Investigator : Shri. SP. Manoharan

Sponsor : Nuclear Power Corporation of India Ltd, Mumbai.

Duration: 2010 - 2012.

Objectives

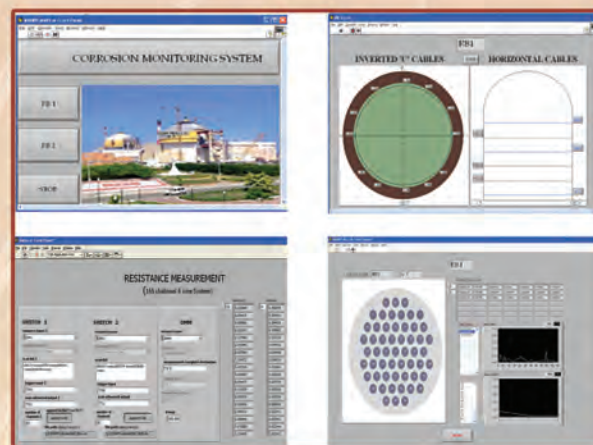
The objective of the project is to monitor the corrosion status of the pre-stressed inverted 'U' cables and horizontal cables in the inner containment wall of the nuclear reactors under construction at Kudankulam. Corrosion monitoring has been carried out by two techniques namely embedded integrated corrosion monitoring sensor and electrical resistance techniques to get representative corrosion status of the reactor building.

Progress highlights

(A) Salient Results & Conclusions

Corrosion monitoring system was commissioned in the reactor building RB#1 & RB#2 of KKNPP, Kudankulam. A corrosion monitoring software has been developed for low resistance measurement of pre-stressed strands in the containment of the reactor building in lab view software. It is a user-friendly graphical menu driven software and it automates corrosion monitoring system and acquired the sensor data through CR-200 data logger and the NI PXI measurement system. The interface contains a reactor figure showing all sensors. The user shall be able to pick statistical data from a sensor by clicking on the sensor position on the reactor figure. All data have saved in a database build into the controlling software. A routine data management and backup provision has been included in the software menu. All statistical data are possible to present as historical trends in user required time intervals.

Hand-on training was given to the NPCIL officials for carrying out corrosion measurements with the help of



Software Menu



SSP-14/06

Studies on the development of high durability and multifunctional concrete

Principal Investigator : Dr. V. Saraswathy

Sponsor : Yonsei University, South Korea .

Duration: 2007 - 2013.

Objectives

To study the high durability and multifunctional concrete.

Progress highlights

(A) Salient Results & Conclusions

Multi component inhibitor formulation for electro injection process towards the corrosion of steel in different concretes:

Electro injection of inhibitors into concrete is considered as one of the simple and economic repair and rehabilitation strategies for civil infrastructures. In the present study, a new multi component inhibitor formulation was designed and evaluated. In the first stage, the inhibitor efficiency was evaluated in simulated cement environments namely ordinary Portland cement (OPC), pozzolana Portland cement (PPC) and Portland slag cement (PSC) extracts in the presence and absence of chlorides.

In the second stage, the inhibitor formulation was electro injected into OPC, PPC and PSC concretes admixed with various percentages of chloride. The Open circuit potential (OCP) of rebar was monitored after the electro injection of inhibitor into concrete. Electro injected specimens were subjected to potentiodynamic polarisation and electrochemical impedance measurements. Electro injection process showed a remarkable 100 fold decrease in the corrosion rate of steel even in the presence of aggressive chloride ions when compared to systems without electro injection.

IR spectra on the surface of the steel rebar confirmed the existence of inhibitor molecule on the embedded steel. Multi component inhibitor formulation showed more than 95% efficiency in terms of reduction in corrosion rate irrespective of chloride levels in different concretes. In the third stage, the passivation potential was monitored for long term exposure period of one year.

Synthesis of nano silica and evaluated their performance in concrete

Nano silica is synthesized from Rice Husk Ash (RHA- an industrial waste) by precipitation method. The effect of nano silica on mechanical strength of concrete, permeability properties of concrete and corrosion resistance properties of concrete were studied.

Marine exposure studies at Mandapam camp and Tuticorin

The objective of this study is to investigate the relative performance of a range of Portland and blended cement concretes (Portland pozzolana cement (PPC) and Portland slag cement (PSC) for long term exposure under tropical marine conditions at the corrosion testing centre, Mandapam camp, and OPMEC unit, Tuticorin, India. The concrete samples (OPC, PPC and PSC) exposed at Mandapam and Tuticorin were subjected to electrochemical measurements such as LPR, Tafel polarization measurements and impedance measurements after five years of exposure period and found that PSC cement is found to perform better than the OPC and PPC concretes.



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(B) Publications

1. V. Saraswathy, S. Muralidharan, L. Balamurugan, P. Kathirvel, A.S.S. Sekar,
Evaluation of composite cements using cyclic polarisation techniques:
KSCE J. Eng.15 (2011) 1415-1418.

2. S.Hameed, A.S.S. Sekar, V. Saraswathy,
Strength and permeability characteristics of self compacting green concrete using crusher rock dust and marble sludge powder,
Arab.J. Sci. Eng. B37 (2012) 561-574.

(C) Honors / Award

Awards/Recognition	Awardee(s)	Awarded to
17 th NIGIS NACE Corrosion Excellency Award (2011) for individual contribution in Corrosion Science and Technology	NACE - Mumbai	Dr.V.Saraswathy Senior Principal Scientist
Raman Research Fellowship - 2011-2012, 25 th July - 24 th Nov. 2011 - University of California, Irvine	CSIR , New Delhi	Dr.V.Saraswathy Senior Principal Scientist



SSP-07/07

Corrosion monitoring of previously installed corrosion monitoring probe sensors and also on the previously monitored pre-stressing cables in 2nd Thane Creek Bridge, Navi Mumbai

Principal Investigator : Er. K. Saravanan

Sponsor : Public Works Department, Thane Creek Bridge Division, Navi Mumbai. .

Duration: 2007 - 2012.

Objectives

The main objective of the project is to ensure the present status of the previously installed corrosion monitoring probes, potential probes and electrical connections taken for monitoring of corrosion of pre-stressing cables. And also to retrieve the damaged probe sensors if any, and periodic corrosion monitoring of probes and pre-stressing cables.

Progress highlights

(A) Salient Results & Conclusions

Accordingly, all the earlier installed corrosion monitoring probe sensors have been examined for their present conditions and 13 probe sensors were found damaged. Then retrieval work has been carried out on these damaged probes and makes them suitable for future corrosion monitoring. Presently except one probe sensor remaining 29 probe sensors are intact for corrosion monitoring. In addition, all the electrical connections of pre-stressing cables have been examined for their present state and found that all the electrical connections are in good condition. Later initial corrosion measurement has been carried out on probe sensors for predicting the % reduction in diameter of mild steel reinforcement. Potential measurement has also been carried out on potential probes.

Data on corrosion measurement has been done on pre-stressing cables using cable resistance measurement. From the initial measurements on probe sensors and potential probes, it was found that the mild steel was in passive condition. The majority of the cable resistance values of pre-stressing cables indicate lesser values than the theoretically assessed values. These values indicate the corrosion free condition of steel in 2nd Thane Creek Bridge. Further monitoring is in progress.



Charge-discharge mechanics of lithium-ion batteries

Principal Investigator : Dr. A. S. Prakash

Sponsor : ISL, General Motors, Bangalore.

Duration: 2009 - 2012.

Objectives

- ❖ To study the mechanical as well as the chemical manifestation of charge-discharge cycling process over different shapes of LiMn_2O_4 and LiFePO_4 flaky particles.
- ❖ To establish the degradation in terms of capacity loss over a number of charge-discharge cycles as a function of
 - (a) Shape of the electrode particles,
 - (b) Rate at which charge-discharge is conducted
 - (c) Temperature,
 - (d) Nature of electrode material,
 - (e) Charging type (galvanostatic and potentiostatic conditions),
 - (f) State of charge.

Progress highlights

(A) Salient Results & Conclusions

The electrode materials composed of three different shapes, flaky, spherical and fibrous LiMn_2O_4 have been synthesized, characterized and are subjected to cycling at varied conditions for instance, varying temperature, operating voltage, charge discharge rates and state of charge (SOC). It was observed that spherical shape particles experience more stress resulting in mechanical degradation leading to capacity loss. The mechanical degradation for three different shapes follows the order, spherical > cylindrical > flaky particles. These results are in agreement with theoretical studies.



B.Tech student donating blood on blood donation camp



SSP-04/10

Investigating the failure of BF gas and L D gas lines to ascertain the reasons for the localized corrosion for the gas lines and suggest suitable remedial measures to solve corrosion – Vizag Steel plant

Principal Investigator : Mr. S. Ramu

Sponsor : Rashtriya Ispat Nigam Ltd., Visakhapatnam Steel Plant, Visakhapatnam.

Duration: 2010 - 2012.

Objectives

To identify the cause of corrosion in blast furnace and LD converter gas pipelines and suggest suitable coating system for the pipelines.

Progress highlights

(A) Salient Results & Conclusions

The corrosion rate of steel material in water brought from V.S.P. was evaluated by weight loss, polarization and impedance methods at 55°C. Several inhibitor compositions were also evaluated. Since the pitting initiated from the inner side of the pipelines, detailed investigations were made on the inner surfaces to find out the reasons for the localized corrosion. The corrosion products collected from the gas pipes were analyzed by XRD, AAS and EDAX techniques. The water collected from these pipelines was also analyzed.

Mild steel strips of size 2'x1" were coated with epoxy primer and chlorinated rubber based top coat and another system of vinyl primer and topcoat were exposed inside the pipelines. The protective performance of these coated strips were evaluated periodically and found that both the systems performed well. The vinyl system was superior than the other and so new strips were coated with the vinyl system and again exposed inside the pipeline for conformation.



"My grandfather once told me that there were two kinds of people: those who do the work and those who take the credit. He told me to try to be in the first group; there was much less competition."

- Indira Gandhi



SSP-05/10

Corrosion problems in N1 bunkers and cooling zone of CCD in SMS (hood corrosion) and suggest suitable solutions in the plant area at Vizag Steel Plant

Principal Investigator : Dr. M. Selvaraj

Sponsor : Rashtriya Ispat Nigam Ltd., Visakhapatnam Steel Plant, Visakhapatnam.

Duration: 2010 - 2012.

Objectives

To study and identify the cause of corrosion in N1 bunkers, steam exhausters, ducts and . cooling zone of CCD in SMS (hood corrosion) study all possible solutions like material change of bunkers, chemical treatment of water by additional corrosion inhibitors, and high temperature resistance To study and identify the cause of corrosion in N1 bunkers, steam exhausters, ducts and . cooling zone of CCD in SMS (hood corrosion) study all possible solutions like material change of bunkers, chemical treatment of water by additional corrosion inhibitors, and high temperature resistance.

Progress highlights

(A) Salient Results & Conclusions

The cause of corrosion in N1 Bunkers and secondary cooling zone were identified and the corrosion products from the bunker area were collected and analyzed by XRD, AAS and EDAX techniques. These results indicate the presence of magnetite iron oxide, iron oxy - hydroxides, Iron sulphide and iron carbonate. The cooling water collected from the bunker indicated the pH range of 4-4.5 due to the presence of fluoride ions. These fluoride ions were leaching out from the fluoride flux used in the process. Suitable inhibitor formulation for minimizing the corrosion is being developed.

Four types of coating system coated on sand blasted as well as wire brushed steel panels were exposed inside the N1 bunker on a stand. The corrosion rate was calculated by exposing the polished mild steel plates inside the N1 Bunker. The protective performance of the coating systems were evaluated periodically and found that the IPN based formulation was performed well in this environment. Thus we have again modified the formulations and exposed IPN based Teflon coated panels and Aluminium spray coated panels in the bunker for evaluation. It was found that Aluminium spray coated formulation perform well than the IPN based Teflon coatings in this bunker environment.



Performance and durability studies on pre-stressed concrete made with Portland pozzolana cement

Principal Investigator : Mr. K.Saravanan

Sponsor : National Council for Cement and Building Materials, Ballabgarh.

Duration: 2010-2012.

Objectives

The performance evaluation studies will be carried out at CECRI on the prestressed concrete beam made with two brands of PPC and one brand of OPC with two grades of concrete. The various corrosion performance studies such as potential time study, electrochemical impedance spectroscopy and Instantaneous corrosion rate measurements will be done on prestressed concrete specimens made with PPC and OPC cements. In addition to the above, corrosion monitoring on prestressed concrete beams will be done using cable resistance measurement for a period of 12 months. Load deflection behaviour, bond strength measurement and carbonation test will also be carried out on PPC and OPC concrete specimens.

Progress highlights

(A) Salient Results & Conclusions

The performance and durability studies on pre-stressed concrete made with ordinary Portland cement (OPC) and Portland pozzolana cement (PPC) was studied. Laboratory evaluation studies on prestressed concrete specimens are in progress for their corrosion resistance by using various electrochemical means in both normal and aggressive environments. The load deflection and bond strength studies are in progress. Based on the data collection so far the pre-stressing steel embedded in PPC concrete exhibits better behaviour than OPC concrete.



SSP-11/10

Development of suitable coating systems for benzol tanks in Vizag Steel Plant

Principal Investigator : Dr. S. Muthukrishnan

Sponsor : Rashtriya Ispat Nigam Ltd., Visakhapatnam Steel Plant, Visakhapatnam.

Duration: 2010 - 2012.

Objectives

To recommend a suitable protective coating system for the benzol tanks in VSP.

Progress highlights

(A) Salient Results & Conclusions

On the spot identification of the corrosion problems associated with the Internal and external structures of the benzol tanks were studied. Corroded products from the tanks were collected and examined in the laboratory. Different coating systems based on conventional epoxy, chlorinated rubber and two types Interpenetrating Polymer Network (IPN) were formulated and applied on the sand blasted mild steel surface as well as rusted surface treated with rust converter.

The performance of the coatings were evaluated by exposing the painted panels in the inner side of benzene and crude benzol storage tanks without touching of benzene and crude benzol storage tanks at VSP. The coating performance was satisfactory for the sand blasted panels exposed in the of benzene tanks for eleven months but failed in the crude benzol tanks after six months. Coatings applied on rust converted surface failed within four months of exposure.

Epoxy coating system developed using high epoxy equivalent weight was exposed in the crude benzol tanks. Performance of the coating was good for six months. Based on the field studies suitable protective coating system was Recommended.



SSP-17/10

Studies on ageing characteristics of multi layered tape wound canister

Principal Investigator : Dr. S. Syed Azim

Sponsor : DRDL, Hyderabad.

Duration: 2010 - 2011.

Objectives

- ❖ Flame retardant characteristics of innermost and outermost layers as per GOST 12.1.044-89 or ASTM Equivalent
- ❖ Resistance to corrosive agents of sea atmosphere and all Weather condition (rain, snow, fog), temperature – 400°C to + 550°C, RH up to 98% at + 400°C as per GOST 15150-69 or ASTM Equivalent
- ❖ Accelerated climatic tests of category 1 as per GOST 15150-69 or ASTM G53.
- ❖ Resistance to fungal growth as per GOST, 9.048-89 as per GOST, 9.049-91(microbiological stability of external surface not more than 3 points) or ASTM equivalent
- ❖ Rodent Test as per GOST 9.057-75 (stability of outer surface against damage by rodents not more than 1 point) or ASTM equivalent
- ❖ Exposure to actual marine environment

Progress highlights

(A) Salient Results & Conclusions

DRDL, has given both Russian canister and Indian samples for all the above tests with various sizes. The samples were subjected to all the above test procedures and the following are concluded.

1. Flame retardant test

Both Russian and Indian samples have passed the test.



Flame Retardant test of the Canister Sample

2. All Weather test

This is carried out by exposing the samples as per the following cycle -40°C for 8 hours followed by exposure to + 55°C and then exposed to 98% relative humidity for 8 hours. 30 cycles were carried out and it was found out that in the Russian sample some fungus growth was noticed as in the Indian sample the outer most layer got detached from the rest layers within 4 cycles of exposure.

3. Accelerated climatic test

The samples were exposed to alternate UV and condensation cycles as per ASTM G-53 for 500 hours. The initial and final gloss values were measured with Sheen Tri-Gloss meter. Both samples have performed equally good. The gloss values of the Indian samples have reduced to large extent, this may be due to paint which is not having UV resistance property.

4. Resistance to fungal growth as per GOST 9.048-89 or per GOST 9.049-91(microbiological Stability of external surface not more than 3 points).

The samples were tested as per GOST Standard and found have passed the test



Russian sample after 28 days(outer layer)



Indian sample after 28 days (outer layer)

5. Rodent Test as per GOST 9.057-75

The canister samples were subjected to rodent test as per the GOST standard. The result indicate that both samples have passed the test.

6. Actual marine exposure

Russian and Indian canister samples were exposed to actual marine environment at Mandapam for 4 months. The samples have not undergone any visible change. The gloss reduction over the Indian canister sample was noticed. This is due the poor weather resistance of the paint applied over the canister.

7. Salt spray test as per ASTM B117

Both the samples were exposed to salt spray test as per ASTM B117 to assess the performance in accelerated marine environment. 5% sodium chloride solution was used to create fog. The samples were subjected to 1200 hours of continuous exposure. Both samples have performed equally and resist the attack by salt fog. In the Russian canister samples fungus growth was observed. In case of Indian canister samples, the outer most got detached from the rest of the sample.

(B) Any other important information

- This study has helped in understanding the performance of these epoxy composite materials.
- Degradation of epoxy composites in presence of fungus has given new R&D area to understand the behavior of these materials.



SSP-19/10

Development of suitable protective coating systems for special mining (SME)

Principal Investigator : Dr. S. Muthukrishnan

Sponsor : Neyveli Lignite Corporation.

Duration: 2010 - 2012.

Objectives

To develop suitable protective coating systems for special mining (SME)

Progress highlights

(A) Salient Results & Conclusions

In this project, CECRI - formulated coatings were applied on sand blasted surface and hand cleaned surface. Both coating performance was observed for nearly one year.

The special mining equipment namely Bucket Wheel Excavator (BWE) 1574 was taken for the development of coatings. The protective coating system consisting of three coats was designed and formulated. BWE 1574 was sand blasted. Coating system was applied in the presence of CECRI scientists during November, 2010. The surface profile was measured and found in the range 20-25 microns. The primer coat thickness should be always greater than the surface profile of the sandblasted area. The primer coat thickness was 50-60 microns. Undercoat and top coat thickness were 80-100 and 30-40 microns only. Interval time between two coats was maintained as 16- 24 hours. Before the application next coat, the previous coating thickness was measured. After the application of final, total thickness of coating was measured. The total thickness of the coating was higher than the 160 microns i.e. the minimum thickness of the three coat system.

It was sent to mines in January 2011. First inspection of the coating was done on 4 May, 2011 along with NLC officials after four months of field operation. All the steering columns were covered with mines soil. For observation, soil was removed and cleaned with water. The painted area was in good condition. The Pylon areas nearly the same coating system was applied about one meter height. Here some soil was deposited on the surface. But paint film was in good condition. Second inspection was carried out on 31 January, 2011 after 13 months field operation. The performance of the coating was good.

The special mining equipment spreader namely Man III which is used to collect the materials in one hand and spread the materials to other directions. The area selected for the application of the coating is not having abrasion. It has to withstand the atmospheric corrosion only. This spreader was coated during two days shut down period May, 2011 at the field itself. Due the site condition and time constrains sand blasting could not carried out. Only hand cleaning was adopted with wire brush. After surface cleaning, primer coating was done on 25th June. The undercoat and top coat as applied on next day i.e. on 26th June, 2011.

First Inspection was done on 2, November 2011 along with NLC officials. The coating was intact after 4 months exposure at the field. Again second time coated area was inspected 1, February, 2012 i.e. after 8 months of field operation. Here the coating performance was satisfactory.



Condition survey and assessment of the different radial gate components for their suitability and structural integrity at Sardar Sarovar Dam Project

Principal Investigator : Dr. G.T. Parthiban

Sponsor : Sardar Sarovar Dam Project, Sardar Sarovar Narmada Nigam Ltd., Gujarat.

Duration: 2010 - 2012.

Objectives

To survey and assess the existing condition of each individual members of the structural members of the radial gates for their suitability and structural integrity

The assessment indicated that the components have undergone uniform corrosion primarily. Localized corrosion was observed in few components. Based on the assessments their utility is being determined.

Progress highlights

(A) Salient Results & Conclusions

Different radial gate components ranging from plain Tie Flats to complex shaped components, weighing several thousands of tons, were assessed for their corrosion, to ascertain their utility at Sardar Sarovar Dam, being constructed across the Narmada River, in Gujarat.



Sardar Sarovar Dam over the Narmada River



Drive unit assembly for Radial Gates



SSP-24/10

Effect of materials aspect on electrode kinetics of Lithium-ion batteries

Principal Investigator : Dr. A. S. Prakash

Sponsor : ISL, General Motors, Bangalore.

Duration: 11-03-2011 to 11-09-2012.

Objectives

- ❖ To study the effect of material aspects on electrode performance of Li-ion batteries, using selected cathodes namely LiMn_2O_4 , $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$, LiFePO_4 and composite cathodes and graphite anode.
- ❖ To estimate capacity loss during first few cycles and the nominal capacity of the cell at different temperatures.
- ❖ To establish the open circuit voltage profiles of the half cells and full cells as a function of state of charge (SOC), at different temperatures.
- ❖ To establish the charge-discharge asymmetry effects, temperature dependence, particle size dependence and mode of operation for phase change electrodes.
- ❖ To establish the presence of anode on the charge-discharge asymmetry of phase change electrodes based cells.
- ❖ To establish the temperature dependence of the battery performance.

Progress highlights

(A) Salient Results & Conclusions

The cathode materials such as LiMn_2O_4 (LMO)- $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$ (NMC) and LiFePO_4 (LFP) and 1:1 composite of NMC-LMO having specified dimensions (1-3 μm) were synthesized using appropriate synthetic techniques. Synthesized samples were characterized by XRD and SEM to determine phase formation and particles size/morphology. Electrode fabrication was carried out using standard procedure. Li-ion cells of 2032 type fabricated and their electrochemical performance was evaluated using galvanostatic, potentiostatic methods at varied conditions. These cells were handed over to our counterpart at GM for further studies.



Development of suitable protective coating systems for special mining (SME)

Principal Investigator : Dr. S. Muthukrishnan

Sponsor : Neyveli Lignite Corporation.

Duration: 2011 - 2013.

Objectives

To develop suitable protective coating systems for special mining (SME).

Progress highlights

(A) Salient Results & Conclusions

The special mining equipment namely Bucket Wheel Excavator (BWE) 1027 was taken for the development of coatings. Three coat systems was designed and formulated. Surface was sand blasted and the coating system was applied during June to August, 2011. The primer coat with conducting polymer of thickness 50-60 microns was applied.

Undercoat and top coat thickness were 80-100 and 30-40 microns only. Interval between the coats was maintained as per the requirement of the system. Each coat thickness was measured. This equipment sent for mines during Oct 2011.

The coating performance was evaluated on January and June, 2012. The coating was intact all places after 8 months field service.



SSP-05/11

Development of wear and corrosion resistant electroless nickel plating process for high strength titanium alloy Ti-10V-2Fe-3Al

Principal Investigator : Dr. K.N. Srinivasan

Sponsor : ADA, Bangalore.

Duration: 2010 - 2012.

Objectives

- ❖ To develop suitable electroless nickel bath for plating on Ti-10V -2Fe-3Al grade titanium alloy components to meet the requirements of ADA, Bangalore as per MIL specifications.
- ❖ To optimize suitable pre-treatment processes for adherent deposit of electroless nickel on titanium
- ❖ To develop a suitable electroless nickel bath with medium phosphorous content (8 – 10%) in the deposit.
- ❖ To deposit electroless nickel on titanium coupons of size 75 x 25 mm (25 Nos.) after standardizing suitable pre-treatment processes for the evaluation of various properties such as hardness, adhesion, hydrogen embrittlement behaviour and fatigue strength. Effect of heat treatment in the presence and absence of oxygen on the above properties will also be studied.
- ❖ To carry out type test and get it approved as per the relevant type test schedule
- ❖ To carry out electroless nickel plating on 6 numbers of slat track components

Progress highlights

- Studied various pre-treatments on Ti substrate.
- Prepared electroless nickel plated Ti samples under various pH and temperatures.
- Heat treated the electroless nickel plated Ti.
- Adhesion testing was carried out on both as plated and heat treated samples.
- Characterisation of the deposits, surface morphology and composition, was carried out by SEM and EDAX .
- Inspected electroless nickel samples displayed at Mandapam camp for atmospheric corrosion testing.

(A) Salient Results & Conclusions

Preliminary work was carried out. Developmental work is under progress.



SSP-07/11

Atmospheric corrosion on steel in 3 locations at new four lane elevated road from Chennai Fort to Maduravayal (NH-4)

Principal Investigator : Dr. M. Natesan

Sponsor : Soma Enterprises LTD, Chennai.

Duration: 2011 - 2012.

Objectives

To identify the pollutant in three locations and the corrosion rates of steel, aluminium and G.I. in these locations in NH-4 in Tamil nadu.

Progress highlights

(A) Salient Results & Conclusions

Mild steel, Galvanized steel and Aluminium panels were exposed in three sites and the corrosion behavior of these metals was evaluated. The atmospheric pollutant in these areas also studied in periodically and reported. Painted panels also exposed for the suitability of the coating system for this climatic condition.



SSP-09/11

Development of electroless nickel plating for Tejas actuator components made up special stainless steel

Principal Investigator : Dr. K.N. Srinivasan

Sponsor : ADA, Bangalore.

Duration: 2010 - 2012.

Objectives

- ❖ To develop suitable electroless nickel bath for plating on 15-5-PH stainless steel to meet the test schedule requirements of ADA, Bangalore as per specifications.
- ❖ To optimize suitable pre-treatment processes for adherent deposit of electroless nickel on 15-5-PH stainless steel
- ❖ To develop a suitable electroless nickel bath with medium phosphorous content (8 – 10%) in the deposit to achieve better corrosion and wear resistance
- ❖ To deposit electroless nickel on 15-5-PH stainless steel coupons of size 75 x 25 mm (25 Nos.) and also inner portion of the steel pipes after standardizing suitable pretreatment processes for the evaluation of various properties such as hardness, adhesion, and hydrogen embrittlement behaviour and fatigue strength.

Progress highlights

Electroless nickel on 15-5-PH stainless steel coupons of size 75 x 25 mm (25 Nos.) and also inner portion of the steel pipes after standardizing suitable pretreatment processes for the evaluation of various properties such as hardness, adhesion, and hydrogen embrittlement behaviour and fatigue strength were deposited.

- Effect of heat treatment in the on the above properties were also studied. The relevant type test schedule was processed out.

- Forward cylinder Dwg No:D2010-00-04 (internal plating) Rear cylinder Dwg No:D2010-01-01 (internal plating) Piston Dwg No:D2010-00-02 (internal and external) .

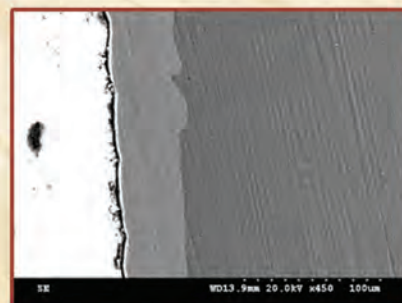
- To carryout type test and get it approved as per Electroless Nickel plating on the steel pipes of similar diameter and wall thickness of the following components to a final plating thickness of 40 μm with a surface finish of 0.4 μm .



Electroless nickel SS tube

(A) Salient Results & Conclusions

Development type Test Schedule for wear and corrosion resistant Internal plating scheme for actuator components of Tejas.



SEM image of Cross sectional view of electroless nickel on SS



Salt spray test (AS PER ASTM B117)

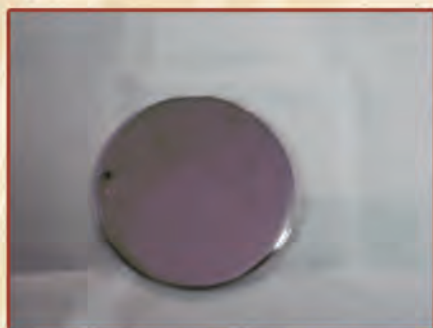
Three batches electroless nickel test coupons prepared at a bath pH of 4-5 to a thickness of 45 microns were subjected to salt spray fog test as per ASTM - B117. It was found that all the coupons withstood the minimum requirement of 144 hours without indication of any corrosion spot.

Salt spray test results of the three batches carried out at CECRI

Test description	Test Value	Batch 1	Batch 2	Batch 3	Test carried out at
Salt Spray test ASTM B117	144 Hrs	Passed	Passed	Passed	CECRI

Surface examination for pits

One Trial piece of the 15 -5 PH steel was tested for the pits on electroless nickel coated surface without any sand blasting. Slowly rotated the coupon while electroless nickel plating to avoid sticking of the bubbles in the coupon and plated to a thickness of 45 microns. After plating it was observed that no pits were observed in the coupons.



Salt-spray test coupons

Atmospheric corrosion test of electroless nickel plated specimens at CECRI Mandapam corrosion testing center

As a part of the ADA project on "Electroless nickel plating on maraging steel components" plated electroless nickel samples at bath pH of 4.5-5.0 and exposed the samples during January 2005 at CECRI marine corrosion testing center at Mandapam camp. Both as plated and heat treated samples (heat treated at 300°C for 10 hrs) were exposed at the testing yard.

In August 2006, CECRI prepared samples at different pH values of the bath and heat treated at 260, 315, 400 and 600°C. These samples were exposed at Mandapam camp for their corrosion resistance behaviour periodically.

CECRI team visited Mandapam testing centre and inspected the samples for their corrosion resistance behaviour.



Closure view of the samples not corroded



SSP-12/11

Durability studies with respect to corrosion resistance of Agni TMT steel rods with CRS property in comparison with Agni TMT steel rods without CRS property, which is to be used in reinforced concrete construction

Principal Investigator : Mr. K. Saravanan

Sponsor : AGNI Steels Pvt Ltd, Ingur.

Duration: 2009 - 2012.

Objectives

The durability studies with respect to corrosion will be carried out at CECRI on AGNI TMT rods (with and without CRS property). "TMT steel rods with CRS property" will be compared with other product "TMT steel rods without CRS property" for its corrosion resistance. This durability study will be done using various corrosion monitoring techniques such as potential – time, impedance, polarization resistance, potentio – dynamic, anodic polarization etc in both simulated concrete environment and actual concrete. Gravimetric study will also be done on these two steel rods in simulated concrete environments with and without chloride. Metallurgical characterizations (mechanical strength, composition, XRD, EDX, SEM, etc) will be carried out on these two steel rods and correlated with the corrosion behaviour of the respective steel rebars.

Progress highlights

(A) Salient Results & Conclusions

The durability studies with respect to corrosion on Agni TMT rods with CRS properties has been compared with the non CRS properties rebars for its corrosion resistance. The performance study has been carried out using various electrochemical and accelerated studies in both simulated concrete environments and actual concrete. The preliminary observations clearly indicates that the CRS TMT rebars exhibits better corrosion property than the other one. Further evaluation is in progress.



Studies on corrosion behaviour of aluminium alloys

Principal Investigator : Dr. G.T. Parthiban

Sponsor : Defense Metallurgical Research Laboratory, Hyderabad.

Duration: 2010 - 2012.

Objectives

To study and analyze aluminium alloys for their exfoliation corrosion and environment assisted cracking behaviour.

Progress highlights

(A) Salient Results & Conclusions

The study on exfoliation corrosion behavior of high strength aluminium alloys has been initiated. The effect of corrosion due to constant loading is also being commenced.



Exfoliation testing in marine atmosphere for aluminium alloys



Modelling and simulation

Principal Investigator : Dr. Bosco Emmanuel

Duration: 2011-2012.

Objectives

- ❖ Theory of corrosion under a thin electrolyte layer and a porous oxide layer for steady state and ac responses.
- ❖ Application of Crystal Shape algorithm nanocrystal shapes of CBD-Cds thin films.
- ❖ Rate constant computation for superoxide reaction with organic halides in aprotic media.

Progress highlights

(A) Salient Results & Conclusions

i) The effect of an inert porous layer sandwiched between a metal surface and a thin electrolyte layer was studied using a model developed by us recently. The corrosion current was computed as a function of the porosity of the barrier layer. The ac response of a metal freely corroding under a thin electrolyte layer which transports oxygen was shown to produce several interesting types of Nyquist plots : single semi-circles/depressed arcs, double depressed arcs and arcs with an intervening Warburg part all by varying the system parameters such as the anodic and cathodic rates and the thickness of the electrolyte layer. In the corrosion literature, depressed arcs were so far explained only by a constant phase element (CPE). The most interesting observation in the present work is that depressed arcs may result even without CPE.

ii) The mathematical algorithm which was developed by us for computing the crystal habits [i.e. the 3-D external shapes] of nano-crystallites present in powder material specimens and in thin films are finding applications in studying shape-selective properties of cathode material for Li-ion battery that influence battery performance and in thin film devices where the crystallite shape determine properties such as the photoluminescence.

iii) Cyclic voltammetry of O₂ gives one electron reversible peak due to superoxide formation and its oxidation. The superoxide ion reacts with the organic halide and forms superoxide and generates bromide ion. The rate of reaction depends on whether the organic halide is benzyl, allyl or alkyl, primary, secondary or tertiary.

The rate constant calculations are being made for a series of reactions of superoxide with 17 different organic halides in non aqueous solvents namely DMF, DMSO and acetonitrile. The organic halides include allyl, benzyl and alkyl iodides, bromides and chlorides.

A Maple program was written to compute the second order rate constants and the so computed values indicate superoxide to be a nucleophile of relatively low strength as compared with common nucleophiles.

(B) Publications & Patents

Publications:

- 1) M.S. Venkatraman, I.G. Bosco, I.S. Cole, B. Emmanuel.
"Model for corrosion of metals covered with thin electrolyte layers",
ECS Trans. 35 (2011) 1-10.
- 2) Influence of substrate on the structural, surface, photoluminescence and computed three dimensional nanocrystal shapes of CBD-CdS thin films.
T. Prem Kumar, D. Sherwood, B. Emmanuel, K. Sankaranarayanan,
J. Comput. Theor. Nanosci. 9 (2012) 1-6.



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Copy right :

1. Software to compute nano-crystal shape (habits) from power X-ray Diffraction data, Daniel Sherwood, Bosco Emmanuel.

Presentations:

1. S. Cole, Murali S. Venkatraman, W.D. Ganther, P. Corrigan, N. Azmat, K.D. Ralston, D.A. Paterson. T. Muster, E. Schindelholtz, B. Emmanuel "Advances in a multi-scale model of corrosion" – 18th International Corrosion Congress Proceedings, Perth, Australia, 2011.

2. Ivan S. Cole, Murali S. Venkatraman, N. S. Azmat, S. Thomas, I.G. Bosco, N. Biribilis, B. Emmanuel. "Porous oxides for self-repair on corroding metals" in Corrosion Mechanisms & Methods, EUROCORR 2011, Sweden.

3. Infant G. Bosco, Murali S. Venkatraman, Ivan S. Cole, B. Emmanuel. "Electrochemical impedance spectrum of metallic corrosion under a thin electrolyte layer controlled by oxygen diffusion" in Corrosion Mechanisms & Methods, EUROCORR 2011, Sweden.

4. Studies on Bifluorenylidene dianion, D. Vasudevan, Nancy Mills. 16th National Convention of Electrochemists, 15-16 Dec, 2011, Coimbatore, Tamil Nadu, P. 85.

5. Applications of crystal shape algorithm to experimental electrochemistry. D. Vasudevan, K. Raghavendran, D. Sherwood, Bosco Emmanuel. 16th National Convention of Electrochemists, 15-16 Dec, 2011, Coimbatore, Tamil Nadu, P. 86.

6. A review on the applications of ionic liquids in organic and electroorganic Synthesis, A.S. Siddharth, S. Kamalasekaran, D. Vasudevan. 16th National Convention of Electrochemists, 15-16 Dec, 2011, Coimbatore, Tamil Nadu, p. 103.

7. Krishna Rao Ragavendran, Hui Xia, Doron Aurbach, Mikhael Levi, Lu Li, Bosco Emmanuel, Devanathan Vasudevan, Daniel Sherwood.

New Directions in understanding the capacity fading in Cathode Materials for Lithium Batteries: a Prototype study on the Crystal Habit of LiMn₂O₄ Nano Particles, 7-8 Feb 2012, 77th Meeting of the Israel Chemical Society, Tel-Aviv, Israel.



OLP-57

Nanoparticles/clusters incorporated Metal Organic Frameworks Electrosynthesis and Catalysis

Principal Investigators : Dr. S. Senthil Kumar / Dr. M. Anbukulandainathan

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

Recent advances in the fast growing field of micro-porous metal organic frameworks (MOFs) have led to numerous practical and conceptual developments. The main focus of this proposal is on fundamental aspects of a previously unexplored scientific subject, we will investigate the applicability of MOF structures with regard to electrochemistry. These structures will be based on metal-nanoparticle loaded MOFs which are anchored to a patterned organic surface.

The possible areas we would like to address during this project.

- An effective electrochemical route for the synthesis of MOFs (Including Al, Cu, Pd, and Ni) with functionalized organic linkers.
- Structure prediction and the electrochemical properties of these synthesized materials.
- Controlled growth of catalytic metal nanoparticles or clusters (including Au, Pt Pd, Ni) within the MOFs Cavities
- Chemical / Electrochemical catalytic properties and the possible study on the mechanism of catalysis, which includes Epoxidation, Friedal-Crafts alkylation, Suzuki-Miyaura coupling and oxidation of alcohols.

Significant Progress

a. Milestone achieved:

- Electrochemical Synthesis of Cu-MOF, Al-MOF was achieved.
- Characterisation of the above by XRD, XPS, FTIR, BET surface area and SEM reveals the formation of the above MOFs, crystalline nature, pore size, surface area and nature of oxidation state of Cu or Al ions.
- Catalysis towards Carbon dioxide and nitrobenzene is demonstrated.

b. Milestone near achievement :

- Works relating to Nanoparticles of metal/metal oxides incorporation into the matrix of MOFs is initiated.

c. Would research being pursued lead to building up of a new research domain:

- Yes

R & D Outputs

- Electrosynthesis and characterisation of Cu-MOF: Application towards electro reduction of carbon dioxide (Submitted to Electrochem. Commun.)
- Investigation on electrochemical route for synthesis of metal (Cu and Fe) organic frameworks: characterizations and its catalytic activity – International Congress on Green Process Engineering, Dec. 6-8 2011, Malaysia.



Any other important information

i) Dr.V. Suryanarayanan has been deputed to Taiwan under DST Indo-Taiwan exchange programme.

ii). Invited talk entitled "Electrochemical Fluorination (ECF) in India" has been delivered at the "First Indian International symposium on fluorine chemistry (1st IISFC)" held at New Delhi during 20-24 February 2012, D. Velayutham.

iii). Selective conversion of perfluorobutyric acid and perfluoroisobutyric acid to 2H-heptafluoropropane and hexafluoropropene has been presented at the 1st IISFC held at New Delhi during 20-24 February 2012. K. Sathish, M. sridhar, P. Shanthan Rao, D. Velayutham, K. Kulangiappar, Raipal Singh, Raju Brahma.

iv). Synthesis and characterization of ammonium and imidazolium anion based room temperature ionic liquids (RTILs) for the anodic oxidation of phenolic compounds on carbon and Pt. electrodes. (Best Paper Award in Oral presentation),

K.R. Saravanan, T.M. Rangarajan, D. Velayutham, V. Suriyanarayanan,

Presented at NCE-16 at PSG Arts and Science College for women, Coimbatore during 15 and 16 December, 2011.

v). Voltammetric studies on the anodic dissolution characteristics of Ni, Cu and their alloys in absence and presence of triethylamine containing non-aqueous fluoride media (Oral presentation).

S. Sathyamoorthi, D. Velayutham, V. Suriyanarayanan, Presented at NCE-16 at PSG Arts and Science College for women, Coimbatore during 15 and 16 December, 2011.



OLP-0058

High performance electrocatalyst and membrane materials for polymer electrolyte fuel cells

Principal Investigator : Dr. A. K. Sahu

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 -2012.

Objectives

- ❖ Dendrimer-encapsulated Pt nano-particles (DENS) enhancing catalytic activity of oxygen reduction reaction for polymer electrolyte fuel cells (PEFCs).
- ❖ Sulfonated polymers blended with natural and synthetic polymers for restricting methanol cross-over in direct methanol fuel cells (DMFCs).

Progress highlights

(A) Salient Results & Conclusions

Catalytic activity of dendrimer encapsulated Pt nanoparticles anchored onto carbon towards oxygen reduction reaction in polymer electrolyte fuel cells was explored. Extensive physical and electrochemical characterizations confirm that Pt/G4-OH-C catalyst exhibits significant enhancement of catalytic activity towards oxygen reduction reaction (ORR). Dendrimer template studied here provides size-controlled preparation of Pt-based catalyst and facilitates uniform dispersion and loading of the catalyst onto carbon support. Hybrid dual-network membranes comprising chitosan (CS)-polyvinyl alcohol (PVA) networks crosslinked with sulfosuccinic acid (SSA) and glutaraldehyde (GA) and modified with stabilized silicotungstic acid (SWA) are explored for their application in direct methanol fuel cells (DMFCs). These membranes modified with sulfonated polyethersulfone (SPES) were also explored in DMFCs. Polyethersulfone (PES) is sulfonated by chlorosulfonic acid and factors affecting the sulfonation reaction, such as time and temperature, are studied. The ion-exchange capacity, degree of sulfonation, sorption, and proton conductivity for the mixed-matrix membranes were investigated.

The methanol cross-over for these membranes is lower in relation to Nafion-117 membrane. A series of novel organic-inorganic hybrid membranes were explored employing Nafion and acid-functionalized meso-structured molecular sieves (MMS) with varying structures and surface area. The structural behavior, water uptake, proton conductivity and methanol permeability of these hybrid membranes have been investigated.

(B) Publications & Patents

1. Catalytic activity of dendrimer encapsulated Pt nanoparticles anchored onto carbon towards oxygen reduction reaction in polymer electrolyte fuel cells, K.K. Tintula, A. K. Sahu, S. D. Bhat, S. Pitchumani, P Sridhar, App. Catal. B: Environmental 110 (2011) 178-185.
2. Chitosan-polyvinyl alcohol-sulfonated polyether sulfone mixed-matrix membranes as methanol-barrier electrolytes for DMFCs, S. Meenakshi, S. D. Bhat, A. K. Sahu, P. Sridhar, S. Pitchumani, A. K. Shukla, J. Appl. Polym. Sci. 124 (2012) E73-E82.
3. Natural and synthetic solid polymer hybrid dual network membranes as electrolytes for direct methanol fuel cells, S. Meenakshi, S. D. Bhat, A. K. Sahu, S. Alwin, P. Sridhar, S. Pitchumani, J. Solid State Electrochem. 16 (2012) 1709-1721.
4. Meso-structured Silica-Nafion hybrid membranes for direct methanol fuel cells, A. K. Sahu, S. Meenakshi, S. D. Bhat, A. Shahid, P. Sridhar, S. Pitchumani, A. K. Shukla, J. Electrochem. Soc. 159 (2012) F1-F9.



OLP-0059

Lithium intercalation behavior of certain pyro/polyphosphates

Principal Investigator : Dr. N. Kalaiselvi

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER)..

Duration: 2010 - 2012.

Objectives

- ❖ Synthesis and characterization of certain LiMP_2O_7 and $\text{LiM}(\text{PO}_4)_3$ compounds.
- ❖ Detailed study on phase analysis, local cation environment, conductivity, morphology and electrochemical behavior of synthesized compounds.
- ❖ Correlation of synthesis-structure-property relationship valid for pyro and poly phosphates.

Progress highlights

(A) Salient Results & Conclusions

- Phase pure and nanocrystalline solid solutions of novel category $\text{Li}_3\text{M}_x\text{V}_{2-x}(\text{PO}_4)_3$ ($\text{M} = \text{Fe}, \text{Co}$) have been synthesized using newer type of CAC and ODHAC methods.
- Deployment of Corn and Oxalyldihydrazide (ODH) as combustible fuels to synthesize monoclinic phosphates is a newer attempt, and the same has resulted in the formation of better performing $\text{Li}_3\text{M}_x\text{V}_{2-x}(\text{PO}_4)_3$ ($\text{M} = \text{Fe}, \text{Co}$) solid solutions.
- Extraction of third lithium from pristine $\text{Li}_3\text{V}_2(\text{PO}_4)_3/\text{C}$ at 4.6 V has been demonstrated without affecting the structural stability upon extended cycling.
- An appreciable capacity of 174 mAh/g (4.9V) and 132 mAh/g (4.5V) have been exhibited by the CAC synthesized $\text{Li}_3\text{V}_2(\text{PO}_4)_3/\text{C}$ cathode.
- LiVPO_4F category fluorophosphates have been synthesized using novel methods.
- Phase pure LiMP_2O_7 compounds have been synthesized by way of fine tuning of synthesis approaches.

vii) An extended solubility limit of $x=0.10$ for Fe dopant in $\text{Li}_3\text{M}_x\text{V}_{2-x}(\text{PO}_4)_3/\text{C}$ solid solutions has been achieved.

viii) $\text{Li}_3\text{Co}_{0.10}\text{V}_{1.90}(\text{PO}_4)_3/\text{C}$ has exhibited the highest capacity (178 mAh g^{-1}) and negligible fade (4%) and the demonstrated cycleability under the influence of 10C rate

(B) Publications & Patents

- Effect of mono- (Cr) and bication (Cr, V) substitution on LiMn_2O_4 spinel cathodes, N. Jayaprakash, N. Kalaiselvi, Gangulibabu, D. Bhuvaneswari, J. Solid State Electrochem. 15 (2011) 1243-1251.
- Synthesis and characterization of $\text{Li}(\text{Co}_{0.5}\text{Ni}_{0.5})\text{PO}_4$ cathode for lithium-ion aqueous battery system, M. Minakshi, Neeraj Sharma, D. Ralph, D. Appadoo, N. Kalaiselvi, Electrochem. Solid State Lett. 14 (2011) A86-A89.
- Role of iron dopant and carbon additive in improving the ionic transport and electrochemical properties of $\text{LiFe}_x\text{Mn}_{1-x}\text{PO}_4$ ($x=0.25$ and 0.75) Solid Solutions, D. Bhuvaneswari, Gangulibabu, C.H. Doh, N. Kalaiselvi, Int. J. Electrochem. Sci. 6 (2011) 3714-3728.
- Modified sol-gel synthesis to prepare nanocrystalline $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$ cathode suitable for rechargeable lithium batteries, Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi, Nano sci. Nano Tech. Lett. 3 (2011) 1-6.



5. Effect of reaction temperature on morphology and electrochemical behavior – A comparative study on hydrothermal and co-precipitation synthesis of LiCoO_2 and LiMn_2O_4 using same set of precursors, K. Sathiyaraj, Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi, IEEE Trans. Nano Tech. 11 (2011) 314-320.

6. Temperature - dependent surface morphology and lithium diffusion kinetics of LiCoO_2 cathode synthesized using combustion method, K. Lakshmanan, Gangulibabu, D. Bhuvaneswari, N. Kalaiselvi, Met. Mater. Int. 18 (2012) 249-255.

7. Role of structural defects in olivine cathodes, K. Sathiyaraj, N. Kalaiselvi, M. Manickam, Prog. Solid State Chem. (2012) 1-5.

8. $\text{Li}_3\text{M}_x\text{V}_{2-x}(\text{PO}_4)_3/\text{C}$ ($\text{M} = \text{Fe, Co}$) composite cathodes with extended solubility limit and improved electrochemical behavior, K. Nathiya, D. Bhuvaneswari, Gangulibabu, D. Nirmala, N. Kalaiselvi, RSC Adv. (2012) In Press.

9. Surfactant co-assisted sol-gel synthesis to prepare $\text{LiNi}_y\text{Mn}_y\text{Co}_{1-2y}\text{O}_2$ with improved electrochemical behavior, D. Bhuvaneswari, Gangulibabu, N. Kalaiselvi, J. Solid State Electrochem. (2012) In press.



OLP-0060

Electrochemical synthesis of hydrogen storage materials by molten salt technique

Principal Investigator : Dr. S. Angappan

Sponsor : CSIR – Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

- ❖ To develop a suitable material (rare earth and alkaline hexaboride) for high capacity hydrogen storage by molten salt technique.
- ❖ To find the suitable melt for the preparation of hydrogen storage materials.
- ❖ To find the hydrogen adsorption / desorption kinetics.
- ❖ To elucidate the mechanism and condition of hydrogen uptake / release.
- ❖ To improve efficient, safe, cost effective reversible hydrogen storage.

Progress highlights

(A) Salient Results & Conclusions

The following six compounds were synthesized by molten salt technique and their characteristics were studied. Further these six compounds were performed for hydrogen absorption studies.

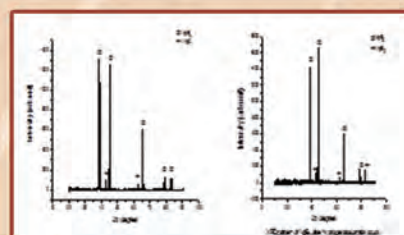
1) MgB_6 2) LaB_6 3) SmB_6 4) $SmCaB_6$ 5) NdB_6 6) $LaCeB_6$



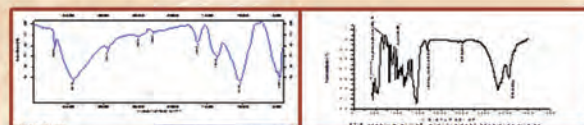
Electrolytic cell

Deposition of MgB_6

SEM image of MgB_6



XRD pattern before - after hydrogen studies



FTIR of MgB_6 before and after hydrogen absorption studies

From the results, no B-H bond was obtained both before and after hydrogen absorption studies for the above six compounds. The color of the crystal, hydrogen pressure, weight of the compound have no change during the hydrogen absorption studies carried out about 120 hrs. By analyzing the literature, Mg and Ca based compound which are very good reversible hydrogen absorption characteristics as 11.5-14.8 wt% of hydrogen uptake density. So, we have to plan for the synthesis of $MgCaB_6$ and their hydrogen uptake / release properties to be studied.



OLP-0061

Chemically modified semiconductor electrodes (CMSEs): "Enzyme-like" (non-enzymatic) approach for sensing applications

Principal Investigator : Dr. V. Ganesh

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2009 - 2012.

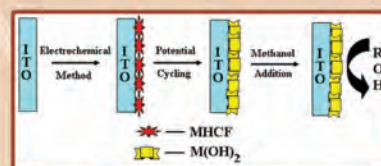
Objectives

- ❖ To create "enzyme-like" (bio-mimics) behaviour on CMSEs without using any enzymes.
- ❖ To develop a simple, cost-effective methodology/strategy for chemical modification of semiconductor electrodes (SEs).
- ❖ To identify the target (analyte) specific redox moieties and their successful immobilization onto SEs.
- ❖ To develop an electrochemical (amperometric) non-enzymatic biosensor for glucose and alcohol by monitoring their direct oxidation process on CMSEs.
- ❖ To make an attempt to fabricate a prototype device for sensing applications.

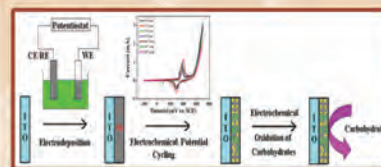
Progress highlights

(A) Salient Results & Conclusions

This project proposal aims at developing sensors and catalytic materials for alcohols and sugars by monitoring their corresponding direct electrochemical oxidation processes using chemically modified semiconductor electrodes. Basically, the target (analyte) binding redox moieties immobilized on semiconductor electrodes result in non-enzymatic detection of sugars and alcohols. Addressing the fundamental issues related with electron transport across semiconductor electrode – electrolyte interface and creating enzyme-like behaviour without the use of enzymes are some of the key features of this project. A simple, cost-effective but efficient and reliable methodology is developed for chemical modification of semiconductor electrodes (Refer to Schemes 1&2).



Scheme 1: Pictorial representation of the strategy adapted for chemical modification of ITO electrodes to design and fabricate electrocatalysts for direct alcohol oxidation process.



Scheme 2: Schematic representation of the methodology followed to design and develop a novel platform for direct electrocatalytic oxidation of carbohydrates in alkaline medium.

(B) Publications

1. Electrochemical behaviour of metal hexacyano ferrate converted to metal hydroxide films immobilized on indium tin oxide electrodes – catalytic ability towards alcohol oxidation in alkaline medium.
V. Ganesh, D. Latha Maheswari, Sheela Berchmans, *Electrochim. Acta.* 56 (2011) 1197-1207. (IF: 3.642).
2. Nickel hydroxide deposited indium tin oxide electrodes as electrocatalysts for direct oxidation of carbohydrates in alkaline medium.
V. Ganesh, S. Farzana, Sheela Berchmans, *J. Power Sources.* 196 (2011) 9890-9899. (IF: 4.283).

(C) Any other important information

Rated "A" grade during the evaluation by a committee headed by DG, CSIR.



Development of Rechargeable Na-batteries

Principal Investigator : Dr. A. S. Prakash

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

- ❖ To develop new Na-insertion materials for Na-ion battery cathode.
- ❖ To explore Na-alloy reaction, conversion reaction and low Potential Na-insertion in order to drive new anodes for Na-rechargeable batteries.
- ❖ To develop non aqueous Na-ion electrolyte which are compatible with the operating voltage window of 2 to 4.6 V.

Progress highlights

(A) Salient Results & Conclusions

New generation of batteries using Na instead of Li

A new layered phase, $\text{NaNi}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3}\text{O}_2$, which is the sodium counterpart of the commercially exploited LiNMC phase is reported. It exhibit reversible Na intercalation hinting at rechargeable Na-ion batteries.

New concepts in energy storage

Nano V_2O_5 /CNT as high power high energy density electrodeCapacitors exhibits high power density and Li-ion batteries a high energy density, the combination of both offers an attractive approach to realize future devices reuniting attractive energy and power capabilities.

• Nano V_2O_5 /CNT composite is also been successfully demonstrated as cathode material for Na-ion batteries.

• Na-ion conducting non aqueous electrolytes have been developed

(B) Publications

1. M Sathiya, A.S. Prakash, K. Ramesha, J.M.Tarascon, A.K. Shukla, V_2O_5 -anchored Carbon Nanotubes for enhanced electrochemical energy storage, J. Am. Chem.Soc. 133 (2011)16291–16299.
2. M. Sathiya, K. Hemalatha, K. Ramesha, A.K. Shukla, A.S. Prakash, Nitrates–melt synthesized $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$ and its performance as cathode in Li-ion cells, Bull. Mater. Sci. 34 (2011) 1693-1698.



Development of the nanoconcrete

Principal Investigator : Er. P. Venkatesan

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

Enhancing the engineering property of the concrete by incorporating finer cement particles produced by heavy energy milling process, by chemical admixtures, by adding nano carbon fibres.

Progress highlights

(A) Salient Results & Conclusions

Ordinary Portland cement (OPC) is fine powered using heavy energy milling process. In the design mix, the cement content is partially replaced by fine powdered OPC. Then the concrete cubes casted. The concrete cubes shown enhanced compressive strength on 7th and 28th day testing.

Compressive strength test on cube specimen showed that with 10% as well as 20% replacement of finer cement resulted in 40% enhancement in the compressive strength after 7th day.

Enhancement in the compressive strength with 10% and 20% replacement of finer cement are given in the table below.

Replacement of finer cement	28 days	120 days
10 %	83 %	78 %
20 %	57 %	29 %

(B) Publications and patents

1. Characterisation and utility study on un-reinforced and fiber reinforced reactive powder concrete.

International Symposium on Cement & Concrete Materials (ISCCM 2011), Ningbo, China, 7-9 November 2011.

2. Formulation and characterisation of concrete with waste cloth.

International Symposium on Cement & Concrete Materials (ISCCM 2011), Ningbo, China, 7-9 November 2011.



OLP-0064

Phase-transfer assisted electrochemical sensing

Principal Investigator : Dr. J. Mathiyarasu

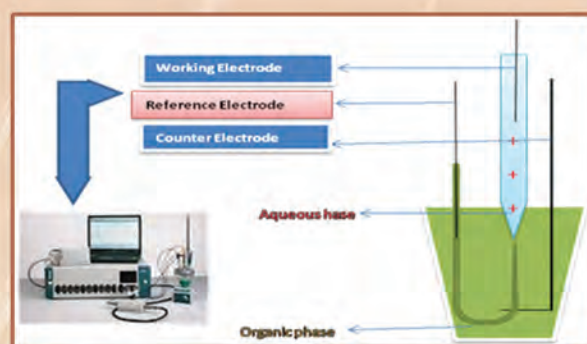
Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

The idea is to demonstrate the controlled transfer of the molecules to the subsequent phase that offers separation and pre-concentration, which is important in analytical point of view. Here the approach entails in taking advantages of the spontaneous transfer (by thermodynamics means) of the molecule between the phases. The proof-of-concepts may be brought into a miniaturized chip device for the purpose of separation and detection of molecules of interest, which will facilitate the development of 'lab-on-a-chip' devices using controlled transfer of a molecules for its separation and detection.

Sodium or potassium ion transfers to the next phase at the micro- interface between two immiscible electrolyte solutions (micro-ITIES) are demonstrated. In this experiment, micropipettes fabricated using shutter puller instruments were used as the tool for the determination of the ionic species at the micro-interface between two immiscible electrolyte solutions (micro-ITIES) in a limited potential window. The main advantage of the microelectrode was to decrease the solution resistance and improve the signal-to-noise ratio.



Experimental set up of micro-ITIES



SEM image of the micropipette with inner diameter 42.56 μm and outer diameter 56.88 μm this is filled with an aqueous solution.



OLP 0065

Development of advanced materials for hydrogen storage

Principal Investigator : Dr. J Davidson

Sponsor : CSIR –Encouraging and Motivating Pursuit of World class Exploratory Research (EMPOWER).

Duration: 2010 - 2012.

Objectives

Development of advanced materials for hydrogen storage

Progress highlights

(A) Salient Results & Conclusions

An experimental facility for the assessment of hydrogen storage in materials has been established under this project funding.



Low temperature method of synthesising Lithium amides was optimized.

Investigated the electro catalytic activity of nickel alloys for ammonia oxidation.

Investigated non- noble electro catalyst Ni-Zn-S alloy deposited on Nickel substrate for ammonia oxidation and obtained maximum current density $100\text{mA}/\text{cm}^2$ which are stable up to 8 cycles.



OLP-0067

DNA based naonmaterials for catalysis, device and sensor applications

Principal Investigator : Dr. Subrata Kundu

Duration: 2010 - 2012.

Objectives

To develop DNA based naonmaterials for catalysis, device, and sensor applications

Progress highlights

(A) Salient Results & Conclusions

DNA based naonmaterials for catalysis, device, and sensor applications.

Different biological molecules, such as peptides, nucleic acids, proteins and amino acids which possess the ability to self-assemble have been used as templates in fabrication and construction of metal nanoclusters and nanodevices. Among these bio-molecules, deoxyribonucleic acid (DNA) molecules have been widely investigated for use as the basic building block for the assembly of computational elements and interconnections for devices. Our approach is to apply DNA as a template for nanowires synthesis and their application as conducting element for nanodevices, catalysis study, and for sensor applications. The linear poly-nucleotide chain in DNA has a favorable diameter of 1-2 nm width and a length that can exceeds few microns, resulting in a high aspect ratio. Template assisted nanowires using DNA can be synthesized with variable lengths ranging from few nanometers to few micrometers.

There are two binding sites in DNA, one is the negatively charged phosphate group and another is the aromatic base molecules. Moreover, there are alternate phosphate groups and sugar units at the backbone of DNA molecule, which can bind with various cationic nanoparticles (NPs) and metal cations by electrostatic interaction.

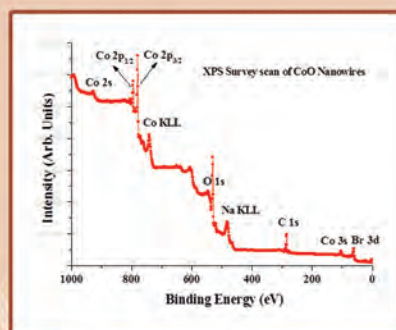
The other important characteristics of DNA include (a) the double-helix rigid chain structure which gives DNA higher mechanical strength (as compared to other template molecules); (b) the well designed polymeric sequence and chemical structure allows DNA to self-assemble into a hierarchy of complex structures, such as squares, cubes and 'T' junctions that may be used to make complex circuit elements; (c) the intermolecular interactions in DNA are most readily programmed and reliably predicted. This viability of DNA as a structural backbone in nanodevices has been highlighted in several examples, wherein this versatile polymer defines the architecture of the scaffold, directs the positioning of components and mediates the growth of an electrically conductive network.

Synthesis of DNA-based nanomaterials and nanowires using wet-chemical, UV-photoreduction, and microwave heating method. We will focus mostly for the synthesis of mono-metallic and bi-metallic nanowires made from Au, Ag, Rh, Ir, Co, and Bi as well as semi-conductor nanomaterials like CdSe, CdTe etc. by adopting suitable synthetic strategies. The synthesis process will follow mainly three steps where (1) the metal ions will first complexed onto DNA scaffold; (2) the metal ions will reduced to form metal NPs and (3) the NPs or nanoclusters will specifically deposit on DNA scaffold. Characterization of the synthesized nanomaterials and nanowires using the UV-Vis, TEM, SEM, AFM, XPS, and XRD analysis. We will evaluate the potential of these nanowires for catalysis reactions, device applications, and for specific sensor applications. The capability of fabricating metallic and semi-conductor nanowires at ambient condition in room temperature with arbitrary topology will offer interesting opportunities for future electronics, catalysis and sensor applications.



Photo-induced generation of shape-selective cobalt oxide nanowires and their magnetic studies.

A new route for the formation of shape-selective CoO nanowires has been developed using a simple microwave (MW) heating method. The process exclusively generates CoO nanowires of different length just by tuning the metal-ion-to-surfactant molar ratios and changing the other reaction parameters. Magnetization measurements indicate that there is no observable coercivity for the short nanowires, but the coercivity increases as the length of the nanowires increases although the magnetic moment values at the maximum applied magnetic field of 2 T have been decreased with increase in the length of the nanowires. The yield of the particles with uniform shapes are found to be significantly high (> 90%) and the particles are stable more than a month under ambient condition. The proposed synthesis method is efficient, straightforward, reproducible, and robust. Other than in catalysis, the cobalt oxide nanomaterials can also be applied for making pigments, lithium-ion battery materials or as solid state sensors and also as anisotropy source for magnetic recording. This detailed work is on progress and we got some results from TEM and XPS analysis as shown below.



XPS survey scan of CoO nanowires

Ongoing work:

Generation of shape-selective cobalt oxide (CoO) nanomaterials by microwave irradiations

Shape-selective formation of CoO NPs has been developed using a simple one-step in-situ non-micellar microwave (MW) heating method. The process exclusively generates different shapes like nano spheres, nano sheets and nano dendrite structures just by tuning the Co(II) ion to surfactant molar ratios and controlling other reaction parameters. The proposed synthesis method is efficient, straightforward, reproducible, and robust. Some of the TEM images are given below.

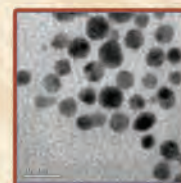
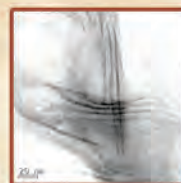


Photo-induced and microwave generation of Shape selective cobalt oxide nanomaterials.

The TEM images and electron diffraction of CoO nanowires at various magnifications



OLP-0068

Development of graphene-based high-performance counter electrodes for dye-sensitized solar cells

Principal Investigator : Dr. R. Thangamuthu

Duration: 2010 - 2012.

Objectives

- ❖ Development of graphene-based coatings, by using physical vapour deposition techniques and solution-based method, on different substrates such as fluorine-doped tin oxide, indium tin oxide conductive glasses and indium tin oxide-coated flexible substrates.
- ❖ Characterization of graphene-based coatings by using XRD, XPS, SEM and TEM. Evaluation of electrocatalytic activity of graphene coatings by using cyclic voltammetry and electrochemical impedance spectroscopy.
- ❖ Fabrication of DSSC assemblies using in-house developed graphene-based counter electrodes and evaluation of their performance.

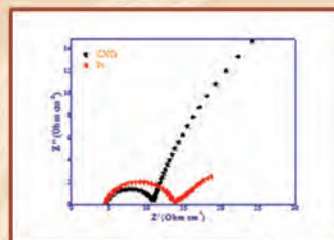
Status: Work is under progress.

On-going Work:

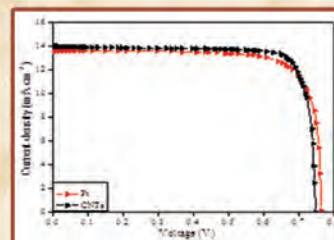
Development of carbon nanotubes-based counter electrodes for dye-sensitized solar cells

Carbon nanotubes (CNT) used in this study, for the fabrication of counter electrode, was synthesized by chemical vapour deposition (CVD) method using bimetallic catalyst, Fe-Cr-SBA-15. The CNT paste is coated on FTO plate by spin-coating method and dried at 60 °C. Then, the CNTs thin-film was heated at 300 °C for 15 min to maintain good adhesion between the CNTs layer and the FTO substrate. The electrocatalytic activity of the CNT-counter electrode is evaluated by using cyclic voltammetry. The charge-transfer resistance (R_{ct}) at the CNT electrode/electrolyte interface was obtained using electrochemical impedance spectroscopy. The DSSC assembly was fabricated by sandwiching dye-sensitized TiO_2 photoanode and CNT counter electrode.

The performance of the DSSC was evaluated with a simulated solar light intensity of 100 mW cm^{-2} . The energy conversion efficiency of the DSSCs based on the CNTs counter electrode and the TiO_2 photoanode reached 8.64% which is comparable with that of platinum-based counter electrode. The results suggest that the CNTs were one of the good candidates as counter electrode material for DSSCs.



Comparison of electrochemical impedance spectrum of CNT and Pt symmetric cells.



Photocurrent-voltage characteristics of DSSC fabricated with CNTs and Pt-based counter electrodes.



OLP-0069

Generation of new nanostructured metal catalyst with high activity surface architecture – An electrocatalyst for fuel cell and sensor applications

Principal Investigator : Dr.C.Sivakumar
Duration: September 2011- August 2013.

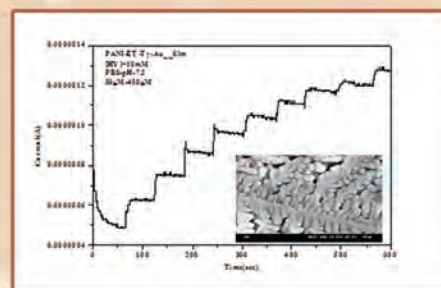
Objectives

- ❖ Generation of metal nanocatalyst monolayer(s) on polymer support – application to fuel cell catalysts
- ❖ Monitoring and quantification of phenolic compounds in environmental, industrial, medical and food samples are of great significance.
- ❖ A novel phenolic biosensor is fabricated using nanofibrillar PANI matrix as a support for the entrapment of Ty-enzyme by simple two process.

Progress highlights

(A) Salient Results & Conclusions

A novel PANI-Au_{nano}-tyrosinase enriched crude extract of potato biosensor film modified GC electrode was successfully constructed for detection of phenol, o-cresol, hydroquinone and catechol. One step procedure was adopted for the controlled fabrication of biosensor platform on GC electrode by cyclic voltammetry/ chronoamperometry and its morphological characterization was examined using SEM, and FT-IR techniques. This PANI matrix has provided good environment for retaining the entrapped/immobilized enzyme and its activity. This biosensor platform exhibits faster response, high sensitivity, good responsibility and long term stability. Based on the catalytic oxidation, PANI-Aunano-Ty modified GC electrode is used as sensor to determine the concentration of phenol, o-cresol, hydroquinone and catechol. At 0.22 V (vs SCE) the sensor platform has fast response and good operational stability. The different parameters, including working potential and pH that governs the analytical performance of the biosensor have been studied in detail and optimized.



Amperometric response of various addition of [Hydroquinone] = 10mM recorded at pH = 7.2 by Amperometric -I/t curve technique in the Potential range 0.22V vs Ag/AgCl at the scan rate of 50 mV/s.
Inset: SEM image PANI-ET-Ty film

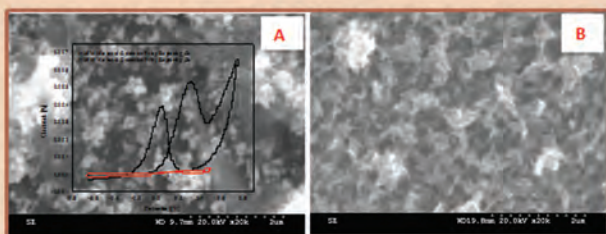
2. Generation of metal nanocatalyst monolayer(s) on polymer support - application to fuel cell catalysts

Non-precious metal nanoparticles such as Cu and Co are electrochemically deposited on PEDOT and are galvanically replaced by Pt nanoparticles as monolayer coverage, which can act as a fuel cell catalyst. This research work explores the fabrication of Pt nanocatalysts monolayer(s) on PEDOT support by galvanic displacement of Cu or Co deposited at under-potentials. The thickness of the Pt monolayer(s) can be controlled precisely by repeating Cu or Co-UPD-GDR.

A new Pt nanocatalyst surface structure (porous cauliflower structure: Fig.1A) with enhanced Pt surface area was attained (double the value) compared to direct deposition of Pt nanocatalyst on PEDOT. The electrocatalytic study of Pt monolayer(s) nanocatalyst entrapped PEDOT support towards methanol oxidation is discussed by each step of Cu or Co-UPD-GDR.



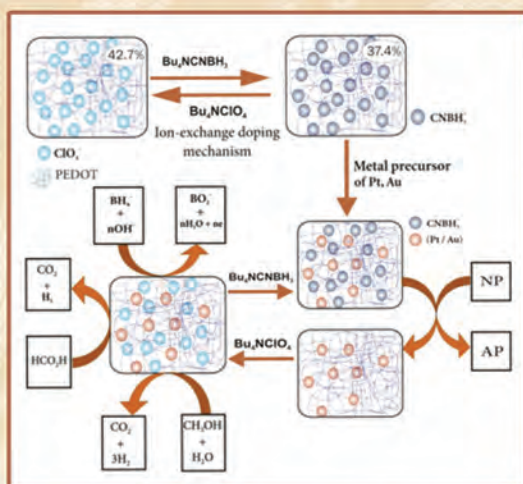
Enhancement of methanol oxidation peak current values was found to be six orders in galvanic displacement of Cu by Pt than the galvanic displacement of cobalt nanoparticles. Other characterizations like Cyclic Voltammetry, SEM, FT-IR, XRD, and AFM results clearly indicates the enhanced electrocatalytic effect, surface structure and binding nature of Pt monolayer(s) on PEDOT support for methanol oxidation.



SEM picture of Pt nanocatalyst monolayer(s) on PEDOT (A) and nanofibrillar morphology of PEDOT (B); Inset 1(A) : [CV of 2.5 M methanol oxidation curve of Pt nanocatalyst-PEDOT film obtained from (a) Cu-UPD-GDR; (b) Co-UPD-GDR at a scan rate of 50mV/s]

(B) Publications

Nanocatalyst U reagent-on-a-polymer film: A new polymer-supported system for (electro-)catalytic reactions C. Sivakumar and KLN.Phani.
[Chem. Commun., 47, 2011, 3535-3537].



Fabrication of PEDOT-supported nanocatalyst U CNBH3- and its catalytic applications



OLP

Plating from low temperature molten salt (LTMS) electrolyte

Principal Investigator : Dr. M.Selvam

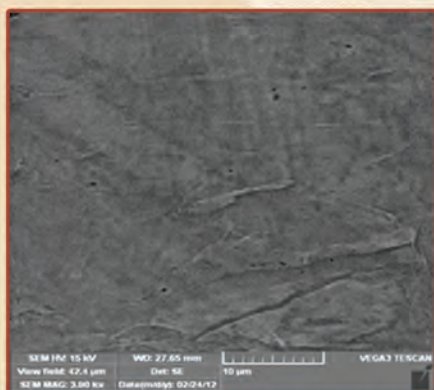
Objectives

- ❖ To study electro polishing of copper and stainless steel using Imidazole as the base chemical for LTMS.
- ❖ To study direct copper plating and its alloy on mild steel from LTMS.
- ❖ To study electroplating of zinc and its alloy from LTMS.
- ❖ To investigate the melting point of copper and zinc from LTMS.

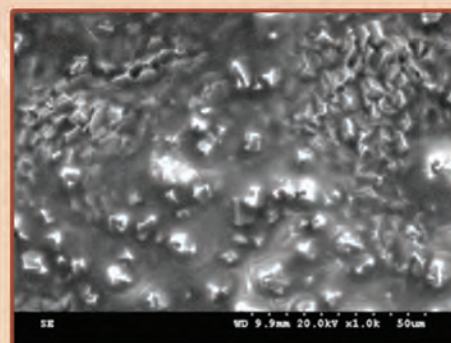
Progress highlights

- ❖ Electro polishing and electroplating of copper from imidazolium ion based electrolyte.
- ❖ Optimization of mole ratio, current density and temperature and analysis and their effect with cathode current efficiency, surface characterisation measurements.

(A) Salient Results & Conclusions



SEM image of Electropolishing of copper from LTMS



SEM image of Electroplating of zinc from LTMS

- Green process
- No glove box
- Melting temperature lower than 1000C
- Wide temperature range for liquid phase



Microbial corrosion, cathodic protection and electrokinetic phenomena

Principal Investigator : Dr. S. Maruthamuthu

Duration: 2011 - 2012.

Objectives

- (a) To investigate the mechanistic aspects of microbial corrosion.
- (b) To understand the electro kinetic phenomena on electro kinetics.

Progress highlights

(A) Salient Results & Conclusions

Update of the cathodic protection potential guideline:

Cathodic protection (CP) potential criterion for carbon steel is different for different environments. Currently -850 mV vs Cu/CuSO₄ (NACE standards - SP0169-2007) for carbon steel in aerated environments and -950 mV vs. Cu/CuSO₄ for anaerobic bacterial environments. However, the detailed understanding of this value with respect to various bacterial forms such as heterotrophic, iron oxidizing and manganese oxidizing bacteria is not studied. Hence it is necessary to investigate both in the lab and field conditions to find the right potential required for the cathodic protection. Energy saving cathodic protection can be developed in different environments viz. soils and water.

Microbial corrosion

(a) In aviation turbine fuel transporting pipeline

Aviation turbine fuel is a mixture of various hydrocarbons and additives. Some fuel-soluble chemicals are added in small amounts to enhance or to maintain the properties related to fuel performance. In the present study, the influence of microbes on corrosion in aviation turbine fuel transporting pipeline is reported.

Chemical and biological analyses of the corrosion product collected from aviation turbine fuel pipeline were carried out. While examining the topography of the pipeline, the possibilities of some water stagnant points were noticed. The reason for the corrosion in the aviation turbine fuel transporting pipeline is investigated and discussed.

(b) Microbiologically influenced corrosion on rails

Corrosion of rails has been a cause of concern for the Southern Railways. Out of many causes, corrosion due to toilet droppings is more pronounced. In this study, the role of bacteria, viz. heterotrophic bacteria, manganese oxidizers, iron bacteria and ureolytic bacteria on rails have been studied. A porous rust layer and fine cracks were noticed on the steels. The changes of microstructure on high carbon materials were studied in presence of fretting corrosion with bacteria. It could be assumed that the ureolytic bacteria and iron/manganese oxidizers may create differential pH gradient on the metal surface which enhances the electrochemical reaction of the metal surface.

Electrokinetic phenomenon

(a) Electrokinetic separation of sulphate and lead from sludge of spent lead acid battery

A novel electrokinetic (EK) technique is applied to separate lead and sulphate from the sludge of used/spent lead acid battery. EK cell employing either titanium electrodes or titanium substrate insoluble anode as electrodes caused migration of sulphates and lead ions respectively into anode and cathode compartments, and accumulation of insoluble lead oxides at the central compartment.



The insoluble lead oxides accumulated at the central compartment in the ratio 1:3, respectively for the high oxygen over-voltage Ti-anode (Ti-EK cell) and low oxygen over-voltage TSIA-anode (TSIA-EK cell) shows the superiority of Ti anode over TSIA anode. Also thermal investigation reveals Pb deposited at Ti-cathode is superior to that from TSIA cathode. This process does not release air/soil pollutants which are usually associated with high temperature pyrotechnic process.

(b) Improved lead recovery and sulphate removal from used lead acid battery through Electrokinetic technique

In this study the improvement in lead (Pb) recovery and sulphate removal from used Pb-acid battery (ULAB) through Electro-kinetic technique, a process aimed to eliminate environmental pollution that arises due to emission of gases and metal particles from the existing high temperature pyrometallurgical process. Two different cell configurations, (1) one with Nafion membrane placed between anode and middle compartments and Agar membrane between cathode and middle compartments and (2) another with only Agar membrane placed between both sides of the middle compartments were designed for the Pb and sulphate separation from ULAB. It conclude that the cell with only Agar membranes performed better than the cell with Nafion and Agar membranes in combinations and also explains the mechanism underlying the chemical and electrochemical processes in the cell.

(C) Publications

1. S. Maruthamuthu, S. Ramachandran, B. Dinesh Kumar, V. Shatish, S. Palanichamy, B. Ananad Kumar, P. Subramanian, S.P.Sah, A. Anbezhil, N. Palaniswamy, Microbial corrosion in aviation turbine fuel (JetA1) transporting pipeline, J. ASTM Int. Published online 11 July 2011.
2. B. Suresh, S. Maruthamuthu, Alika Khare, N. Palanisamy, V.S. Muralidharan, R. Ragunathan, M. Kannan, K. Navaneetha Pandiyaraj, Influence of thermal oxidation on surface and thermo-mechanical properties of polyethylene, J. Polym. Res. 18 (2011) 2175-2184.
3. S. Maruthamuthu, B. Dinesh Kumar, S. Ramachandran, B. Anandkumar, S. Palanichamy, M. Chandrasekaran, P. Subramanian, N. Palaniswamy, Ind. Eng. Chem. Res , 50 (2011) 8006 – 8015.
4. S. Maruthamuthu, T. Dhani babu, A. Veluchamy, S. Palanichamy, P. Subramanian, N. Palaniswamy, Electrokinetic technique for the separation of sulphates and lead from sludge of used lead acid batteries, J. Hazard. Mater. 193 (2011) 188–193.
5. B. Anandkumar, R.P. George, S. Maruthamuthu, N. Palaniswamy, R.K. Dayal, Corrosion behavior of SRB desulfobulbus propionicus isolated from an Indian petroleum refinery on mild steel, Mater. Corr. 62 (2012) 355-362.
6. C. Soundarrajan, A. Sankari, P. Dhandapani, S. Maruthamuthu, S. Ravichandran, G. Sozhan, N. Palaniswamy, Rapid biological synthesis of platinum nanoparticles using Ocimum sanctum for water electrolysis applications. Bioproc. Biosyst. Eng. 35 (2011) 827 – 833.
7. C. Soundarrajan, A. Sivasankar, S. Maruthamuthu, A. Veluchamy, Improved lead recovery and sulphate removal from used lead acid battery through Electrokinetic technique, J. Hazard. Mater. 193 (2012) 188-93.



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8. Perumal Dhandapani, Sundram Maruthamuthu and Gopalakrishnan Rajagopal, Bio-mediated synthesis of TiO_2 nanoparticles and its photocatalytic effect on aquatic biofilm, *J. Photochem. Photobio.* 110 (2012) 43-49.
9. B. Subramanian, P. Dhandapani, S. Maruthamuthu and M. Jayachandran, Biosynthesis of Calcium Hydroxylapatite Coating on Sputtered Ti/TiN Nano, *J. Biomater Appl.* 26 (2012) 687-705.
10. Andivelu Ilangovan, Subramani Malayappasamy, Samraj Muralidharan, Sundaram Maruthamuthu, A highly efficient green synthesis of 1, 8-dioxo-octahydroxanthenes, *Chem. Central. J.* 5 (2011) 81.
11. E.S. Challaraj Emmanuel, T. Ananthi, B. Anandkumar, S. Maruthamuthu, Accumulation of rare earth elements by siderophore forming *Arthrobacter luteolus* isolated from rare earth environment of Chavara, India, *J. Biosci.* 37 (2012) 25-31.

(C) Honors / Award

Awards/Recognition	Awardee	Awarded to
Best poster award in NACE International conference in CORCON 2011, on the paper titled "Electrochemical behaviour of calcium precipitating bacteria on orthodontic wire"	NACE International Mumbai	Bio-corrosion group CSIR - CECRI



MLP-006

Electropolymerised layers for corrosion protection of non ferrous metals

Principal Investigator : Dr. S. Sathiyarayanan
Duration : 2011 - 2012.

Objectives

To develop electropolymerised PANI layers on aluminium alloys for corrosion protection

Progress highlights

(A) Salient Results & Conclusions

A study has been made on the effect of electropolymerised PANI films on corrosion protection performance of epoxy coating on AA 2024 and AA 7075 aluminium alloys. Polyaniline was electropolymerised on both the alloys by galvanostatic method. A post treatment of cerium was given to seal the pinholes of PANI film. Epoxy coating was applied over these films and their corrosion protection performance was found out by EIS studies in 3% NaCl and salt spray test. EIS studies have shown that the coating resistance (R_c) of PANI with the epoxy coated aluminium alloys has remained above $106 \Omega \text{ cm}^2$ whereas the alloys coated with epoxy alone have shown the R_c values less than $104 \Omega \text{ cm}^2$. Besides, the salt spray test showed a better corrosion protection of PANI with epoxy coated aluminium alloys.

Effect of anionic surfactant on electrosynthesis of polyaniline and its electrochemical activity studied. Electrodeposited PANI-nano SiO_2 composite and PANI- TiO_2 nano composite coatings on AA 2024 -T6 attempted and its corrosion protection performance evaluation continued.

(B) Publication

1. Electropolymerised polyaniline films as effective replacement of carcinogenic chromate treatments for corrosion protection of aluminium alloys, K. Kamaraj, V. Karapakam, S. Syed Azim, S. Sathiyarayanan, Synth. Met. 162 (2012) 536.

Papers presented in conferences

Electrodeposited PANI-nano SiO_2 composite coatings on AA 2024-T3 and its corrosion protection performance, K. Kamaraj, V. Karpakam, T. Siva, S. Sathiyarayanan
Conference on Engineering coatings ENGGOAT-2012, IIT Mumbai, Feb 9-11, 2012.



MLP-008

Studies on marine corrosion and biofouling on metals, alloys and materials performance of concrete and building materials in marine environment

Principal Investigator : Dr. G. Subramanian

Sponsor : Council of Scientific and Industrial Research, New Delhi.

Duration: 2011 - 2012.

Objectives

- ❖ To study the relation between corrosion and fouling on engineering alloys.
- ❖ To study the role of water quality on the corrosion and biofouling characteristics of engineering alloys.
- ❖ To study the role of water quality/biofouling on strength of metals and alloys.
- ❖ To evaluate the performance of concrete and building materials in marine environment. Recovery of metals from effluents by electrolytic method.

Progress highlights

(A) Salient Results & Conclusions

- ❖ The corrosion behavior and biofouling characteristics of marine engineering alloys have been studied.
- ❖ Experiments have been carried out to remove the copper content of the raw effluent using DSA anode and stainless steel spiral cathode for
- ❖ Mineralization of the copper recovered effluent by electro coagulation method.
- ❖ Durability of concrete of different composition in natural seawater at different depths have been carried out.
- ❖ The galvanic corrosion behavior of the different metal combinations used in the actual missile assembly in natural seawater with 1:1 area ratio, have been studied. The galvanic potential and galvanic current values of various metal combinations have been monitored.
- ❖ Conducting polymer paints and coatings for corrosion protection of metallic structures have been evaluated in marine atmosphere.

(B) Publications

1. V. Balasubramanian, S. Palanichamy, R. Rajaram. Effects of seaweed extracts on the primary biofilm forming bacteria. J. Marine Bio. Asso. India 53 (2011) 104-110.
2. S. Maruthamuthu, T. Dhanibabu, A. Veluchamy, S. Palanichamy, P. Subramanian, N. Palaniswamy. Electrokinetic separation of sulphate and lead from sludge of spent lead acid Battery. J. Hazard. Mater. 193 (2011) 188-193.
3. S. Maruthamuthu, B. DineshKumar, S. Palanichamy S. Ramachandran, B. Anandkumar. Microbial Corrosion in Petroleum Product Transporting Pipeline. J. Ind. Eng. Chem. Res. | 3b2 | ver.9 | 6/6/011 | 14:1(2011).
4. S. Maruthamuthu, S. Ramachandran, S.P. Sah, B. Dinesh Kumar, V. Shatish, S. Palanichamy, Anand kumar, P. Subramanian, A. Anbezhil, N. Palaniswamy. Microbial corrosion in aviation turbine fuel (Jet A 1) transporting pipelines. J. ASTM Int. 8 (2011).
5. M. Eashwar, G. Subramanian, S. Palanichamy, G. Rajagopal. The influence of sunlight on the localized corrosion of UNS 31600 in natural seawater. Biofouling, 27: (2011) 837-849.
6. S. Palanichamy, G. Subramanian, M. Eashwar Corrosion behaviour and biofouling characteristics of structural steel in the coastal waters of gulf of Mannar (Bay of Bengal), India. Biofouling 28 : (2011) 441-451.



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7. M. Eashwar, P. Sathish Kumar, R. Ravishankar, G. Subramanian. Sunlight enhances calcareous deposition on cathodic stainless steel in natural seawater. Biofouling 28: (2012: In Press).

8. S. Chellammal, P. Kalaiselvi, P. Ganapathy, G. Subramanian. Anodic incineration of Phthalic anhydride using $\text{RuO}_2\text{-IrO}_2\text{-SnO}_2\text{-TiO}_2$ coated on Ti anode. Arab. J. Chem. (2012: In Press).

(C) Technology Developed / Transferred

i. Technology developed

1. Green inhibitor for corrosion prevention in HCl medium.
2. An improved electrochemical process for recovery of dilute copper from mixed industrial effluent.

ii. Technology transferred

"A novel eco-friendly technology for de-rusting iron & steel components" has been licensed to M/s. Larsen & Toubro Limited, Puducherry on 22.12.2011 with demonstration and know-how transfer.

(D) Any other important information

Electro-cleaning (derusting) of the steel U head components - 2 Nos. of L&T has been done and dispatched to L&T, Puducherry during August 2011. L&T expressed their satisfaction towards the effectiveness of the process.



MLP-0009

Influence of sunlight, biofilms and salinity on stainless steels in natural waters

Principal Investigator : Dr. M. Eashwar

Duration: 2010 - 2012.

Objectives

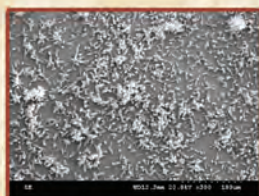
- ❖ Influence of sunlight on :-
 - (a) passivity and localized corrosion of stainless steels
 - (b) calcareous deposition during cathodic protection in marine waters
- ❖ Effects of salinity and biofilms on the cathodic polarization behaviour of stainless steels in natural waters

Progress highlights

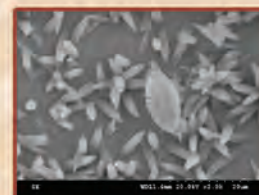
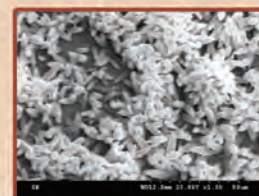
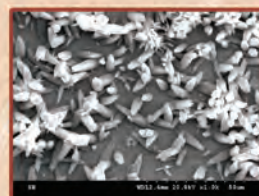
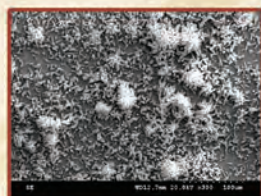
(A) Salient Results & Conclusions

During the year, an influence of sunlight on calcareous deposition was examined independently during day and night phases of cathodic polarization. As exemplified by SEM the calcareous deposit formed in daytime was composed of finer calcareous crystals, providing more compact and more uniform surface coverage than the one formed at night. These results not only bear important implications for cathodic protection, but also provide intriguing analogy to coral reef development.

Night



Day

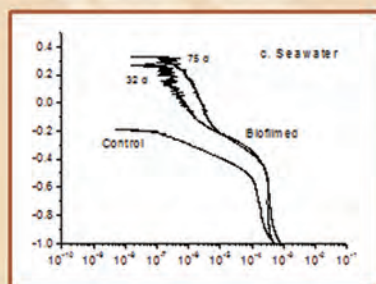
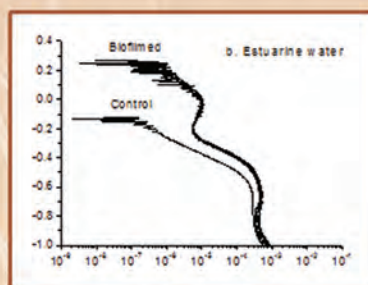
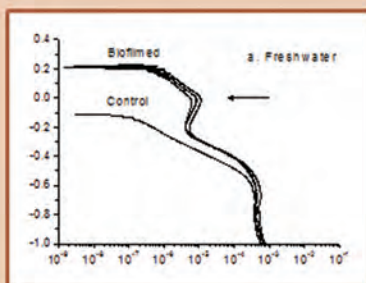


(a) through (g). Calcareous deposition on cathodic stainless steel surfaces. The images (a), (c) and (e) show deposits formed at night, while (b), (d) and (f) are corresponding images for daytime.

Under the theme of an effect of salinity, three types of natural waters were chosen: freshwater from a perennial pond located within 5 km of the laboratory, estuarine waters of intermediate salinity from Vaigai Estuary on the Palk Bay, and full-strength seawater from the Gulf of Mannar. The characteristic reduction peak for alloy UNS S31600 at ~ 0 mV vs saturated calomel electrode (SCE), the "nose" of the cathodic polarization curve often reported in the literature, was conspicuous in fresh and estuarine waters, but never appeared in full-strength seawater. These polarization features provide extremely important inputs to our understanding of passivity and passivity breakdown of stainless steels in natural waters from perspectives of site specificity, biofilm ecology and the electronic structure of passive films.



Potential vs SCE, V



Current density, $A\ cm^{-2}$

Cathodic polarization curves for control and biofilmed UNS S31600 in the three types of waters. Note the absence of the characteristic reduction peak at 0 mV vs SCE (the "nose" of the cathodic scan, indicated by an arrow) in full strength seawater.

(B) Publications & Patents

1. M. Eashwar, G. Subramanian, S. Palanichamy, G. Rajagopal.

The influence of sunlight on the localized corrosion of UNS 31600 in natural seawater. *Biofouling* 27:(2011) 837-849.

2. S. Palanichamy, G. Subramanian, M. Eashwar (2012) Corrosion behaviour and biofouling characteristics of structural steel in the coastal Waters of Gulf of Mannar (Bay of Bengal), India.

Biofouling 28:(2012) 441-451.



MLP-0050

Development of self assembling polymers containing nanopigments for corrosion protection in high temperature environment

Principal Investigator : Dr. M. Selvaraj

Duration: 2010 - 2012.

Objectives

Development of self assembling coating for the protection of steel Structures. Micro capsules of epoxy resin has been prepared for incorporation in IPN polymer for Self healing coatings. This self healing coating protects the metallic substrate from physical damage.

Progress highlights

(A) Salient Results & Conclusions

i) Synthesis and characterization of silicone – acrylic interpenetrating polymer network (IPN)

Different composition of silicone air drying and non drying resins with acrylic monomers were prepared by using Dibutyl Tin dilaurate as cross lining agent. The performance of these IPN was characterized by FTIR, TG/DTA, NMR and SEM studies. The corrosion resistance performance of these IPNs was evaluated by Accelerated tests and electrochemical measurement. It was found that IPN2 has very good corrosion resistance performance than the other IPNs.

ii). Preparation of nano titanium dioxide and its characterization

Nano TiO_2 has been prepared and characterized by XRD and TEM methods. The prepared TiO_2 has 20 nanometer in size. This pigment was incorporated in the IPN and evaluated the coating for corrosion as well as high temperature applications.

iii) Preparation of micro capsules

Micro capsules of epoxy resin has been prepared from low mol.wt. epoxy resin as core material and amino resin as shell material. The prepared capsules are in agglomerate with each other, which is separated by ultrasonification.



(B) Publications & Patents

1. Preparation and characterization of nano titanium dioxide for corrosion resistance application.
A.M. Kamalan Kirubaharan, M. Selvaraj, K. Maruthan, D. Jeyakumar.
J. Coat. Tech. Res. 9 (2012) 163-170.
2. Investigating the self healing process on coated steel by SVET and EIS technique .
S. Neema , M. Selvaraj, J. Raguraman, S. Ramu.
J. Appl. Polym. Sci. (accepted for publication).
3. A Chapter was published in the Encyclopedia of Composite. Interpenetrating Polymer Network: High Performance,
M. Selvaraj, Lee: Encyclopedia of composites 2 Edition, (2012) volume 5, P. 3444.
ISBN-10:0-470-12828-3
ISBN -13:978-0-470-12838-2-John Wiley and Sons.
4. Self healing efficiency of epoxy capsules in primer coat with different binders on mild steel substrate.
M. Selvaraj, S. Ramu.
18th International Corrosion Congress,
Perth, Australia, 20-24 November 2011.



Processing of tube anodes for cathodic protection

Principal Investigator : Dr. K. Subramanian

Sponsor : Protech Anodes and Alloy Engineers Ltd, Karaikudi, Tamil nadu.

Duration: Six months.

Objectives

To process tube anodes for cathodic protection

- a) Titanium tube anodes of diameter 25.4 cm and length 50 cm – (150 nos)
- b) Titanium tube anodes of diameter 25.4 cm and length 100 cm – (50 nos) for cathodic protection application with mixed metal oxide coating

Progress highlights

(A) Salient Results & Conclusions

100 numbers of MMO coated titanium tube anodes each of diameter 2.54 cm, length 50 cm were designed, fabricated and supplied to the client for cathodic protection work.



Design, fabrication and processing of MMO coated tubular anodes for cathode protection



TSP-07/11

Coating of titanium expanded mesh anodes of size $60 \times 47 \text{ cm}^2$ (fitted with copper cored titanium tube current distributors) supplied by the client with mixed metal oxide coating suitable for electrolytic production of tetra alkyl (ethyl, propyl & butyl) hydroxide (TAAH).

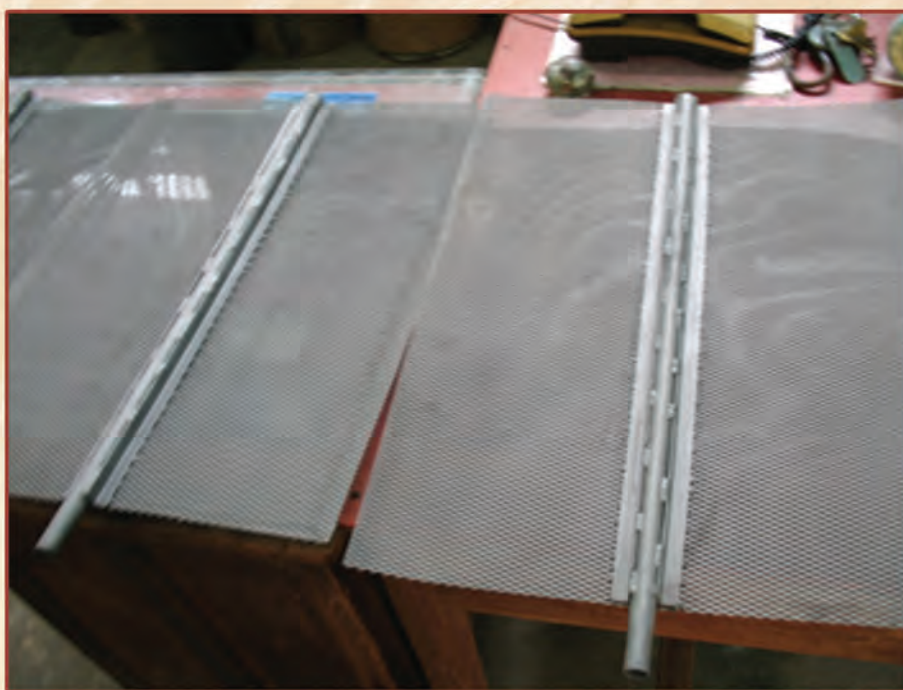
Principal Investigator : Dr. K. Asokan

Sponsor : M/S Tatva Chintan Pharma Chem Ltd, Ankleswar, Gujarat.

Duration: 6 Months.

Objectives

To process 16 numbers of Titanium expanded mesh anodes of size $60 \times 47 \text{ cm}^2$ with mixed metal oxide coating suitable for electrolytic production of tetra alkyl (ethyl, propyl & butyl) hydroxide (TAAH).



Electrodes for the Electrochemical Production of Tetra Alkyl Amonium hydroxides processed for M/s Tatva Chintan Pharma Chem Ltd, ankleswar, Gujarat



TSP

Design, fabrication and processing of 6 numbers of cylindrical expanded mesh titanium anodes with mixed metal oxide coating

Principal Investigator : Dr. K. Asokan

Sponsor : Concrete corrosion Engg Group, CECRI, Karaikudi.

Duration: 2 months.

Objectives

To design, fabrication and processing of 6 numbers of cylindrical expanded mesh titanium anodes with mixed metal oxide coating.



Design, fabrication and processing of cylindrical mixed metal oxide coated titanium expanded mesh anodes for concrete corrosion studies (CECRI)



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Tailpiece



Characterization and Measurement Laboratory

Characterization and Measurement Laboratory is a central analytical facility that provides specialized analytical services to the institute to the as well as other organizations like academic institutions and industries. Analytical instruments like Thermo gravimetric analyzer – TGA/DTA (SDTQ-600 model), Elemental analyzer – CHNS (Vario EL III model, Liquid chromatography-HPLC/GPC (Shimadzu LC 8A, LC6A and Prominence 20A) and Atomic Absorption Spectrometer – AAS (Varian Spectraa 220 model) are housed in this laboratory.

Materials for advanced batteries, fuel cells, hydrogen production, concrete samples, functional materials, solar cells materials and polymers are analyzed using TGA/DTA.

The AAS instrument is used to analyze trace elements in sea water analysis, drinking water analysis, pollution control, plating solutions, battery electrolytes, thermal products and corrosion products.

With HPLC/GPC instrument, analysis of synthetic organic chemicals and molecular weight determinations of conducting polymers, polymers and various resins used in paint formulations and industrial effluents for pollution control are carried out. The CHNS analyzer is used for the determination of percentage of composition of carbon, hydrogen, nitrogen and sulphur in samples like organic compounds, polymers, battery materials, soils, plant extracts, tannery wastes, thermal products etc. In June 2011 a new GPC/HPLC – Shimadzu Prominence 20A was installed.





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Central Instrumentation Facility

The Central Instrumentation facility acquires and maintains sophisticated analytical equipments all under one roof and provides service to the R & D projects of CECRI, Research scholars, academic institutions and industries. The facility has grown into an important R & D facilities group for analysis of bulk materials and surfaces using Spectroscopy, Resonance, and Surface analytical, X-ray and Chromatographic techniques. Apart from the major analytical facilities, this division undertakes the development of custom built electronic instruments for CECRI's in-house R & D projects and development of electrochemical instruments on specific request from academic institutions and industries. Recently we have developed a complete automation package based on LabVIEW to monitor the Force and Corrosion Monitoring of Nuclear Power plants at Kaiga in Karnataka at a cost of 78 lakhs. We have expertise in computerised data acquisition, design of electronic instruments using embedded controllers and PLC's. This division has executed many sponsored projects and consultancies. CIF conducts a 5-Day training programme on "Instrumental Methods of Analysis" during October every year for the benefit of R & D personnel, teaching faculties from colleges and engineers employed in process control industries.

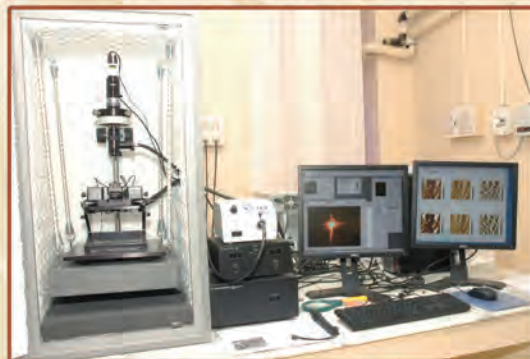
- ❖ UV-VIS-NIR Spectrophotometer – VARIAN Cary 5000 Scan and Cary 500 Scan.
- ❖ Fluorescence Spectrophotometer – VARIAN Cary Eclipse.
- ❖ FT-IR Spectrometer – TENSOR 27, Bruker Optik GmbH.
- ❖ Laser Raman Microscope – Renishaw Invia.
- ❖ Nuclear Magnetic Resonance (NMR) Spectrometer – BRUKER Avance 400 MHz.
- ❖ Electron Paramagnetic Resonance (EPR) Spectrometer – BRUKER BIOSPIN, EMX Plus.
- ❖ Micro-hardness Tester – Everone Enterprises, MH-6.
- ❖ Atomic Force Microscope – Agilent Technologies, Series 5500.
- ❖ Scanning Electron Microscope with EDAX – Hitachi S-3000H and TESCAN VEGA 3 SBH.
- ❖ X-ray Photoelectron Spectrometer (XPS) – Thermo Scientific, Multilab 2000.

- ❖ Scanning Vibrating Electrode Technique (SVET) – Princeton Applied Research.
- ❖ Powder X-ray Diffractometer (XRD) – PANalytical PW3040/60 X'pert PRO and BRUKER D8 ADVANCE.
- ❖ X-ray Fluorescence Spectrometer (XRF) – Horiba, XGT 2700.
- ❖ X-ray Fluorescence Coating thickness instrument – CMI International, XRX series.
- ❖ Transmission Electron Microscope (TEM) – FEI, Tecnai 20 G2.
- ❖ Ion Chromatograph – Metrohm.
- ❖ Gas Chromatograph / Mass Selective Detector (GC/MS) – Agilent 7890A series GC with 5975C MS.
- ❖ Inductively Coupled Plasma Mass Spectrometer (ICPMS) – Thermo Electron Corporation, X series 2
- ❖ Particle Size Analyzer - Microtrac .
- ❖ Metallurgical Microscope with image analyzer –
- ❖ Leica Microsystems .
- ❖ Temperature Modulated Differential Scanning Calorimeter with TOPAM – Mettler Toledo.

Analytical instruments installed during 2011-12

ATOMIC FORCE MICROSCOPE (AFM)

Make: Agilent Technologies
 Model No. Series 5500 Microscope
 Modes: Contact and non contact mode, Lateral Force Microscopy, Tapping mode, Magnetic Force Microscopy, Electric Field Microscopy, Conductive AFM, Electrochemical SPM, Surface potential measurements, Liquid imaging mode, Scanning Tunneling Microscopy and Nano lithography.



ATOMIC FORCE MICROSCOPE – AGILENT SERIES 5500



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POWDER X-RAY DIFFRACTOMETER (XRD)

Make: BRUKER
Model No: D8 ADVANCE
Types of samples: Powders, plates and coatings



POWDER X-RAY DIFFRACTOMETER – BRUKER D8 ADVANCE

NANO PARTICLE SIZE ANALYZER

Make: Microtrac Inc.
Model No: Nanotrac NPA 253
Measurement range: 0.8 nm to 6.5 microns



PARTICLE SIZE ANALYZER – MICROTRAC

Scanning Electron Microscope (SEM) with EDAX

Model No: TESCAN - VEGA 3 SBH
Country of origin: Czech Republic
Resolution: 3 nm at 30 kV
Magnification: 4x to 10,00,000x
SE detector: Everhardt Thornley type SE detector with YAG crystal

EDAX

Model No: Bruker easy EDX (liquid nitrogen free)
Energy resolution: 133 eV
Detection range: Boron to Americium (Atomic numbers 5 to 95)
Sputter coater model: SC 6720



SCANNING ELECTRON MICROSCOPE – TESCAN VEGA 3 SBH



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Central Facility - Telephones Division

CECRI procured a Siemens HiPath 4000 V5.0, IP based Multimedia communication system with ISDN, IP and SIP based architecture from Siemens Enterprise Communications GmbH & Co., Germany to cater the need of advanced communication facilities. The system was installed during December 2011. The present system uses the existing IP network for installation of IP phones.

The salient features of the HiPath 4000 system:

- ❖ 384 analog extension ports with CLIP facility and an expansion provision for 720 additional ports
- ❖ 288 IP extension ports with an expansion capability of 512 lines
- ❖ 04 ISDN PRI lines supporting 30 digital channels
- ❖ 20 Unified communication licenses to access the services of E-mail, Fax, Voice Mail and instant messages in a single screen.
- ❖ Direct inward dialing facility
- ❖ Automatic call back
- ❖ Call forward, call hold
- ❖ Call transfer
- ❖ Boss and secretary function
- ❖ Do-Not-disturb
- ❖ Music on hold
- ❖ Audio conferencing
- ❖ Voice mail with message recording and retrieval facility etc.



*Newly Installed Central telephone facility
Siemens HiPath 4000 V5.0*



Engineering and Technical Services Division

Machine Shop:

Engineering works like fabrication, carpentry works, lathe works, welding works, PVC works and fitting works to support for various R&D divisions was carried out. Special fabrication works was carried out at CNU area. More than 500 job card works was finished. Special lathe works for the fabrication of rotating electrodes was done.

Newer Fabrications Done at CNC Machining Centre:
Some of the special works are



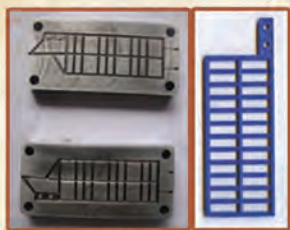
Three axes Prototype profile polishing machine



Creep Testing Specimen



Flow field for Hydrogen generation



Battery Grid injection molding Die & Product

Electrical Works:

Completed:

- Removing of power DB and UG cable including power boards.
- Providing MCCB panel board and laying of UG cable for battery building.
- Providing false ceiling, painting and electrical works in CNU.

Under Progress:

- Removing overhead lines by providing UG cable.
- Modernisation of Transformer point I & II

Estimated:

- Conversion of Metal Finishing Laboratory into Central Instrumentation Facility.
- General maintenance to the institute and maintenance of internal street lights are being carried out. Two 166 KVA generators and two 500 KVA generators are being maintained and operated to provide power supply to the institute during power shut down period.

Air conditioning:

Around 15 new split air conditioners were installed at various instrument facility areas. Precision air conditioner for Cluster system is being maintained. General maintenance of approximately 450 air conditioners is being done by the section. Operation and maintenance of air conditioners at Science Auditorium is being done.

Glass Blowing:

In the process of assisting R&D work for all divisions, around 150 job works were carried out in scientific glass works section.

Engineering Drawing:

Around 300 drawing works were carried out for 50 job cards and in addition certificate writing work for all courses were carried out in the section.

General:

Supporting all official functions by providing all required engineering services.



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Computer and Networking Unit

Computer & Networking Unit (CNU) is providing Hardware & Software support for the Research & Development activities of CECRI. CNU is also involved in the development of software for Desktop Applications, Office Automation, Website and Intranet. The mandate of CNU is to achieve the goal of paperless office. CNU is also engaged in the Management of Network Systems, Storage Area Network, High End Servers, Cluster Computing Facility, Maintenance of Computers & other peripherals, LCD Projection Systems, Video Conferencing Facility and Plasma Display Systems.

Infrastructure Available

- ❖ Centralized Network Facility for campus wide Network Connection (Local Area Network).
- ❖ One Gbps National Knowledge Network (NKN) and 8 Mbps dedicated leased line for internet and intranet services.
- ❖ Fiber-Optic communication (through OFC cables) which permits transmission over longer distances and at higher bandwidth.
- ❖ Robust firewall system to filter unauthorized access to the server resources and to prevent intruders from causing damage to the resources.
- ❖ Data Center with Storage Area Network (SAN) of 20 TB capacity, high end servers for ERP implementation, DHCP Services, CECRI Mail Services, Web Services, Intranet and Databases.
- ❖ Plasma Display System to put on show important events / announcements of CSIR-CECRI.
- ❖ LCD Projection Systems for Seminars/ Meetings and Video Conferencing Facility to connect people in different locations to interact online for project meetings, review meetings, presentations and scientific discussions.
- ❖ HPC Cluster facility with 22 nodes (each node has 4 CPUs) + Master + NAS (2TB HDD).

Software developed

- ❖ Online Application for recruitment to the post of Scientists and Technical Assistants at CSIR-CECRI.
- ❖ The functionalities of Intranet Services were expanded with the augmentation of more modules viz., Online hosting of Office Orders, Minutes of Meetings, Enhancement of Director's Column, Home page, etc.,.
- ❖ Online Purchase Indent Software was enriched with more features.
- ❖ Data Analysis using Neural Network and Database development for Electrochemical applications.

Migration of Services/ Systems

Migrated CECRI mail services from a private client to National Informatics Center (NIC, New Delhi).

Redesigning & Migration of CECRI website is under progress.

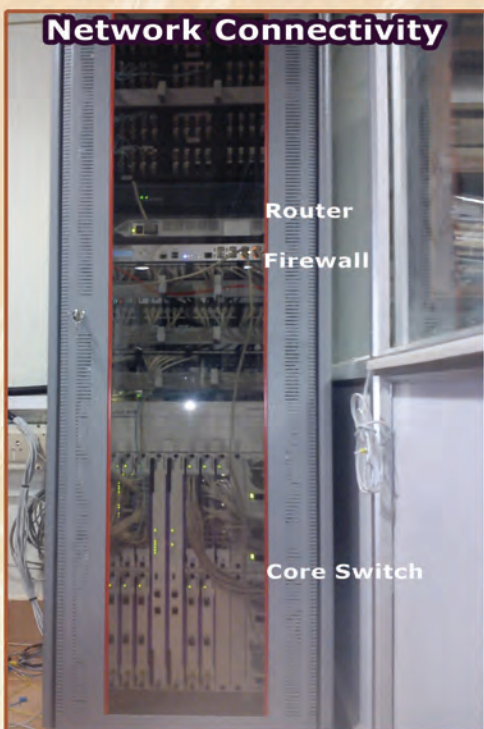
** Implementation of CSIR Enterprise Transformation Project is under progress.



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Data Center





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Electro Organic Division

Seminar/Conference/Workshop/Lectures arranged:

1. Brain storming session on "Electroorganic synthesis":

Brain storming session on "Electroorganic synthesis" has been conducted on 04-11-2011. Prof. K.K. Balasubramanian and Prof. K. Sankaranarayanan, IIT Chennai have participated and delivered lecture on electrosynthesis. Road map of our division has been presented before the experts for critical analysis.

2. One day work shop On "OSDD" Programme (20-12-11):

Welcome address :Dr.N.Palaniswamy, Chief scientist
Inaugural address: Dr. V. K. Venkatesan,
Keynote address: Dr Vijaya Mohanan K. Pillai, Director, CSIR-CECRI
Total Participants: 107
Invited Speakers: 12
Participants from Universities: 28
Ten invited lectures were delivered at the OSDD workshop

3.NMR & EPR committee has Organized a ONE DAY WORKSHOP ON "PRINCIPLES & PRACTICE OF ADVANCED EPR SPECTROSCOPY" on 19-03-2012 at CSIR - CECRI, Karaikudi.

Prof.J.Subramanian, visiting faculty of CSIR-CLRI, Chennai delivered lectures and demonstrated the EPR experiments to the participants.

Any other important information

i) Dr.V.Suryanarayanan has been deputed to Taiwan under DST Indo-Taiwan exchange programme.

ii) Invited talk entitled 'Electrochemical Fluorination (ECF) in India' has been delivered at the First Indian International Symposium on Fluorine Chemistry (1st IISFC) held at New Delhi during 20-24 February 2012. D.Velayutham.

iii) Selective conversion of perfluorobutyric acid and perfluoroisobutyric acid to 2H-heptafluoropropane and hexafluoropropene has been presented at the 1st IISFC held at New Delhi during 20-24 February 2012. K.Sathish, M.sridhar, P.Shanthan Rao, D.Velayutham, K.Kulangiappar, Raipal Singh, and Raju Brahma.

iv) Synthesis and characterization of ammonium and imidazolium anion based room temperature ionic liquids (RTILs) for the anodic oxidation of phenolic compounds on carbon and Pt electrodes. (Best Paper Award in Oral presentation), KR.Saravanan, T.M. Rangarajan, D.Velayutham, V.Suriyanarayanan, Presented at NCE-16 at PSG Arts and Science College for women, Coimbatore during 15&16 December, 2011.

v) Voltammetric studies on the anodic dissolution characteristics of Ni, Cu and their alloys in absence and presence of triethylamine containing non-aqueous fluoride media (Oral presentation) S.Sathyamoorthi, D.Velayutham, V.Suriyanarayanan, Presented at NCE-16 at PSG Arts and Science College for women, Coimbatore during 15&16 December, 2011.

Honours/ Recognition of the Project Staff

Sri.S.Sathyamoorthy project assistant has been awarded CSIR-SRF.



Electro Inorganic Division

(A) Publications and patents

1. Nitrate reduction in water: Influence of the addition of a second metal on the performances of the Pd/CeO₂ catalyst,

A. Devadasa, S. Vasudevan, F. Eprona,
J. Hazard. Mater 185 (2011) 1412–1417.

2. Effects of alternating and direct current in electrocoagulation process on the removal of fluoride from water,

S. Vasudevan*, B. Suresh Kannan, J. Lakshmi,
S. Mohanraj, G. Sozhan,
J.Chem.Technol.Biotech 86 (2011) 428 - 436 .

3. Development and performance evaluation of Proton Exchange Membrane (PEM)based hydrogen generator for portable applications,

R. Balaji, N. Senthil, S. Vasudevan, S. Ravichandran,
S. Mohan, G. Sozhan*, S. Madhu, J. Kennedy,
S. Pushpavanam, M. Pushpavanam ,
Int. J. Hydrogen Energy 36 (2011) 1399 – 1403 .

4. Studies relating to an electrochemically assisted coagulation for the removal of chromium from water using zinc anode,

S. Vasudevan, J. Lakshmi,
Water Science and Technology: Water supply 11
(2011) 142 - 150.

5. Studies on the Al-Zn-In – alloy as anode material for the removal of chromium from drinking water in electrocoagulation process,

S. Vasudevan*, J. Lakshmi, G. Sozhan ,
Desalination 275 (2011) 260 - 268.

6. Effects of alternating and direct current in electrocoagulation process on the removal of cadmium from water,

S. Vasudevan*, J. Lakshmi , G. Sozhan,
J. Hazard. Mater – 192 (2011) 26 – 34.

7. Polyvinyl Alcohol Based Membrane as Separator for Alkaline Water Electrolyzer,

S. Seetharaman, S. Ravichandran, D.J. Davidson, S. Vasudevan, G. Sozhan,
Sep. Sci. Technol. 46 (2011) 1563 - 1570.

8. Effects of alternating and direct current in electrocoagulation process on the removal of cadmium from water – A novel approach,

S. Vasudevan, J. Lakshmi,
Sep. Purifi. Technol. – 80 (2011) 643 – 651.

9. Sulfonated poly (ether ether ketone)-based composite proton-exchangemembrane for energy production.

S. Seetharaman, G. Sozhan, S. Ravichandran,
S. Vasudevan, J. Davidson
Int. J. Polym. Mater. 60 (2011) 742-753.

10. Sulfonated polystyrene-block-(ethylene-ran-butylene)-block-polystyrene (SPSEBS) membrane for sea water electrolysis to generate hydrogen,

S. Ravichandran , R. Balaji, B. Suresh Kannan, S. Elamathi,
D. Sangeetha, J. Lakshmi, S. Vasudevan, G. Sozhan,
ECS Trans. 33 (2011) 157-166.

(B) CSIR – CECRI technologies at cover page of the journal “Research Journal of Chemistry and Environment”





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(C) CITATION

WILEY'S ULLMANN'S CITATION

Dr. S. Vasudevan, Principal Scientist, CSIR-CECRI, Karaikudi is among the first Indian authors to contribute to WILEY's prestigious ULLMANN'S Encyclopedia of Industrial Chemistry - the world's largest benchmark reference in the fields of applied chemistry, industrial chemistry, and chemical engineering. The 7th edition has been published in August 2011 and it has 40 hardbound volumes with more than 1,000 articles written by over 3,000 experts from leading chemical industries, academia and research institutions across the world. Fully international in scope and coverage, the contents have been compiled under the supervision of a renowned global Editorial Advisory Board.

The articles are arranged in alphabetical order with more than 30,000 pages, 22,000 figures, 8,000 tables, 19,000 cross-references and 85,000 indexing keywords. His contribution entitled on

"Chlorine oxides and chlorine oxygen acids"

H. Vogt, J. Balej, J.E. Bennett, P. Wintzer, S.A. Sheikh, P. Gallone, **S. Vasudevan**, K. Pelin.

Appeared in ULLMANN'S Encyclopedia of Industrial Chemistry, 7th Ed, Volume, 8, page 623-684





Industrial Metal Finishing

Publications:

In Journals

1. Electroless deposition of nickel-cobalt-phosphorus nanoalloy,
K. N. Srinivasan, T. Selvaganapathy, R. Meenakshi, S. John, Surf. Eng. 27 (2011) 65.
2. Development of electroless Ni-P-B₄C composite coatings, S. Karthikeyan, G. Venkatachalam, K.N. Srinivasan, T. Vasudevan, S. Narayanan, Electroplat. finish. 30 (2011) 18-21.
3. Colouring of anodised aluminium by electroless method, M. Selvam, Surf. Eng. 27 (2011) 711 - 718.
4. Characteristics of Zn-Cr₂O₃ composite coatings, S. Karthikeyan, G. Venkatachalam, S. Narayana, K.N. Srinivasan, Electroplat. finish. 30 (2011) 12-15.
5. Development of electroless Ni-P-BaSO₄ composite coatings, S. Karthikeyan, G. Venkatachalam, K. N. Srinivasan, S. Narayanan, Electroplat. finish. 30 (2011) 31.
6. Nickel plating of synthetic diamond particles, M. Selvam, Electroplat. finish. 30 (2011) 1 - 4.
7. Studies on electrodeposition of copper from methanesulphonic acid bath, F. Florence, Nisha, S. Rajendran, K.N. Srinivasan, S. John, Int. J. Chem. Tech. Res. 3 (2011) 1318-1325.
8. Synthesis and characterization of electroless nano crystalline Ni-P on aluminium, N. Latha, V. Raj, M. Selvam, P. Manisankar, Int. J. Chem. Sci. 10 (2012) 479-489.
9. Electroless deposition of composite coatings containing kaolin nanoparticles in a nickel-phosphorus matrix, K.N. Srinivasan, P.R. Thangavelu, TIMF, UK., 90 (2012) 105 - 112.

In Proceedings

1. Electrodeposition of nano crystalline nickel using pulse technique for hi-tech applications, S. Srinivasan, S.M. Silaimani, G. Vivekanandan, P. Veeramani. "Nanoscience, Engineering and Technology-ICONSET 2011" Satyabama University, Chennai 28-30 November 2011.
2. Zinc-cobalt alloy coating –A better corrosion protective coating" G. Vivekanandan, S. Srinivasan, N.V. Shanmugam, P. Veeramani, National convention of Electrochemists, Coimbatore 15-16 December 2011.
3. Studies on AC anodizing of aluminium in sulfuric acid electrolyte containing sodium sulfate. R. Renuka, M. Selvam, XX International Materials Research Congress, Cancun, August 14 - 19, 2011.
4. Electrodeposition of zinc from low temperature molten salt: imidazole-zinc chloride, S. Srinivasan, M. Selvam, R. Renuka, XX International Materials Research Congress, Cancun, August 14 - 19, 2011.
5. Electrodeposition of zinc-nickel alloy from alkaline non cyanide bath. K. Shanmugasigamani, P.R. Thangavelu, K.N. Srinivasan, M. Selvam, RATES 2012 conference, Alagappa University, Karaikudi, March 22-23, 2012.
6. Domestic solar gadget – three in one model. K. Shanmugasigamani, P.R. Thangavelu, K.N. Srinivasan, M. Selvam. National conference on Renewable energy utilization –Indian perspective, 5-6 Jan 2012 at GRU, Dindugul.



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Any other important information Seminars organized

Under the auspices of SUN Society and Rural Energy Centre and Department of Physics, Gandhigram Rural Institute we organized a two-day National Conference on "Renewable Energy Utilization-Indian Perspective" during 5-6th Jan 2012. Dr. K.N. Srinivasan, as a chairman for technical committee, brought out a souvenir containing the abstracts received from various authors.

Brain storming

One day Brain storming session on Industrial Metal Finishing, in collaboration with EPMFT division, on 17/02/2010 at CECRI was organized. Outside experts were invited for the session and road map for the division was finalized

Refresher course

Industrial Practice of Electro Plating and Metal Finishing

Course coordinator: Dr. K.N. Srinivasan

The above course was conducted at CECRI during 19 to 23rd Dec 2012. Twenty three participants from various organizations were attended and benefited the course. At the end of the course participants were taken to CECRI, corrosion testing centre at Mandapam camp.

Maintenance of Electroplating Baths

Course coordinator: Dr. N.V. Shanmugam

The above course was conducted at CECRI during January 2012. Twenty five participants from various organizations were attended and benefited the course. At the end of the course participants visited to CECRI, corrosion testing centre at Mandapam camp with our course coordinating team member.

Honours/ Recognition of the Project Staff

i). Dr N.V. Shanmugam was awarded "Best Electroplaters Award-2010" by SAEST

ii). Received the best paper award for the paper entitled "Domestic solar gadget – three in one model" by K Shanmugasigamani , PR Thangavelu K.N.Srinivasan and M.Selvam from the organizers of the National conference on Renewable energy utilization –Indian Perspective to be held during 5-6 Jan 2012 at GRU, Dindugul

PhD degree supervised

Mr. A. Thillaivavnan, received his PhD degree for his thesis on "Optimization of Machining process for the electro discharge Machining using Non Traditional Algorithms" from Anna University, Chennai under the co guidance of Dr. K.N. Srinivasan.

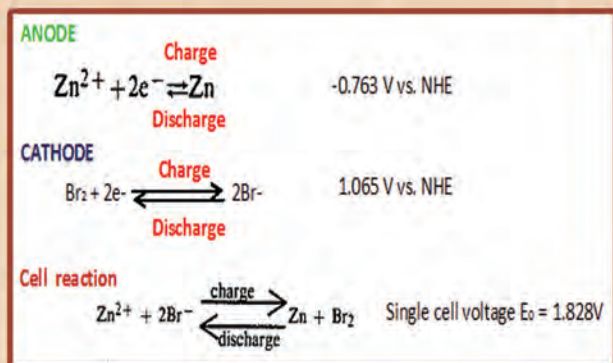


Fuel Cells

1. Methodological Information

Red-ox flow battery theoretically should have no performance loss because it relies on the electro-chemical reaction between electrolytes and not between the electrodes and electrolyte. The present project 'zinc bromine red-ox flow battery' is basically a utility tool for future energy security efforts for successful gathering of energy.

The electrochemistry of this energy storage system is



And the technical data is 75-80% cycle efficiency, 80-85 W h/Kg energy density and with an unit design life time of 20-25 years; show promise for use as an energy storage system for onsite power generation and grid electricity voltage or frequency stability applications.

2, The Red-ox Energy Access Package (REAP) for TAP-SUN project

Zinc Bromine red-ox flow battery research and development program under the activity code REAP is one of the priority program of the TAP-SUN primarily non conventional energy harvest sector. One of the major advantages of this system is 100% discharge capacity and can be left in this completely discharged state without damage, which means that the rated capacity is real capacity.

Accordingly the project is structured keeping in mind that whatsoever resources and gathering technology it may be, the judicious utilization of substantial renewable energy can only be realized if electrical energy can be stored efficiently on a large scale.

Implementation, approach and strategies

To achieve the desired objective of the efficient energy storage project, TAP-SUN provides financial assistance so that the project REAP will be able to deliver fully functional end-of-deliverable

R&D work undertaken during the report period against objectives

In phase with the TAP-SUN line of approach to implement Zinc Bromine red-ox flow battery under the activity code REAP as an efficient energy storage system; the work package was divided into six phases for the report period

- Constitution of a team and work allotment
- Literature survey
- Material collection
- Infrastructure facility identification
- bring into system phase
- Our accomplishments
- Test phase

The start up phase in the report period was mostly roofed over the first four phases because of the proprietary nature of the system.

Our accomplishments

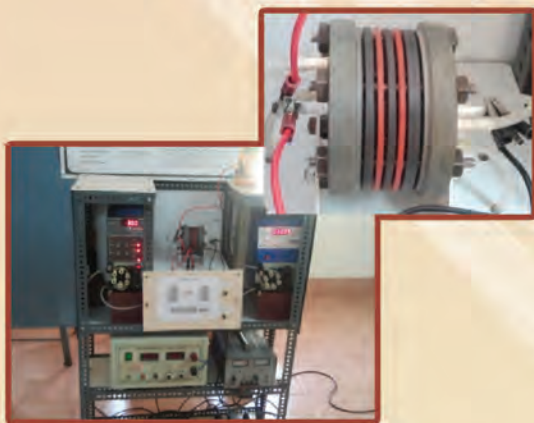
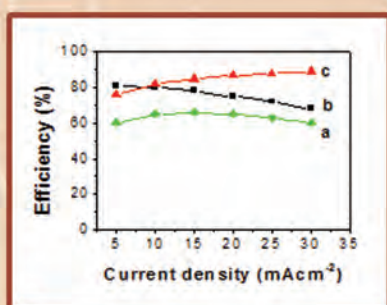
- 2 mm thick carbon plastic composite (60:40 wt%) bi polar electrode with resistivity of 2.6 m ohm.cm (four terminal measurement taken while applying pressure on the sample) was successfully fabricated. (in plane XY 2.6 and through plane 5.5 m ohm cm)
- The resistivity was further reduced to 1 m ohm. cm when the thickness of the electrode was increased to 5 mm.
- Active bromine layer was formed with activated carbon (surface area 942 m²/g) plastic composite (70:30 wt%) layer.
- Plastic frames with electrolyte flow fields were successfully provided for the separator and electrodes.



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Test phase

Several batches of single cells were assembled and tested successfully to optimize preparation parameter variables. Open circuit voltage the cells were 1.76 V and 1.56 at a load current density of 20 mA/cm². (literature value 35mA/cm²) the energy efficiency plot exhibited a curved structure with a maximum efficiency value of 65% at a current density of 15mA/cm².



Logical approach for encountered problems

Root cause analysis

Describing the problem we are facing

Gathering data associated with the problem

Identifying potential causes for the problem

Identifying which causes will solve or change in order to prevent repeat problems

Identifying solutions that will be effective in preventing repeat problems

Implementing changes

Observing changes to ensure that they have effectively eliminated the problem



REAP future endeavors

1. A number of technical improvements are being implemented to fabricate scale up multi-cell assembly test unit from this small area single and multi cell studies.
2. To increase the usable power band width of the load voltage; which is 20% lower than the state-of-art band width.
3. The stack module is now in the middle stage of development in this running year and with further refinement will quickly lead to a fully functional product for life and field test
4. With the acquainted knowledge through the small cell test, the research and development team will be able to successfully solve all fundamental engineering and development challenges which are being encountered.



Horticulture Division

The Central Electrochemical Research Institute's vast area of 300 acres comprising laboratory garden, lawn/garden, guest house, commemorative plantation zone, eco- park and the orchard area are brought into green canopy. To honor of the superannuated staff the commemorative plantation zone has been developed and in maintained in pleasant manner.

To meet our own requirement ornamental plants, lawn grass like Mexican type, Korean type grass are developed. Beside this, to make the campus in evergreen condition the some of the important tree seedling nursery also developed. The existing orchard garden is being brought under development and utilization.

Sandal wood sapling

As a part of the social forestry development and conservation, this year Sandal wood sapling plantation was done in the orchard garden.



Social forestry – Sandal wood sapling plantation

Tree plantation on Gandhi Jayanthi

During Gandhi Jayanthi celebrations, tree plantation was done in the front side of the CECRI campus. On this gracious occasion Dr. T. Ramasamy, Secretary, Department of Science and Technology, New Delhi shared with us.



Gandhi Jayanthi celebration and mass cleaning campaign



Avenue tree sapling plantation on road side



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Corrosion Protection Division

Book published:

"Handbook on Corrosion of Aluminium Alloys", Ram Mohan and G.T. Parthiban, Published & Released during 1st Global Corrosion Summit, 24-25 August 2011, at India Habitat Centre, New Delhi, by Chamber of Indian Industries – Corrosion Management Committee.

Technical advice to Indian Oil Corporation Limited (IOCL), Pipelines Division, Western Region Pipelines Morbi Road, Gauridad, PB.No.1007. Bedipara, Rajkot-360003 (Gujarat):



Our Beneficiaries :

- ✦ Nuclear Power Corporation of India (NPCIL), Mumbai.
- ✦ Nuclear Fuel Complex (NFC), Hyderabad.
- ✦ Indian Oil Corporation Limited (IOCL), Chennai.
- ✦ National Council for Cement and Building Materials (NCCBM), New Delhi.
- ✦ Yonsei University, South Korea.
- ✦ Board of Research in Nuclear Sciences (BRNS), Mumbai.
- ✦ Defense Metallurgical Research Laboratory (DMRL), Hyderabad.
- ✦ Sardar Sarovar Narmada Nigam Ltd., (SSNNL), Vadodara.
- ✦ AGNI steels pvt Ltd., Ingur.
- ✦ Public Works Department (PWD), NAVI Mumbai.

Extra mural human resource developments

- 1). Ph.D/M.Sc./M.Phil/ME student's thesis/project work from various academic institutions was supervised.
- 2). Research Intern were trained.
- 3). Refresher courses conducted on Cathodic Protection.

The technology "*Neutral paint removing jelly for PSLV/JSLV nozzle hardwires*" was transferred to Vikram Sarabhai Space Centre, Thiruvananthapuram during March 2012 for the removal of 400micron thick old paint from the nozzles for ₹ 5 lakhs.





Offshore Platform & Marine Electrochemistry Centre, Tuticorin



View of CECRI's Marine Electrochemistry Centre at Tuticorin



Exposure wells



Closure view of a well

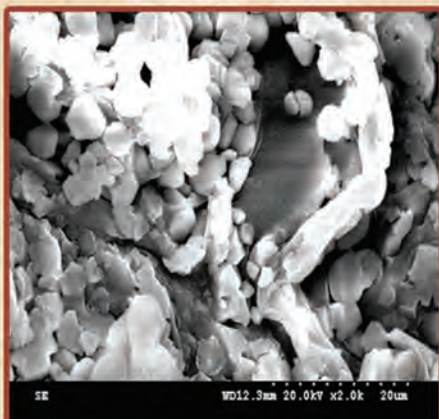
CECRI established this Centre in 1987 within the Tuticorin new harbour area on the southeast coast of India. It stands in the open sea at a water depth of about 6 m, allowing natural immersion of rafts and specimens into the ocean waters. This Centre is thus unique, being only the third facility of its kind in the world. The immersion facility is supported by a well equipped laboratory for studies of marine corrosion, biofouling and cathodic protection.



Pollution Control Division

Studies on removal of Cr(VI) by bio-sorption using *Pseudomonas putida* and *Bacillus licheniformis*:

The extent of Cr (VI) removal from water at Ci of 30 mg/L and 65 mg/L by modified biotechnical methods using *Pseudomonas putida* and *Bacillus licheniformis* microbes in both free cell state and immobilized state (immobilized in biodegradable biomaterial under optimized conditions), resulted in its removal by up to ~70%. The final optimized environmental conditions for maximum removal of Cr (VI) with reference to a few parameters like nutrient matrix, biomaterial matrix, pH conditions etc are evaluated. The impact of pH on the efficiency of *Pseudomonas putida* microbes when immobilized shows better efficiency compared to microbes when not immobilized due to protected environment for the microbes in immobilized state. This work has initiated new hopes for intensified microbial activity in odd environments. This is preliminary work and is in progress.



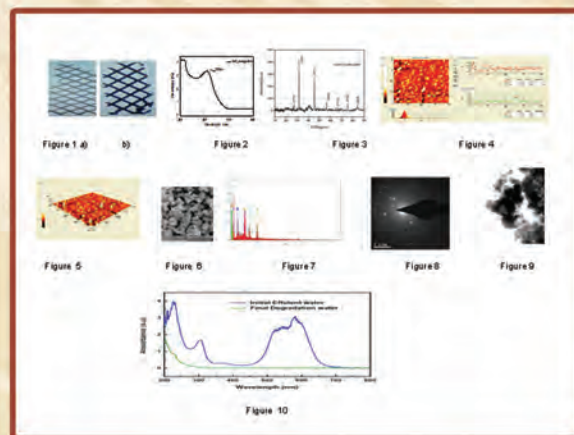
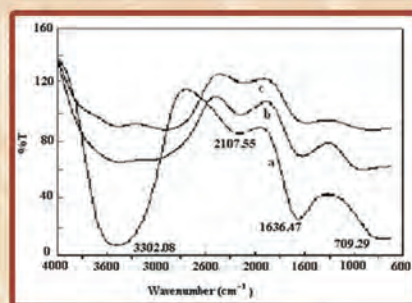
Pseudomonas putida immobilized in modified bio-material during the experimentation (1x2k)

Removal of procion blue dye by electrochemical oxidation using Ti/nano-IrO₂ anode

An attempt was made to prepare and coat iridium oxide nano-particles over titanium mesh (Anode) at room temperature by dip coating method for removal of procion blue (61211 CI Reactive Blue) from water by Electro-Oxidation. SS 304 was used as cathode. As much as 99.3% of colour

Treatment of dye effluent by electrochemical and biological processes:

Batch EO methods for the biologically pre-treated textile dye effluent using the anode titanium mesh/RuO₂ and SS cathode at appropriate distance and optimum current density reduced COD by about 63% and the colour removal by 78%. Figure below indicates a comparative FTIR spectrum of the Textile dye waste water at different stages of treatment: a) before b) during and c) after the EO treatment. The graph c) indicates removal of dye effluents by about 75%. The graph a) indicates presence of Ar-OH groups (phenol), R-OH, R-COOH and RxN-Hx, Rx-C-H, -C=O (2107.99 cm⁻¹), C=C conjugated diene and N=N etc. All these functional groups were observed to be destructed and removed during EO.





CSIR-CECRI ANNUAL REPORT 2011-2012

Knowledge Resource Centre - Physical Library

Library is a storehouse of knowledge. CECRI Library has a unique collection with ample resources in the areas of electrochemistry and its allied fields. Since its inception in 1953, it has been catering to the needs of its scientists, research scholars, students and staff of the institute for their research and academic activities.

The library uses computerization for circulation of books and journals. Functions like acquisition, cataloguing and circulation have been automated using LibSys software. It uses OPAC (online public access catalogue) by which users can view availability and status of documents in the library, and browse the resources on their desktop through intranet.

Collection

The library has a rich collection of books, journals, patents, standards, theses and other documents of research value. Currently, the library subscribes to about 90 journals of which 70 are international. Apart from subscribed journals, the library also gets journals through exchange and gift. To-date, the library resources stand at over 48,000 volumes of books and back volumes of journals and more than 10,000 other scientific documents such as theses, patents, standards and other documents of research and academic value. The library follows arrangements of books according to the standard edition of Universal Decimal Classification (UDC) system. During the period 2010-2011, 92 books and monographs were procured.

Apart from print resources, the library plays a unique role in providing access, delivering service, with more than 2000 scholarly electronic journals through CSIR e-Journals Consortium. The CSIR e-Journals Consortium provides access to world's leading S&T literature published by scientific publishers such as Elsevier, Springer, John Wiley, Taylor and Francis, Oxford University Press, Nature Publishing Group, AAAS, American Institute of Physics, American Chemical Society and Royal Society of Chemistry. access to the entire content of publications from

The e-library has access to the entire content of publications from the Electrochemical Society, USA. It also facilitates access to secondary databases such as Web of Science - the web-enabled bibliographic database that covers all mainstream journals in all fields of science and technology, and Delphion and Derwent Innovation Index, a comprehensive value added patent information with the citations. The library has a stand-alone access to the electronic version of ASTM Standards.

Moreover, as an institutional member of the Electrochemical Society Inc., USA and the International Society of Electrochemistry, Switzerland, the library has online access to the contents of their publications.

Services

The main function of the library is to provide information services and access to bibliographic and full text digital and printed resources to support scholarly and informational needs of CECRI scientists and research scholars. The library serves as a knowledge centre for the students of B.Tech at CECRI. It has an in-house bindery and reprographic facilities.

The library also facilitates exchange of journal articles among laboratories through JCCC service under the CSIR e-Journals' Consortium. Document supply service is also made available from other laboratories and NISCAIR, New Delhi if the user is willing to bear the expenses involved.

Besides, it provides photocopying service on request for nominal charges. This is done according to the copyright rules.

Reference Service

The library has a unique collection of reference materials. Reference queries are responded to immediately by qualified library professionals.



CSIR-CECRI ANNUAL REPORT 2011-2012

Knowledge Resource Centre, e-Library

Mission and Vision

- ❖ Inter-operable institutional open-access repository of CECRI's research articles and proceedings of symposia, conferences and doctoral theses etc.
- ❖ Research trends in electrochemistry through literature-based analysis (growth, impact of research, citation analysis, etc.), and utilization of research through input, output and impact of R&D at CECRI.
- ❖ Columns on recent advances in their areas of research by scientists, both within and outside CECRI.

Expertise:

Information Science

- ❖ Literature survey and Patent search

- ❖ Impact factor and Scientific impact analysis

Computer Applications

- ❖ Development and management of websites, Repositories, Blogspots, Forums etc.
- ❖ DTP-creation/design/layout of journal, reports, proceedings, brochures, posters, handouts, presentations, schematics etc.

Activities during 2011-2012

Posters highlighting the research activities of CECRI were designed for CSIR Technofest- 2010, CSIR Foundation Day, various conferences and seminars.

Automation of the Knowledge Resource Centre using Libsys Software.

Website for e-Library was updated with the following features:

- ❖ Research Output containing the list and full text of publications from CECRI.
- ❖ Forms download section containing commonly used forms arranged in groups.
- ❖ CECRI News, a bi-monthly newsletter, providing snapshots of happenings.
- ❖ New Arrivals section for books and Displayed Journal for journals currently displayed in KRC.
- ❖ News Articles of interest to CECRI.
- ❖ News Clippings containing the press coverage of events of CECRI and CSIR.
- ❖ The History of Electrochemistry providing a brief highlight of the evolution.





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Health Centre

CECRI health centre provides medical facility for staff and their dependants, pensioners and their dependants, BTech students and staff working in various projects. On an average 60 to 70 cases are examined every day.

Routine biochemical and urine examinations are carried out in the laboratory. Newly detected diabetes, hypertension and renal cases are treated and advice given on diet and exercise. The importance of regular BP check-up and investigations are also stressed. Periodical check-up and investigations are carried out for chronic cases like diabetes, hypertension cardiac and renal problems. If any expert opinion is required patients are referred to the referral hospitals.

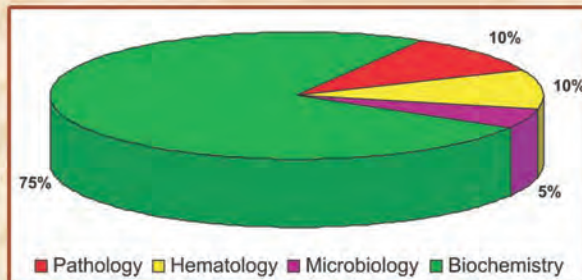
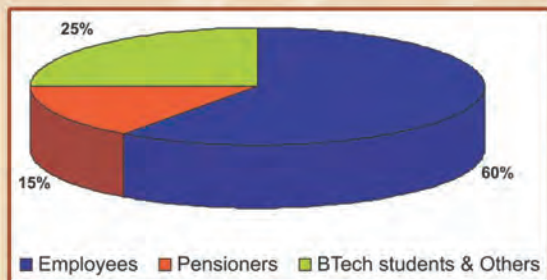
During this report period, 460 Consultation cases were shifted to the referral hospitals.

Blood, urine, and other samples were routinely collected and investigated for pathological, biochemical, hematology, microbiological factors.

The health centre has facilities for O.P., lab investigation, ECG, I.V. fluids and nebulizer. It also has an ambulance equipped with oxygen cylinder and emergency drugs

Specialists were recognized in Karaikudi for surgery, medicine, diabetes, pediatrics, orthopedics, dermatology, ENT, OG, ophthalmology etc. An oral polio camp was conducted for the children of 0-5 yrs. 40 children attended the camp. Necessary data were collected for AROGYA software implementation.

During the Report period a total of 4462 biochemical and 1039 pathological investigations were investigated at our Health Centre.





Patent Cell

Patents filed and granted

Filed : 3
Granted : 2

Filed

1. Improvements in or relating to designing fluid flow field bipolar plate for solid polymer electrolyte hydrogen generator therefor.

G. Sozhan; S. Vasudevan; S. Mohan; S Ravichandran; D.J. Davidson

2. A process for electrochemical dying with VAT dyes on cotton/viscose fabrics using an amine free environmentally benign complex (mixed metal / metal ligand).

M. Anbukulandainathan; K. Firoz Bapu;
R. Senthilkumar; M. Noel; A. Muthukumaran.

3. A method of detection of nitric oxide by electrochemical reduction and the development of NO monitor.

Sheela Berchmans; S. Vincent; S.A. Varadharajan;
V. Yegnaraman

Granted

1. Improvements in or relating to the development of a maintenance free reference electrode for multifarious applications.

V.S. Muralidharan, H. Dolli, N.S. Rengaswamy, M. Raghavan.

IN 249266, Publication date 21/10/2011.

2. Development of chemical resistant geopolymers fly ash.

V. Saraswathi, R. Selvaraj, K. Kumar, R. Jeyaram, R. jeyaram.

IN 247430, Publication date 08/04/2011.



Chlor-Alkali Division

CECRI-Chlor Alkali Industries' Get-together was held on 8-4-2011 in Chennai

The get-together was organized by the Chlor-Alkali Division and TTBD-CECRI.

Eight delegates representing various Chlor Alkali Industries (AMAI) in India participated in the deliberations.

In welcoming the gathering Dr. V.Yegnaraman, stressed the need for strengthening the Research institute-Industry's interaction.

Dr. K. Asokan, Scientist & Head, Chlor-Alkali Division, CECRI, presented the technological achievements and contributions of CECRI made to Indian Chlor-Alkali Industry.

- TSIA technology developed by CECRI for Indian Chlor Alkali Industries has saved energy to the tune of 6800 million kWh (31-3-2009).

- CECRI's catalytic coatings for titanium anodes of membrane cells and with a service life of over 6 years. The technology was transferred (2004) to Grasim Industries (Chemicals Division), Nagda, M.P.

- Catalytic coatings for nickel cathodes of membrane cells and have a service life of over 6 years. The process was patented in India and USA. The technology was transferred (2004) to Grasim Industries

- Both anode and cathode coating technology are being used by Grasim industries to recoat their anodes and cathodes in their 100000 TPA (NaOH) Uhdenora Membrane electrolyzers since 2004.

- With the expertise developed over the last three decades, CECRI is also attending to trouble shooting in the commercial chlor-alkali plants in India

- With the expertise developed over the last three decades, CECRI is also attending to trouble shooting in the commercial chlor-alkali plants in India.

- CECRI extended its expertise in membrane cell technology to the production of potassium permanganate (KMnO_4) and other quaternary ammonium hydroxides such.

- Tetra Methyl Ammonium hydroxide (TMAH) (Transferred to NOCIL, Navi Mumbai).

- Tetra ethyl ammonium hydroxide (TEAH), tetra propyl ammonium hydroxide (TPAH) and tetra butyl ammonium hydroxide (TBAH) (Transferred to Tatva Chintan Pharma Chem.ltd, Ankleswar, Gujarat).

ii) Dr. K. Subramanian, Scientist, CECRI presented recent technological contribution made to Indian Chlor Alkali Industry. He also presented a bird's eye view on the R&D proposal to be submitted to 12th Five Year plan "Energy and Precious Metal Conservation in Chlor-alkali industry" to provide a means to tide over the recent electrical energy crisis and precious metal crunch.

a) Development of Nano structured electrocatalysts for anodes and cathodes of chlor-alkali membrane Cells.

b) Development of oxygen depolarised gas diffusion cathode (ODGDC) for chlor-alkali cells.

iii) Dr. S. Pichumani, Scientist, in-charge, CECRI, Chennai Unit, presented the development and commercialization of 500 kWh Hydrogen-oxygen Fuel Cell. He presented a plan for integration of 1-5 kWh capacity fuel cells with chlor-alkali membrane plants in India.

iv) Dr. G. Sozhan, Scientist, presented electrochemical generation of hydrogen in solid polymer electrolyser and also explained about their development of electrochemical compressor.



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v) Dr. Vijaya Mohanan K. Pillai, (Outstanding Scientist), summed up the deliberations of the get-together.

Topics discussed in the meeting

1. Regarding regular interaction with CECRI (CSIR) and Chlor-Alkali Industry (AMAI)

Sri. Patil (GACL, Dahej) stressed that Communication network and coordination work with industry and CSIR should be strengthened

Sri. BR Yadav (DCW, sahurapuram)- informed that

- Under AMAI Banner we can organize another get together
- Every year AMAI will have annual summit of industries, CECRI can participate in it
- Sri. BR. Yadav (DCW) will be nodal person between CECRI(CSIR) and Chlor-Alkali industry (AMAI)
- CECRI – chlor alkali industry partnership project for zero discharge from the industry

2. Anode and cathode coatings

CECRI informed that technology cost for anode and cathode coatings is ; Rs. 20 lakh + Rs. 20 lakh = Rs. 40 lakh, coating plant cost ; Rs. 40 lakh (a furnace- 110 kw, with automated/controlled instrumentation)

3. Fuel cell – membrane cell integrated research work

Sri. SC mittal of DCM, Gujarat told that they would offer facilities to CECRI to take field trails for CECRI's fuel cell and provide hydrogen fuel freely at DCM

4. Research and Development: to be undertaken for Indian chlor-Indian industry

The following R& D requirements for the Industry have been arrived at the get together

Title of the project proposal :

Energy and Precious Metal Conservation in Chlor-alkali industry

- i) Rejuvenation of cation exchange membrane used in commercial chlor-alkali cells
- ii) Savings on the consumption of Precious metal compounds in the manufacture of anode and cathode coatings

- a) Development of nano structured catalyst for anode and cathodes
- b) Development of non-precious metal based cathode coatings

iii) Improvements in secondary brine purification
-Development of methods for removal of Ba^{2+} , Iodine and chlorate from brine.

iv) To develop methods to find out at what extent the anode/cathode coatings and membrane have lost their activity without dismantling the electrolyser from the data available during operation of cell after the completion of 3 years or after observing abnormalities in the performance of electrolyzers.

v) Operation of laboratory scale chlor-alkali cell on pilot plant basis- for studying the membrane performance, effect of impurities, newly developed anode and cathode coatings ----Mid Term Objective

vi) Operation of oxygen depolarised gas diffusion cathode fitted chlor-alkali cell- Long-term objective.

5. Other topics such as polarisation rectifier, solid sludge handling, zero discharge from the plant, price of hydrogen were also discussed.



CECRI- Chlor Alkali Industries' Get together at Chennai (8-4-2011)



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Academy of Scientific and Innovative Research (AcSIR)

AcSIR

The Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Government of India introduced and passed the Academy of Scientific and Innovative Research (AcSIR) Bill, 2010 in the Lok Sabha on 5 September 2011. The Bill was introduced with the objective to establish an Academy for furtherance of the advancement of learning and prosecution of research in the field of science and technology (S&T) in association with the Council of Scientific and Industrial Research (CSIR) and to declare the institution known as the Academy of Scientific and Innovative Research, to be one of national importance to provide for its incorporation and matters connected therewith or incidental thereto. AcSIR was established by an Act of Parliament, the Academy of Scientific of Scientific Innovative Research Act, 2011 vide The Gazette of India No.15 dated February 7, 2012 and notified on April 3, 2012.

AcSIR is created to develop the highest quality personnel with cross disciplinary knowledge, aiming to provide leaders in the field of science and technology. The Academy shall primarily focus on research and imparting instructions in a such a manner that the methodology is novel and off the beaten track. Further, the Academy aims to:

- Nurture a research-propelled, technology-enabled, industry-linked, socially conscious higher education platform
- Achieve a seamless integration of intellectual strengths with current market needs with a people centric focus
- Develop niche capability required to bolster research efforts in futuristic science
- Provide the opportunity to work on the frontier and contemporaneously challenging areas for nurturing innovation.

AcSIR is an institution and of national importance. The Academy have the structure of a multi-centric institution based on a hub-and-spoke model. CSIR headquarters located at New Delhi act as a hub responsible for centralized administration connected with all the 37 CSIR laboratories (spokes) act as actual campuses for different subjects/areas based on their respective specializations. AcSIR aims at substantially increasing the number of researchers in integrative and inter-disciplinary areas of science and engineering in a cost-effective manner.

Students' Academic Committee (SAC)

The Students' Academic Committee has been constituted for creative mentoring of all CECRI Ph.D. Students. SAC look into all issues related to the academic welfare of students in CECRI. It deals with the matters pertaining to Ph.D. admission, screening of application if necessary, interviews of Ph.D. students and orientation programme of Ph.D. students admitted. The Committee designs and implements mandatory course work for all Ph.D. students of CECRI irrespective of their University of Registration in line with AcSIR requirements. It finds out the ways for enhancing the quality of CECRI Ph.D. students. It also interfaces with all the respective Universities for Ph.D. registration, supervision and evaluation of thesis, viva-voce etc. SAC also addresses and offers solutions to problem arising during the course of Ph.D. tenure for the healthy student-guide interactions, change of guide etc.

SAC activities

1. SAC Office was created to maintain the records of Ph.D. students and to prepare the correspondence pertaining to them.
2. During January 2012 nine students were admitted for Ph.D. programme under AcSIR.
3. On the occasion of National Science Day, Prof.G.Baskaran, Raja Ramana Fellow, Institute of Mathematical Science, Chennai has delivered a Lecture on "Natural Sciences and Mathematics" on 28.02.2012. Technical Presentations were made by Research Scholars and Ph.D. students. Awards were given to the best presentation to both the Research Scholars and Ph.D. students (2 each).

Ph.D. synopsis submitted:

1. Ms. P. Porkodi - 24.11.2011 (Guide: Dr. D. Jeyakumar)
Title: "Studies on new synthetic routes for the preparation of materials-Molecular precursor-based approach".
2. Mr. R. Karthikeyan - 12.1.2012
(Guide: Dr. SheelaBerchmans)
Title: Development of mediatorless microbial fuel cells using acetobacter aceti and gluconobacter roseus as whole cell electrogenic biocatalysts"



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Ph. D. thesis submitted

1. Mr. G. Saravanan (Guide: Dr. S. Mohan)
Title: "Studies on the electrodeposition of chromium and its alloy from eco-friendly Cr(III) electrolytes and Room Temperature Ionic Liquids-RTIL"

2. Ms. C. Nithya (Guide: Dr. S. Gopukumar)
Title: "Synthesis and electrochemical evaluation of high performing cathode materials for lithium rechargeable Batteries".

Deputation of Ph.D. students abroad

1. C. Jeyabharathi, CSIR SRF was deputed to Germany for the period from 6th June, 2011 to 30th September, 2012 to avail DAAD Sandwich Model Fellowship.

2. S. Harish, CSIR SRF was deputed to France to avail Sandwich Ph. D. Fellowship 2011 in LACCO-UMR CNRS n°6503 University of Poitiers, France during 30th June – 31st December, 2011.

Course work for Ph.D. scholars

The following three courses were conducted during the period:

1. Fundamentals of Electrochemistry
2. Electrochemical Power Sources
3. Corrosion Science

Ph. D. Students under AcSIR:

S.No.	Name of the student	Name of the Guide	Date of admission
1	Jaison M J	Dr. Vijayamohanan K Pillai	August 2011
2	Muniah Yeddala	Dr. Vijayamohanan K Pillai	September 2011
3	Demudu Babu Gorle	Dr. M.Anbu kulandainathan	December 2011
4	B. Chandra sekhar	Dr. N. Kalai selvi	December 2011
5	Zance S S	Dr. S. Ravichandran	January 2012
6	Aneesh. K	Dr. Sheela Berchmans	January 2012
7	G. Kruthika	Dr. P. Murugan	January 2012
8	Vineesh TV	Dr. K.L.N. Phani	January 2012
9	Sumana Kundu	Dr. Vijayamohanan K. Pillai	February 2012

Ph.D students admitted under Bharathidasan:

S.No.	Name of the student	Name of the Guide	Date of admission
1	P. Manikandan	Dr. P. Periyasamy	April 2011
2	S. Varadharajan	Dr. Sheela Berchmans	March 2011
3	N. Prabhu	Dr. D. Jeyakumar	March 2011
4	R. Anandhakumar	Dr. B. Subramanian	February 2011
5	P. Anandhaganes	Dr. D. Jeyakumar	April 2011
6	R. Ravikumar	Dr. S. Gopukumar	May 2011
7	A.V. Narendra kumar	Dr. James Joseph	October 2011
8	A. Ananthi	Dr. K.L.N. Phani	October 2011
9	B. Venkata Rami Reddy	Dr. S. Gopu kumar	October 2011
10	N. Sreekanth	Dr. K.L.N. Phani	October 2011
11	R. Pavul raj	Dr. S. Mohan	October 2011
12	T. Naresh kumar	Dr. K.L.N. Phani	October 2011
13	C. Srinivasarao Vusa	Dr. Sheela Berchmans	October 2011
14	B. Gnana sundara Raj	Dr. N. Lakshminara simhan	October 2011
15	V. Sannasi	Dr. D. Jayakumar	October 2011
16	T. Siva	Dr. S. Sathya narayanan	October 2011
17	S. Boopathi	Dr.S.Senthilkumar	October 2011



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Centre For Education (CFE)

CECRI has been running a four-year, eight-semester BTech course in Chemical and Electrochemical Engineering since 1988 under the aegis of Centre for Education (CFE). This course is a unique and judicious combination of chemical and electrochemical engineering, and is unlike any other offered anywhere else in the world. One aspect of its uniqueness is that the course is conducted by scientists and engineers actively involved in electrochemical science and technology.

The programme is approved by AICTE (All India Council of Technical Education) and it is affiliated to Anna University, Chennai.

Academic results (2011-12 batch)

No of students secured first class with distinction: 5
No of students secured first class: 29

Placements

Of the total number of 34 Students, 32 candidates got placed with dignified salaries ranging from 15000 INR to 70000 INR. Reputed firms like Corrttech, CTS, Amarraja Batteries Al Alshrafi, HOV, TVS motors, Hema Engineering, consolidated metal finishing, Bloom energy and Sheen electroplaters have recruited our B. Tech students.

University admissions

Our B. Tech students could fetch admission in certain reputed Universities from abroad like Rhode Island, Clarkson University, Oxford university, University of Manchester, and Technical University of Dortmund.

In-plant training

The B. Tech students attended in-plant training in reputed industrial organizations like Birla Carbon, CPCL, Vedanta Copper, Saint Gobain, Salem steel plant, Dharrangadara chemicals, Wheels India Ltd, Exide batteries, HPCL, Travancore Titanium, and Hema engineering Ltd.

NAME	EVENTS	AWARDS
Arun.S.Siddarth,	Chemclave'12,	First Prize
H.Mohamed Asif and S.Dinesh (III year)	IIT Madras	(Poster Presentation)
K. Arun Sudarshan and S. Anand Kumar (III year)	CHEMFUENCE'12 Anna University - Chennai	First Prize (Oral Presentation)
S. Anand Kumar (III year)	NCRMS'12 A.V.C College - Mayavaram	Best Paper Presentation Award

Red Ribbon Club

Invitation from the members of Red Ribbon Club lead by the District Manager, Sivaganga wing has been extended to our B. Tech. students to talk on the perils of AIDS, with a special focus on the methods to control adolescent tendencies. The lecture included a general overview on the activities of RRC and a video featuring a detailed analysis of AIDS prevalence in India, discussing safe practices to avoid diseases. The lecture was well received by the audience and in an interactive session, number of students presented their views with respect to the points discussed in the lecture.

Sports

The annual sports meet ARMAGEDDON 2012 has been organized and conducted by our students that included over 30 individual and team events. CECRI's cricket team reached semi-finals at the zonal tournament and John Rajasundar of third year has been selected to play in the inter-zonal cricket team. In athletics, Sunil Yadav of final year won two silver medals in the zonal athletic meet held at PSNA College, Dindigul. In another event, 10 of our students represented CECRI in the TIES athletic meet held at Trichy. S. Karthikeyan of third year, a former national medallist in Badminton played at the inter-university level badminton tournaments held at Vellore and Vijayawada.



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Blood donation camp

In a public goodwill gesture, CFE has conducted a voluntary blood donation camp for B.Tech students by inviting a medical personnel from Karaikudi Government hospital. Blood collection was performed by trained medical professionals with complete adherence of sterile norms. More than 25 students participated actively in the blood donation camp, held on 2nd October, 2011.

Career counselling programme by CECRI B. Tech. Alumni Association (CBTAA)

A two-day B. Tech. career counselling program has been organized by the CECRI B. Tech Alumni Association (CBTAA) under the initiation of Venkatraghavan Srinivasan, an alumnus of 1992-96 batch. The sessions featured series of interactions with former students, in which number of points related to career development have been discussed. Due emphasis has been placed on both employment prospects after B. Tech. as well as the opportunities for pursuing higher studies. Former students settled abroad were contacted through web conferencing. Mock interviews had also been conducted for the students of final year in order to enhance their confidence during the time of campus recruitment. B. Tech Admissions (2012 batch):

33 of the allotted 35 seats in the state quota have reported for admission. Five seats reserved for students from other states were filled on 3rd August 2012 on the basis of AIEEE rankings by conducting on-campus counselling.

Orientation programme

The 25th Fresher's orientation programme was conducted by the students of final year on 8th August 2012. The programme consisted of special talks by the Director, Dean and Hostel Wardens. Dr.Vijayamohan K Pillai, Director, CECRI gave an inspirational talk to encourage freshers and about the general scope of Electrochemical science and technology. Dr.P.Subramanian, Dean (Administration) provided an overview the B.Tech program and the facilities made available for the students. Freshers were then called on stage to introduce themselves and a smooth platform of getting mutually introduced with the senior students has been provided through the said program.

Open day

The B.Tech students have played a vital role in organizing CSIR- CECRI open day. A separate stall was set up for the B.Tech students to display their work. The opportunity was well utilized by the students

Summer fellowships

Given below is a list of students who have been selected for the summer research fellowship programme offered by Indian National Academy of sciences (INSA) to some of our students for the year 2012.

NAME	ORGANISATION	GUIDE	PROJECT TITLE
M.S. Pavithra (IV – year)	IISER – Mohali	Dr. Samrat Ghosh	Electrochemical Recovery of Sodium from bio diesel by products Solid State Fuel Cells
G.Sridevi (III Year)	BARC, Mumbai	Dr.B.N.Wani	
M.Narmadha (III Year)	IISc, Bangalore	Prof.S.Sampath	Amide based room temperature molten electrolyte for rechargeable batteries

In-plant training

The B. Tech students attended in-plant training in reputed industrial organizations like Birla Carbon, CPCL, Vedanta Copper, Saint Gobain, Salem steel plant, Dharangadara chemicals, Wheels India Ltd, Exide batteries, HPCL, Travancore Titanium, and Hema engineering Ltd.

SELECT 2012

SELECT 2012 was a national level symposium organized by the B.Tech students on 24-25 February 2012. The inaugural address was delivered by Dr.E.Perumal Pillai, Registrar, Anna University of Technology Madurai Following are some of the statistics of this event.

No of external delegates: 130

No of technical sessions: 4

No of papers presented: 81

as cleared the UPSC examination (All India Rank: 105), 2012



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INTERFACE 2012

Interface 2012 was a national level cultural festival organized by our students on 26th February 2012. It includes numerous events such as quiz, solo singing, dancing, treasure hunt etc, debates, skits, miming, instrumental music, etc.

No of events: 22

Total no of participants: 107

Alumni awards

The following alumni awards have been presented to the final year students who have excelled in academics.

1. K.V. Prasad Memorial award: B. Prabhuraj.

2. Hiran. D. Bharucha Memorial award: S. Ruth Sneha.

Commendable achievements

1. Joseph Sharkey became the first student from CFE to gain admission for a doctoral degree in Physics at the prestigious Oxford University. He is also the proud recipient of Clarendon Fellowship, which covers Rs 87.5 lakhs for his doctoral studies.

2. D. Balamuraliof 2003-2007 batch has cleared the UPSC examination (All India Rank: 105), 2012





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International Collaboration and Publicity Foreign deputaion of scientists

S.No	Name of Scientist	Grade	Country visited	Purpose of visit	Period of deputation	Source of funding
1	Shri A. Manokaran	Sci.	Germany	Hannover Fair at Germany	4 th April 8 th April, 2011	TLP0208
2	Dr. B. Subramanian	Sci.	Japan	FY2011 JSPS Invitation Fellowship Programme for Research	29 th April 2011 29 th Feb. 2012	JSPS-Japan
3	Dr. Santosh Kumar D. Bhat	Sci.	Canada	Oral presentation at the 219 th ECS Meeting	1 st – 6 th May, 2011	SIP-18
4	Dr. Akhila Kumar Sahu	Sci	Canada	Oral presentation at the 219 th ECS Meeting	1 st – 6 th May, 2011	SIP-18
5	Dr. S. Ravichandran	Sci.	Canada	Oral presentation at the 219 th ECS Meeting	1 st – 6 th May, 2011	NWP-22
6	Dr. S. Vasudevan	Sci	Malaysia	Keynote address in 5 th ICCE-11	May 27 – 29, 2011	NWP 22
7	Dr. P. Venkatesan	Sci.	Budapest, Hungary	EuroNanoforum 2011	30 th May – 1 st June, 2011	CSIR Empower Project DU 03/OLP 063 (Special incentive)
8	Dr. R. Thirunakaran	Sr.Technical Officer	Taiwan	Indo-Taiwan Collaborative Programme	5 th – 21 st June, 2011	
9	Mr. C. Jeyabharathi	CSIR SRF	Germany	DAAD Sandwich Model Fellowship	6 th June, 2011 – 30 th Sep. 2012	DAAD, Germany
10	Dr. Vijayamohanan K. Pillai	Acting Director	Finland	Invited lecture at EU-India EICOON Workshop	13 th – 17 th June 2011	EICOON, Finland
11	Mr. S. Harish	CSIR – SRF	France	Sandwich Ph.D Fellowship 2011 in LACCO-UMR CNRS University of Poitiers	30 th June– Dec.31 st 2011	French Embassy
12 13 14	Dr. A. Sivashanmugam Dr. A. Manuel Stephan Ms. N. Angulakshmi	Sci. Sci. SRF	Singapore	Oral presentation of their Papers in ICMAT-2011 at Suntec City	26 th June – 1 st July, 2011	CSIR & DST, IAP 004 DST
15	Dr. V. Ganesh	Scientist	Canada	Visiting Researcher at University of Manitoba	01.08.11 31.01.12	University of Manitoba, Canada



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S.No	Name of Scientist	Grade	Country visited	Purpose of visit	Period of deputation	Source of funding
16	Dr. N. Kalaiselvi	Principal Scientist	Korea	INSA-NRF Exchange Programme	3 weeks from 3 rd August, 2011	INSA & CECRI Local hospitality provided by KERI, Korea
17	Dr. Vijayamohan K. Pillai	Outstanding Scientist & Director	Brazil	Invited talk at the Indo-Brazil meeting, Foz do Lguacu	26 th – 28 th August, 2011	Air fare, Visa fee – DST Local hospitality – Brazilian academy of Sciences
18	Dr. S. Senthilkumar	Scientist	USA	BOYSCAST Programme University of Texas at Austin	21.09.11 – 20.09.12	DST, New Delhi
19	Dr. M.V. Ananth	Sr.Principal Scientist	Japan	Poster presentation in 62 nd Annual Meeting	11 th – 16 th Sep.2011	IAP – 004 (TA – Abroad)
20	Dr. P. Sridhar	Sr.Principal Scientist	USA	Oral presentation in 220 th ECS Meeting	9 th – 14 th October 2011	SIP-008 (TA-Abroad)
21	Dr. G.V.M. Kiruthika	Scientist	Korea	Oral presentation in ICAE-2011	7 th – 10 th Nov. 2011	DST & IAP 004 (TA Abroad)
22	Dr. M. Natesan	Sr.Principal Scientist	Australia	For Oral presentation in 18 th ICC	20-24 th Nov.2011	CSIR, SSP 07/11 & SSP04/10
23	Dr. M. Selvaraj	Sr.Principal Scientist	Australia	For Oral presentation in 18 th ICC	20-24 th Nov.2011	DST, CSIR, CNP 05/10 & IAP 0004
24	K.G. Nishanth	SRF	Italy	Oral Presentation in European Fuel Cell Conference & Exhibition, Rome	14.12.11 16.12.11	SSP 14/07 (TA-Abroad)
25	K. Manokaran	Junior Scientist	Germany	Pre-dispatch inspection and training for steam reformer at WS Reformer	17.01.12 20.01.12	TLP 0208
26	Dr. V. Suryanarayanan	Scientist	Taiwan	Indo-Taiwan Joint Research Programme	30.01.12 17.02.12	CII/GITA – Air fare & visa fee NSC, Taiwan – local hospitality at Taiwan
27	Dr. A. Sivashanmugam	Sr.Principal Scientist	Taiwan	Indo-Taiwan Joint Research Programme	19 – 29 February, 2012	GITA, New Delhi & NSC, Taiwan
28	Dr. S. Sathiyarayanan	Sr.Principal Scientist	USA	Lecture in the 6 th International Smart Coatings Symposium	22 – 24 February, 2012	NWP-12 & IAP 004 (TA-Abroad)
29	Dr. N. Lakshminarasimhan	Scientist	Korea	Visiting Researcher at POSTECH	01.03.12 – 31.03.12	POSTECH, Korea
30	Dr. S. Gopukumar	Sr.Principal Scientist	Japan	DST-JST Joint Collaborative Project	26.03.12 – 29.03.12	NWP-56 & JST, Japan
31	Dr. S. Sathiyarayanan	Sr.Principal Scientist	Germany	Max Planck Institute for Colloids and Interfaces, Golm	Aug – Sep 2011	CSIR DAAD Scientist exchange programme



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List of persons visited from foreign countries to CECRI

S.No.	Name of Scientist	Title	Purpose of visit	Deputation Period
1	Dr. Atef Shenouda CMRDI Egypt	--	To strengthen the research relation between CECRI and CMRDI	25 th April, 2011
2	Prof. J.I. Yamaki Prof. S. Okada Mr. Yohei Shinjo Mr. Joji Sato JST, Japan	India - Japan Cooperation Programme (DST-JST) 2007 – Joint Project entitled "Development of high performing electrode materials for Lithium Ion Batteries to be used in information and communication equipment	To discuss the Project	5 th – 8 th January, 2012
3	Herr. Dr. Yashodhan Pramod Gokhale and Dr. Julian Schwelzel, IFAM Institute, Germany	Preparation of high performing Li-ion battery electrode materials via solution combustion synthetic route and their performance evaluation using pouch cells	To carry out research work under Indo-German CSIR-IB-BMBF Cooperative Science Programme	4 th – 13 th January, 2012
4	Dr. K. Vairavan Emeritus Professor	Dr. R.M. Alagappa Chettiar: The Life and Legacies of a Visionary	To deliver a lecture on Dr. RM. Alagappa Chettiar	14 th February, 2012
5	Prof. M.A.Oturan Laboratoire Geomatériaux and Environment (LGE), University of Paris-Est, France	Water Resources, Pollution and Treatment by Electrochemical Advanced Oxidation Processes	(i) Discussion on Indo-French collaborative project (ii) Exchange of students and future visits (iii) Invited talk on Advanced Oxidation Processes (iv) Professional exchange in environmental chemistry, current researches and future outlook	19.2.2012 – 24.2.2012
6	Prof. Dr. Rudolf Holze, Technische Universität Chemnitz, Germany	Electrochemistry: From Energy Conversion to Materials Science	To deliver an invited lecture.	March 20, 2012
7	Dr. Jorg Ackermam Centre Interdisciplinaire De Nanoscience De Marseille, France	New Polymer nanomaterials for Solar energy conversion	To deliver an invited lecture	28 th March, 2012



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List of Awards Received during April 2011- March 2012

1. Dr. N.V. Shanmugam, Sr.Principal Scientist was awarded N.M. Sampat Award NEST -2011 by the Electrochemical Society of India, Bangalore.
2. NACE International Gateway India Section presented the Corrosion Awareness Award 2010-11 to Dr. V. Saraswathy, Senior Principal Scientist.
3. SAEST, Karaikudi awarded the Best Electroplater Award for the year 2011 to Dr. R. Sekar, Senior Technical Officer.
4. Dr. S. Sathiyarayanan, Sr. Principal Scientist received the Akzonobel Excellence Award for Coating Research & Promotion for the year 2011-12 from SSPC India, Mumbai.
5. His Excellency the Governor of TamilNadu nominated Dr. D. Velayutham, Sr. Principal Scientist as a Senate Member of Alagappa University, Karaikudi for a period of three years from 02.12.2011.
6. School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala presented the Certificate of Award of Erudite Visiting Professor to Dr. Vijayamohanan K. Pillai, Acting Director, CECRI and Outstanding Scientist under The Erudite Scholars-in Residence Programme by Government of Kerala.
7. Dr. M. Jayachandran, Chief Scientist and Dr. B. Subramanian, Sr. Scientist received the ISAPS'11 Paper Award at the "International Symposium on Applied Plasma Science" held during September 26-30, 2011, Japan.
8. Mr. S.R. Suseendiran, B.Tech III year Student (Supervisor : Dr. S. Mohan) awarded first place for his Paper at the National Conference on Advanced Nanomaterials held at Periyar University,during 6-7 February, 2012.

9. Dr. Vijayamohanan K. Pillai, Director received K.S.G. Doss Memorial Award from SAEST, Karaikudi at the 16th National Convention of Electrochemists (NCE-16) held at P.S.G.R. Krishnammal College for Women, Coimbatore during December 15-16, 2011. He also received Professor Gurumurthy Memorial Endowment Award from Annamalai University.

CECRI FOUNDATION DAY 2011

CSIR-CECRI Foundation Day 2011 was celebrated on July 25, 2011. Dr.S. Sundararajan, Director, National Institute of Technology, Tiruchirappalli delivered the Foundation Day Lecture on "Corrosion Research – Past, Present and Future".

CSIR Foundation Day - 2011

CSIR Foundation Day was celebrated at CECRI on September 26, 2011. Professor M.S. Ananth, Distinguished Professor, IISc, Bengalure and Former Director, IIT Madras, Chennai delivered the Foundation Day Lecture on "Innovation and the University".

On the eve of CSIR Foundation Day, CECRI observed "Open Day" for two days on 29th and 30th September, 2011.



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Seminar & Training Section

a) Industry Oriented Technology Courses

CECRI offers a variety of course to scientific and technical personnel employed in industries, government and academic institutions. These moderately priced courses are designed to impart the necessary knowledge and skills and are conducted by talented and highly competent scientist with help of skilled auxiliary / technical staff. Participants will be given ample opportunities to have hands-on-experience.

During 2011-12 we conducted 13 Industry Oriented Technology Courses in the following subjects.

1. Corrosion Science and Engineering (4 modules)
2. Batteries (2 modules)
3. Central Instrumentation Facility (1 module)
3. Electrochemical Materials Science (1 module)
4. Industrial Metal Finishing (2 modules)
5. Electroplating Metal Finishing Technology (3 modules)

The courses are structured as modules each lasting 5 days. 140 participants from various organizations attended the courses during 2011-12.

Please see in annexure –I

Special Programmes

- a) National Technology Day celebration on 11th May, 2011.
- b) IYC -2011 Motivation Programme for Kendriya Vidyalaya Students during 17-18 August, 2011.
- c) IYC – 2011 Motivation Training Programme for PG (Chemistry) Teachers during 12 & 13 December, 2011.
- d) SAC organizing a course in Technical English during 23-26 January, 2012.
- e) CPYLS - 2011 programme during 5-7 March, 2012.



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Annexure - I Industry oriented technology courses conducted during 2011 - 2012

S.No.	Name of Course	Duration	No of Participants
1	Corrosion Control in Boilers and Heat Exchangers (CSE-1)	08.08.11 to 12.08.11	12
		12.09.11 to 16.09.11	11
2	Cathodic Protection Systems & Devices (CSE-3)		
3	Pipeline Corrosion and its Control (CSE-4)	19.09.11 to 23.09.11	3+2=5
4	Paints for Corrosion Protection (CSE-6)	10.10.11 to 14.10.11	14
5	Instrumental Methods of Analysis (CIF)	17.10.11 to 21.10.11	8+1=9
6	Lead Acid Batteries : Science & Technology (BAT-1)	31.10.11 to 04.11.11	8
7	Lead Acid Battery Care & Maintenance (BAT-2)	14.11.11 to 16.11.11	7
8	Surface Coatings by Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD) and Surface Analyses (ECMS)	21.11.11 to 25.11.11	7
9	Industrial Practice of Electroplating and Metal Finishing (IMF-1)	19.12.11 to 23.12.11	25
10	Maintenance of Electroplating Baths (IMF-2)	02.01.12 to 06.01.12	18
11	Electroplating of Copper, Nickel, Chromium and Precious Metals (EMFT-1)	16.01.12 to 20.01.12	5
12	Trouble - shooting in Electroplating and Metal Finishing (EMFT-2)	06.02.12 to 10.02.12	7
13	Electroplating and Anodizing Principles and Practices (EMFT-3)	13.02.12 to 17.02.12	12
		TOTAL	140



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
1	National Workshop on Recent Trends in Electro Chemistry on 28th April 2011 at CECRI, Karaikudi -	Scientist/ Sr. Scientist Sr. Principal Scientist/ -63 Technical officer-32 SRF/JRF -17 Project Assistant -51 Senior Technician -9 Research Intern-17	189	-
2	Corrosion Awareness day 2011 on 25th April 2011 at CECRI, Organized by NCCI & CECRI, Karaikudi.	TOTAL -189 Scientist/ Sr. Scientist Sr. Principal Scientist/ -47 Technical officer-18 SRF/JRF-2 Project Assistant -28 Senior Technician -2 Research Intern-2 TOTAL -99	99	-
3	One day Workshop on Recent Development in Nano Technology and its application organized by: Kodaikannal Institute of Technology, Machur, Kodaikannal - 624 104 during 9th April, 2011.	Shri. R. Senthilkumar	1	Research Fellow
4	National Conference on Technological Advances in Civil Engg. TACE - 2011 organized by Dept. Civil Engg, School & Mechancial & Building Sciences during May 3rd -4th ,2011 at Chennai	Dr. P. Venkatesan	1	Principal Scientist
5	National Seminar on "Lead Batteries Technology & Environment" during May 27th, 2011 at Chennai by Lead Zine Development Association (ILZDA) M.B. Road, New Delhi - 110 062.	Er. P. Seenichamy	1	Sr. Technical Officer
6	SERC School on Electrochemical Systems, May 16th -28th ,2011 by Dept. of chemistry and chemical Engg. India Institute of Technology Bombay, Powai, Mumbai - 400 076.	Mr. R. Anantha kumar Ms. M. Sathiya	2	SRF(P) SRF
7	XI Tamil Science Congress at Gandhigram Rural University Gandhigram, Dindugul - 624 302. During 25th -27th June, 2011	Dr. K.N. Srinivasan Dr. N. Kalaiselvi Shri. PR. Thangavelu	3	Sr. Principal Scientist Senior Scientist Sr. Technical Officer
8	Training programme on "Competency Development for Technical Officers" held at HRDC, Ghaziabad, during 20th - 24th June 2011.	Dr. S. Muralidharan Dr. R. Sekar	2	Senior Technical Officer (2) Senior Technical Officer (2)
9	"Research Methodology: Multivariate methods of analysis" for Senior Scientist to be held at HRDC, Ghaziabad, during 4th - 8th July, 2011.	Dr. P. Veeramani Dr. S. Muthukrishnan Dr. G.N.K. Ramesh Babu	3	Sr. Principal Scientist Sr. Principal Scientist Sr. Principal Scientist
10	Eight Technology Led Entrepreneurship programme to be held at IICT, Hyderabad, during July 04th -18th , 2011	Shri. K. Soundra Rajan Shri. Gangulibabu Shri. N. Rajasekaran	3	JRF (G) SRF Project Assistant
11	"Emotional Intelligence for Managerial Efficiency" at HRDC, Ghaziabad, to be held during 18th -20th July 2011.	Dr. A.Manual Stephan Dr. S. Angappan Shri. M. Ananda Kumar	3	Senior Scientist Senior Scientist SO (R&C)
12	Programme on "Fly Ash Utilization" at Conference Centre, University of New Delhi, North Campus, Delhi. During 21st -22nd July, 2011 organized by Sri Ram Institute of Industrial Research, Delhi.	Dr. K. Saravanan	1	Principal Scientist



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
13	International Conference on Biomaterials and Implants: prospect and possibilities in the New Millennium (BIO-2011) during 21st-23rd July 2011 organized by Central Glass & Ceramic Research Institute, Kolkata – 700 032.	Dr. R. Thangamuthu Dr. Subrata Kundu R. Ananthakumar	3	Senior Scientist Scientist JRF
14	Indian section of the Electrochemical Society has arranged for all lecture series on Advances in Lithium Batteries at Ilsc, Bangalore. during 25th – 29th July 2011.	Dr. T. Premkumar Dr. N. Kalaiselvi Ms. T. Sridevikumari Shri. P. Manikandan	4	Sr. Principal Scientist Senior Scientist SRF SRF
15	"Management Development Programme" at HRDC, Ghaziabad scheduled to be held during 29th July 2011.	Shri. D.P. Marret	1	F & AO
16	"Basic Training Programme on use of Hindi through Computer" at Central Hindi Training Sub Institute, No.E-3,C, Rajaji Bhavan, Resent Nagar, Chennai during 01st-12th, August 2011.	Shri. AR. Kumaran Shri. T. Ebenezer Rajendran Shri. Y. Nagoor Gani Shri. S.V. Loganathan	4	PS Asst. (G) G.I Asst. (G) Asst. (G)
17	National Conference on "Recent Trends in Green Synthesis" organized by Dept. of Industrial Chemistry, School of Chemistry, Alagappa University, Karaikudi – 3 during 5th -6th August 2011.	Shri. R. Senthil Kumar	1	SRF
18	Training Programme on "Research Methodology and Statistical Methods: Designing for breakthroughs" during 16th -20th August 2011 at HRDC, Ghaziabad.	Dr. Mrs. R. Vedalakshmi Dr. Jay Prakash Tiwari	2	Principal Scientist Senior Scientist
19	Conference on "Science Technology and Applications of Rare Earths – 2011, (STAR-2011)" during 19th -20th August 2011 organized by Rare Earth Association of India (REAI), Indian Rare Earth Limited, Udyogamandal – 683 501, Kerala.	Dr. L. John Berchmans Dr. S. Angappan	2	Principal Scientist Senior Scientist
20	National symposium "Electro-chemical science Technology (NSEST-2011)" at Bangalore, during 19th -20th August 2011 at Munar by the Electro-chemical society of India, Ilsc campus, Bangalore.	Shri. A. Muthurasu	1	JRF (P)
21	Symposium on the "Chemistry in Societal and Environmental Needs" during 29th -31st August 2011 organized by centre for International Cooperation in sciences (CICS) and Central Leather Research Institute, Triple Helix Auditorium, CLRI, Chennai - 600 025.	Dr. N. Ilayaraja Dr. R. Manu	2	RA (CSIR) Sr. RA (CSIR)
22	Programme on "Crafting and managing R&D projects" at HRDC, Ghaziabad. (UP) during 19th -23rd September 2011.	Dr. Davidson Dr. S. Palraj	2	Scientist Sr. Technical officer
23	One day Seminar on "Discovery to Measurement Technology" organized by Agilent Technology, at Trichy. during 21st September 2011.	Dr. M. G. Neelavannan Shri. P. Murugesan Shri. A. Kumaravel Shri. R. Senthilkumar	4	Sr. Technical Officer Technician SRF SRF
24	International year of Chemistry (IYC2011) CRSI – North Zone a Seminar in University of Jammu, Organized by University of Jammu, Jammu – 180 006, during September 22nd -24th, 2011	Dr. M. Anbukulandainathan	1	Principal Scientist
25	Asia – Pacific Workshop on Characterization of Materials during 22nd -24th, September 2011, at Crystal Growth Centre, Anna University Chennai, Chennai – 25.	Er. S. Ambalavanan Er. Jensi Marriam Shri. S. Saravanan	3	Sr. Principal Scientist Project Assistant Project Assistant



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
26	Professional Skills Development Programme for PS/PA/Stenographer from 28th -29th September 2011 at HRDC, Ghaziabad.	Shri. M. Nehru Pandiaraj Ms. M. Nageswari Ms. M. Indudevi	3	Sr. Steno Sr. Steno Sr. Steno
27	NACE Conference (CORCON-2011) and Expo on corrosion during 28th September – 1st October 2011 at Hotel Intercontinental, The Lalit, Mumbai.	Ms. V. Karpakam Shri. T. Siva Shri. K. Kamaraj Dr. M. Natesan Dr. S. Maruthamuthu	5	Project Assistant Project Assistant SRF Sr. Principal Scientist Sr. Principal Scientist
28	National Conference on "Networking of Libraries, Resources, Technologies and users in the knowledge society" organized by Central Library, National Engineering College, Kovilpatti – 628 503, Thoothukudi –Dist. during 13-15 October 2011.	Dr. N. Meyyappan	1	Sr. Technical officer
29	12th National Conference on Safety Health and Environment for Sustainable Growth: Challenges & Responses" during 19th – 21st October 2011, at Vigyan Bhawan, New Delhi.	Shri. L. Thomas Alexander	1	Security Officer
30	1. International conference and Exhibition on Green Buildings during 20th -22nd October 2011, at Pragati Maidan, New Delhi organized by CII 2. Conference on Green Homes	Dr. R. Selvaraj	1	Principal Scientist
31	49th National Metallurgists Day and 65th Annual Technical Meeting of the Indian Institute of Metals (NMD-ATM-2011) during 13th -16th November, 2011 at Hyderabad.	Dr. L. John Berchmans Dr. S. Angappan Shri. MP. Gunasekar	3	Principal Scientist Sr. Scientist Sr. Technical Officer
32	ICI- Fib "Workshop on Service Life Design of Concrete Structures" during 14th -15th, November, 2011 at India Habitat at Centre, Lodhi Road, New Delhi organized by Indian Concrete Institute, New Delhi.	Shri. P. Venkatesan	1	Principal Scientist
33	Symposium on modeling & Simulation Challenge in the Design and Development of future vehicles during 14th November 2011 at The Banquet Hall, Vivanta by Taj, ITPL, Bangalore.	Dr. P. Murugan	1	Scientist
34	Management Development programme from 14th -18th November, 2011 at HRDC, Ghaziabad	Shri. K. Muralidharan Shri. A. Ganesan	2	A.O SO (F&A)
35	One day Workshop on "Recent Trends in Nano Scale Science & Technology" during 23.11.2011 at Anna university of Technology Madurai, Alagar Koil Road, Madurai	Dr. L. Lakshminarasimhan	1	Sr, Scientist
36	Workshop on "Marine Corrosion and Surface Engineering" during 24th -26th November, 2011 at CAS in Marine Sciences & Dept. of Civil & Structural Engg. Annamalai University, Parangipettai. In Collaboration with NCCI, Karaikudi - 6	1. Shri. S.P. Manoharan 2. Shri.V. Raju 3. Shri.A.R. Elamparithy 4. Shri.K. Arumugasamy 5. Shri.C. Soundar Rajan 6. Dr. Rakesh Barik 7. Shri. Dhandpani 8. Dr. K. Thangavel 9. Shri. P. Venkatesan 10. Dr. S. Muralidharan 11. Sri. A.K. Parande 12. Shri A. Madhavan Mayandi 13. Shri. M.S. Karthikeyan 14. Shri. S.P. Karthick	30	Sr. Principal Scientist Sr. Technical Officer Sr. Technical Officer Sr. Technical Officer Research Scholar Scientist Project Assistant Chief Scientist Principal Scientist Sr. Technical Officer Scientist Sr. Technical Officer Technical Officer Project Assistant Research Intern



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
		15. Miss. S. Subalakshmi 16. Shri. A. Sivasankar 17. Shri S. Arul Xavier 18. Dr. S. Palanisamy 19. Shri. K. Maruthan, 20. Shri. R. Jeyaram 21. Shri. K. Kamaraj 22. Shri. P. Siva 23. Ms. V. Karpakam 24. Shri. G.T. Parthiban 25. Mrs. Thirumalai 26. Shri. P. Madhavan 27. Shri. P. Karthik 28. Shri. V. Selvamani 29. Dr. S. Chellammal 30. Ms. P. Kalaiselvi		JRF JRF Sr. Scientist Sr. Technical Officer STA Project Assistant Project Assistant Project Assistant Sr. Principal Scientist Principal Scientist Project Assistant Project Assistant Research Intern Principal Scientist Sr. Tech. Officer
		TOTAL - 30		
37	5th Training Programme on Competency Development for Technical Officers during 28th November to 2nd December 2011 at HRDC, Ghaziabad - 201002 (UP)	Dr. K. Kulanjiappar Er. K. Maruthan,	2	Sr. Technical Officer Sr. Technical Officer
38	International Conference on Nanoscience, Engineering & Technology, (ICONSET -2011) during 28th -30th November 2011 at Sathyabama University, Chennai and IGGAR, Kalpakkam.	Dr. P. Veeramani Dr. S. Muthukrishnan Dr. S. Palraj Shri. G. Vivekanandan	4	Sr. Principal Scientist Sr. Principal Scientist Sr. Technical Officer Research Intern
39	Winter school on "Chemistry and Physics of Materials at International Centre for Materials Science (ICMS)" JNCASR, Bangalore during 5th -10th December 2011	Shri. P. Arun Kumar	1	SRF
40	Pre-Conference Workshop NDE of Concrete Structures during 6th & 7th December, 2011 at Chennai Convention Centre (CTC), Chennai organized by Indian Society for Non Destructive Testing, Chennai Chapter	Dr. P. Vedalakshmi	1	Principal Scientist
41	International Symposium on "Surface Protective Coatings and Indo-German Conference on Surface Engineering" during 7th -9th December, 2011 at SSPC, 2011 C/o. Corrosion Science & Engg. Dept. IIT Bombay, Powai, Mumbai	Ms. V. Karpakam Shri. T. Siva Dr. S. Syed Azim Dr. S. Sathiyarayanan	4	Project Asst Project Asst Sr. Principal Scientist Sr. Principal Scientist
42	International Conference on "Green Chemistry (ICGC-2011)" during 7th -9th December 2011, Organized by Dept. of Chemistry School of Chemical Sciences & Pharmacy Central University of Rajasthan, Kishngarh Dist, Ajmer, Rajasthan.	Dr. K. Kulangiappar	1	Sr. Technical Officer
43	ISEAC - WS 2011 ISEAC International Symposium Cum Workshop on Electrochemistry during 7th -10th December 2011 organized by Indian Society for Electroanalytical Chemistry (ISEAC), Mumbai.	Ms. S. Priya	1	SRF
44	2nd International Conference on "Advanced Nanomaterials and Nanotechnology (ICANN - 2011) Jointly by Dept. of Physics and Centre for Nanotechnology" IIT, Gowahati, Assam. during 8-10 Dec, 2011	Dr. A. Manual Stephan Ms. Angulakshmi	2	Sr. Scientist SRF
45	"Basic Training Programme on use of Hindi through Computer" at Central Hindi Training Sub Institute, No.E-3,C, Rajaji Bhavan, Resent Nagar, Chennai. during 12th -16th December, 2011.	Shri. S. Ramakrishnan Shri. K. Meyyappan Shri. Vamsi Krishna Shri. Lakshmi Narayan Sundar	4	Assistant (F&A) Security Assistant Assistant Assistant (G)



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
46	International Conference on Advanced Materials during 12th -16th December, 2011 at Dept of Physics, PSG College of Technology, Coimbatore.	Mr. J. Karthikeyan	1	JRF
47	Sixteenth National Convention of Electro Chemists (NCE-16) during 15th -16th December, 2011 at P.S.G.R. Krishnammal College for Women, Coimbatore organized by SAEST, Karaikudi - 6	Sr. Principal Scientist - 11 Senior Scientist - 6 Scientist - 1 Principal Scientist - 4 Scientist Fellow - 1 Sr. Technical Officer - 5 Research Intern - 8 Research Scholar - 1 Project Assistant - 4 JRF - 4 SRF - 1 QHS - 1 Ph. D Scholar - 1 B. Tech Student - 1 Research Associate 1 TOTAL - 50	50	
48	Ninth National Conference on Solid State Ionics (NCSSI - 2011) Organized by Dept. of Physics & Materials Science & Engineering, Jaypee Institute of Information Technology, Noida (UP) during 15th -17th, December 2011	Dr. Jay Prakash Tiwari	1	Scientist
49	IYC -2011 One day Workshop on "Open Source Drug Discovery" during 20th December, 2011	Universities: Professor - 8 PDF - 1 Scholars - 14 Students - 5 CSIR-CECRI: Sr. Principal Scientist - 7 Principal Scientist - 1 Senior Scientist - 2 Scientist - 3 Sr. Technical Officer - 4 Research Intern - 3 Project Assistant - 4 JRF - 3 SRF - 3 B. Tech Student - 6 TOTAL - 64	64	
50	One day Workshop on "Open Source Drug Discovery" (OSDD) in C/o International Year of Chemistry 2011 Organized by Electro Organic Division, CSIR-CECRI, Karaikudi. during 20th December 2011	Postgraduate Students -20 Invited Speakers(CSIR) -10 Faculty Member CECRI-10	40	
51	Programme on "Planning for life after Retirement" during 21st -23rd, December 2011 at HRDC, Ghaziabad (UP)	Dr. M. Natesan Dr. Mrs. C. Marikkannu	2	Sr. Principal Scientist Sr. Principal Scientist
52	Clinic on Failure Analysis (CFA-2011) during 22nd -24th, December 2011 at organized by IGCAR, Kalpakkam	Dr. Rakesh Chandra Barik Dr. S. Maruthamuthu Shri. P. Dhandapani Shri. Soundarajan	4	QHS Sr. Principal Scientist Project Assistant Project Assistant
53	Workshop on "Introduction to Gaussian: Theory & Practice during 02nd -06th, January 2012 at CLRI, Chennai-20.	Shri. J. Karthikeyan	1	JRF
54	6th Asian Conference on Electrochemical Power Sources" (ACEPS-6) at Hotel Green Park, Chennai. during 05th -08th January, 2012. organized by CSIR - CECRI, Karaikudi. & Indian Institute of Science, Bangalore.	Director Chief Scientist Sr. Principal Scientist - 12 Senior Scientist - 5 Scientist - 4 Principal Scientist - 4		



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
		Scientist Fellow Doc Fellow Sr. Technical Officer – 8 Research Intern – 5 Project Assistant – 8 JRF – 4 SRF – 5 TOTAL – 50 As Committee Members Shri. D. Vasantha Kumar Shri. S.P. Karthikeyan Shri. C. Kumarasamy Shri. G. Menon Shri. D. Lakshmanan Shri. C.T. Ganeshnamoorthy Shri. Mr. Arun Kumar Ms. P. Saraswathi Shri. L. Thomas Alexander Shri. M. Nagarajan TOTAL - 69		Asst. (G) Sr. Technician Sr. Technician Sr. Technician Sr. Technician Technician Sr. Steno Security Officer Technician
55	National Conference on Renewable Energy Utilization Indian Perspective" during 05th & 06th January 2012 at Gandhiram Rural Institute (Deemed university) Gandhigram, Dindugul. Organized by solar utilization Network Society CSIR-CECRI, Karaikudi.	Shri. P.R. Thangavelu Dr. M. Selvam Dr. K.N. Srinivasan Mrs. K. Shanmuga Sigamani Shri. G. Manimekalai Shri. M. Raja Shri. P. Venkatesan Dr. S. Palraj Dr. M. Paramasivam (8.03.12)	9	Sr. Technical Officer Sr. Principal Scientist Sr. Principal Scientist Sr. Principal Scientist Project Assistant Project Assistant Principal Scientist Sr. Tech. Officer Sr. Principal Scientist
56	"Workshop on Electrochemical Techniques for Nanoscale Surface Engineering" (ECTNSE-2012) during 05th -06th, January 2012 at BARC, Mumbai.	Dr. GNK. Ramesh Babu Dr. S. Mohan Dr. R. Manu Shri. J. Maharaja Shri. Rajasekaran Shri. R. Pavulraj	6	Sr. Principal Scientist Sr. Principal Scientist Scientist Pool Project Assistant Research Scholar JRF
57	International Conference on Biomaterials Implant Devices and Tissue Engineering (BIDTE-12) during 06th - 08th, January 2012 organized by Rajalakshmi Engineering College (REC) Chennai.	Dr. Rakesh Chandra Barik	1	QHS
58	Training Programme on "IPR and WTO Issues" held at Administrative Training Institute, BARC Mumbai during 09th - 13th January 2012.	Shri. J. David Livingston	1	Sr. Technical Officer
59	An "International Conference on Science, Society and Sustainability with a theme" Many Species, One Plant for Posterity Organized by Lady Doak College, Madurai – 625 002, during 10th -13th January 2012.	Shri. R. Rajasekar Dr. K. Radhakrishnan	2	Principal Scientist Sr. Technical Officer
60	International conference on frontiers in Materials Science for energy and Environment "(ICFMS 2012)" Organized by Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai-600 034, during 11th -13th, January 2012.	Dr. M. Anbukulandainathan Mr. K. Firoz Babu Mr. R. Senthilkumar	3	Principal Scientist SRF SRF
61	Second "International conference on Nanomaterials: Synthesis, Characterization & Applications" (ICN-2012) during 12th -15th, January 2012 at M.G. University, Priyadarshini Hills-Po, Kottayam-686 560.	Dr. A. Manuel Stephan Shri. R. Venkatkarthick	2	Sr. Scientist Project Assistant
62	"Professional Skills development Programme" for PS/PAS / Stenographer from 18th -20th January 2012 at HRDC, Ghaziabad.	Sri. A.R. Kumaran Sri. N.S. Radhakrishnan	2	PS Sr. Steno (MACP)
63	International Conference on Nano Science and Technology (CONSAT-2012) during 20th -23rd, January 2012 at Hotel Taj Krishna, Hyderabad, organized IARCI, Hyderabad.	Dr. C. Sivakumar Dr. Jai Prakash Tiwari Shri. Sankar Rao	3	Sr. Scientist Scientist JRF (P)



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
64	"One day workshop on Enterprise Network" at computer Society of India, CIT campus, Chennai-600 113. on 22nd January 2012.	Dr. Mrs. P. Thirumalai Shri. R. Kalidoss	2	Sr. Scientist Sr. Technical Officer
65	"Workshop on CSIR – 800" to be held at C-MMA CS, Network Building, Bangalore during January, 28th to January, 31st, 2012.	Dr.V.V. Giridhar Dr.K. Radhakrishnan	2	Principal Scientist Sr. Technical Officer
66	ICI- Fib "Workshop on Service Life Design of Concrete Structures" during 14th -15th, November, 2011 at India Habit at Centre, Lodhi Road, New Delhi organized by Indian Concrete Institute, New Delhi.	Shri. P. Venkatesan Details Recd. on 3.01.12	1	Principal Scientist
67	"Official Language Efficiency Development programme for DFA/CDFA/FAO from 1st – 3rd February, 2012, at HRDC, Ghaziabad.	Shri. P. Venkata Rao	1	FAO
68	One day "National Seminar on SME Battery Sector – Issues and Concerns" during 4th February 2012 at Hyderabad. organized by Shivam Info, No.6 CSE Block B, Dilshad Garden, Delhi.	Shri. P. Seenidhamy	1	Sr. Technical Officer
69	"Symposium on New Development in NMR and Conference of the National Magnetic Resonance Society (NMRS-2012)" during 05th -08th February 2012 Organized by IISc, Bangalore-560 012.	Dr. S. Radhakrishnan	1	Sr. Principal Scientist
70	"International Conference on Luminescence and its Applications ICLA – 2012" during 7th -10th February 2012 organized by Rajiv Gandhi University of Knowledge Technologies, Campus of IIIT-H, Gachibowli Hyderabad and Luminescence society of India.	Dr. D. Jeyakumar Dr. N. Lakshminarasimhan Shri. P. Arunkumar	3	Sr. Principal Scientist Sr. Scientist SRF
71	Conference on "Engineering Coatings, Processes, Control and Application (ENGCOAT-2012)" Organized by Indian Institute of Technology, Mumbai, during 09th -11th February 2012.	Dr. S. Sathyanarayana	1	Sr. Principal Scientist
72	International Workshop on "Advanced Energy Materials (IWAEM – 2012)" during 9th & 10th February 2012 at School of Physics, Alagappa University, Karaikudi	Ms. C. Nithya Shri. R. Ravi Kumar Shri. B. Venkata Rami Reddy M. Jeevan Kumar Reddy	4	SRF SRF (CSIR) JRF Research Intern
73	IMS National Workshop on "Corrosion and Condition Monitoring" at Bhabha Atomic Research Centre (BARC) Mumbai during 13th – 17th, February 2012.	Dr. Rakesh Chandra Brick	1	QHS
74	11th National Conference on "100 years of Library & Information Science Education in India" at Bishop Hebar College (Autonomous), Trichy during 18th February 2012.	Shri. P. Murugiah	1	Bearer, CDC
75	Training Course on "Corrosion Prevention and control during 14th & 15th, February 2012 at IC&SR, IIT Madras organized by ASM International Chennai Chapter (ASM), Chennai.	J. Vijayakumar	1	JRF (P)
76	3rd Training /Workshop on Planning and Preparing a best Ph.D Thesis of an International Quality" at BM Das hall, CLRI, Adyar, Chennai during 13th -15th February 2012.	Ms. V. Karpakam Shri. K. Kamaraj Shri. S. Anandha Kumar Shri. N. Rajasekaran Shri. R. Ravikumar Shri. B. Venkata Rami Reddy	6	Project Assistant SRF (CSIR) JRF Research Scholar SRF JRF
77	Training Programme on "S&T Communication Skills" from 15th -17th February, 2012 at HRDC, Ghaziabad.	Dr. C. Sivakumar Shri. K. Saravanan	2	Sr. Scientist Principal Scientist
78	International Conference on Construction Chemicals at Hotel Ramala Powai, Mumbai. during 17th -18th February 2012 Organized by CCMA, Mumbai.	Shri. P. Venkatesh	1	Principal Scientist



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
79	International conference on "Recent Trends in Advanced Materials (ICRAM-2012)" during 20th -22nd February 2012 organized by school of Advanced Sciences, VIT university, Vellore - 632 014.	Dr. K.R. Murali Dr. R. Thangamuthu Ms. B. Bharathi Ms. S. Pavithra	4	Sr. Principal Scientist Sr. Scientist Research Intern B.Tech 3rd Student
80	"First Indian International symposium on fluorine Chemistry" during 20th - 24th, February 2012 at New Delhi City Centre (NDC) Connaught Place, New Delhi.	Shri. S. Sathyamoorthi	1	JRF (P)
81	"CSIR Sponsored National Seminar on Modern in Chemistry MTC-2012 Green Chemistry at Dept. of Chemistry, PSNA College of Engg. & Technology during 23rd - 24th February 2012.	Shri. M. Raja Shri. R. Navanitha Krishnaraj	2	JRF (P) JRF
82	Training Programme in CIPET, Chennai on "Testing and quality control of Plastic Materials and Products on February 23rd to 24th, 2012 at Chennai.	Shri. R. Rajendran	1	Sr. Technician
83	National Training Programme on "New Technology and their Implications" for women Scientists & Technologists from February 27th, March 2, 2012 at NIAS, Bangalore.	Dr. Mrs. Shobha . J Dr. Mrs. T. Vijayabarathi	2	Sr. Principal Scientist Sr. Principal Scientist
84	Seminar on "Recent Trends in Chromatography and Mass Spectrometry" at Hotel Breeze Residency, 3/14, MC Donald's Road, Trichy during 22.02.2012 organized by SPINCO BIOTECH PVT LTD	Dr. M.G. Neelavannan Shri. A. Kumaravel	2	Sr. Technical Officer SRF
85	National Conference on "Recent Advancements in Nanomaterials for Sensor Applications (NANOSE-12) during 8th - 9th, March 2012 at Alagappa University, Karaikudi.	Shri. S. Arul Xavier Stango	1	JRF
86	UGC-SAP "National Seminar on Scientometrics and Informetrics during 9th & 10th, March 2012 at Annamalai University, Dept. of Library & Information Science, Annamalai Nagar.	Shri. P. Murugiah	1	Bearer
87	National Conference on Magnetic Materials and Applications (MegMa 2012) during 12th & 13th, March 2012 at IIT, Madras, Chennai.	Shri. S. Selva Chandra Sekaran	1	Project Assistant
88	International Conference of "EXPO on Renewable Energy Renergy -2012" during 12th & 13th, March 2012 at Chennai Trade Centre, Nandambakkam, Chennai	Er. S. Ambalavanan Er. P. Seenichamy	2	Sr. Principal Scientist Sr. Technical Officer
89	Quality Management Systems Foundation and Internal QMS Auditor Training Course during 12th -14th, March 2012 at Indian Institute of Quality Management, Govt. of India Min. of Communications & Information Technology, Dept. of IT, ETDC Campus, Malviya Industrial Area, Jaipur.	Dr. S.M. Rajendran Er. V. Muthumani	2	Prin. Scientist Sr. Technical Officer
90	"Training Programme on Solar PV Grid Connected Power Plants" 5th Batch from 12th -17th, March 2012. at National raining Centre for Solar Technology, Karnataka Power Corporation Ltd., DG Plant Permisses, S.N. Hall, Yelahanka, Bangalore.	Er. K. Maruthan Shri. P. Madhavan	2	Sr. Technical Officer Project Assistant



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Deputations for conferences / seminar/ workshop, etc.

Sl. No	Name of Conference/ Workshop/Seminar etc.,	Name of Scientist / T.O /JRF/SRF/QHS	Total Nos	Designation
91	Ninth Technology Let Entrepreneurship Programme to be held at IICT, Hyderabad During 15th - 30th , March 2012	Shri. M. Jeevan Kumar Reddy Shri. B. Venkata Rami Reddy	2	Research Intern JRF
92	Conference on "Patinformatics and Business Planning organized by CSIR-URDIP, "Jopasana",85/1, Paud Road, Kothrud, Pune. during 19th -21st, March 2012. Venue: National Chemical Laboratory, Pune	Dr. SM. Rajendran Dr. N. Meyyappan Shri. David Livingston	3	Principal Scientist Sr. Technical Officer Sr. Technical Officer
93	Training Programme for "Newly recruited Junior Scientist and Scients (BS & CS)" held at HRDC, Ghaziabad, during 18th -27th , March 2012	Dr. Shailendra Kumar Jha Dr. Santhosh Kumar Bhatt	2	Scientist Scientist
94	National Conference on "Recent Advances in Textile and Electrochemical Sciences -2012 (RATES-2012) and Water and Food Security Celebrating the World Water day" during 22nd & 23rd, March 2012 at Dept. of Industrial Chemistry, Alagappa University, Karaikudi.	Dr. D. Velayutham Dr. M. Selvam Dr. KN. Srinivasan Dr. V. Suryanarayanan Shri. PR. Thangavelu Mrs. Shanmuga Sigamani Ms. C. Sudha Shri. J. Karthikeyan Shri. S. Karpagamoorthy Shri. S. Sadiq Batcha Shri. S. Sathyamoorthy Shri. KR. Saravanan Dr. R. Sekar Shri. M. Raja Shri. Someshwar Pandeya	14	Sr. Principal Scientist Sr. Principal Scientist Sr. Principal Scientist Scientist Sr. Technical Officer Sr. Technical Officer Research Intern Research Intern Research Intern Project Assistant Project Assistant Sr. Technical Officer JRF (P) Hindi Officer
95	Advanced Translation Training Course from 27.02.12 to 02.03.12 at CTB, New Delhi.	Shri. Someshwar Pandeya	1	Hindi Officer
96	Training Programme on "Acereiditation of Laboratories" under the plan scheme "National Programme of Training of Scientists & Technologies Working in Govt Sector" at Jaipur, during 26th -29th , March 2012	Dr. M.V.T. Dhananjeyan Er. V. Muthumani	2	Sr. Scientist Sr. Technical Officer
97	International Conference on Recent Developments in Environmental Impact Assessment & Integrated Approach for Carbon Management: Solutions Technology Development and Pollution Assessment RDEIA-IACM 2012, at CSIR-NEERI, Nagpur. during 28th -30th, March 2012.	Shri. K. Saravanan	1	Principal Scientist
98	UGC & DST Sponsored National Seminar on "Role of Microbes in Health, Agriculture and Industry" at Dept. of Biotechnology, Alagappa University, Karaikudi. during 26th -27th March 2012.	Dr. S. Maruthamuthu Shri. V. Raju	2	Sr. Principal Scientist Sr. Technical Officer
TOTAL			744	



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Invited Lectures / Lectures arranged

S.No	Lecture Title	Name & Address of the Speaker	Date
1	Electro analytical Techniques	Dr. V. Yegnaraman, Director, CECRI, KKDI-2	04.04.2011
2	International year of chemistry	Dr. K.L.N. Phani, Scientist.F, CECRI, KKDI-6	11.04.2011
3	Short Notes about CMRDI (Central Metallurgical Research & Development Institute) Hints about the Electrochemical behavior of Li ₂ Sn Si Cu O ₆ as negative Electrode.	Prof. Atef Shenouda, Associate Professor in CMRDI visitor CV, Raman Fellowship in the Dept. of Inorganic & Physical Chemistry, IISC, Bangalore.	26.04.2011
4	Nanomagnetic Materials: Synthesis and Applications Prospective	Dr. P. Saravanan, Scientist, (DMRL), Hyderabad.	06.05.2011
5	Emerging Technologies – Strategies for exponential and sustained growth "National Technology Day Celebration 2011"	Shri. N. Sriram, President M/s. Harita – NTL Ltd, Chennai.	11.05.2011
6	"Nanostructure, dissolution & Nature of Chemical species of novel microcidal silver films deposited by magnetron sputtering"	Prof. Sudhindra B. Sant, Dept. of Metallurgical and Materials Engg. Indian Institute of Technology, Kharagpur.	25.05.2011
7	Training Course on "Red Hat Enterprise Linux Clustering and Storage Management Technologies"	M/s. Hewlett Packard & M/s Integrated Technology (distributor of HPC facility) Tiruchirappalli.	07.06.2011 08.06.2011 (Full Days)
8	CSIR-CECRI Foundation Day – 2011 Lecture on "Corrosion Research – Past, Present and Future.	Dr. S. Sundarajan, Director, National Institute of Technology, Tiruchirappalli.	25.07.2011
9	Ion dynamics Issues and Challenges (Research Scholars)	Dr. Jeyaprakash Diwari, Scientist, FM Division.	06.08.2011
10	Theoretical Predictions on Hydrogen Storage Materials for Sustainable Feature	Dr. N.S. Venkataramanan, Post Doctoral Associate, California State University, USA	17.08.2011
11	Presentation on 8th Technology Led Entrepreneurship Programme at ICT, Hyderabad during July 3-18, 2011 They will make the presentation on their experience	Mr. Gangulibabu, Mr. Rajasekaran & Mr. K. Sundarajan, Research Scholar.	17.08.2011
12	Evolution of Electro analytical Techniques	Dr. V. Yegnaraman Former Director, CECRI	19.08.2011



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Invited Lectures / Lectures arranged

S.No	Lecture Title	Name & Address of the Speaker	Date
13	Coordination chemistry of Anions: Development of Bipodal, Tripodal and caged Receptors for Recognition of Anions.	Dr. P. Lakshminarayanan, Post doctoral Associate, Department of chemistry, University of Oregon	21.09.2011
14	Solar Paint	Mr. P. Mathavan, Project Staff, CTE Division	08.10.2011
15	Participative Vigilance (Observance of vigilance Awareness Period)	Shri. Krishnasamy, IRS, Commissioner of Income Tax, Madurai	08.11.2011
16	AFM Studies of Pseudomonas aeruginosa biofilms on porous silicon	Prof. P. Gautam, Centre for Biotechnology, Anna University, Chennai	15.11.2011
17	Controlled synthesis of Nanostructures using Microemulsions (As a part of IYC)	Prof. Ashok Kuma Ganguli, Dept. of Chemistry, IIT Delhi, New Delhi.	30.11.2011
18	Synthesis of Biodiesel from palm oil using base catalyst via transesterification process and the corrosion behavior of synthesized biodiesel on diesel engine parts.	Miss. B. Amudhapriyam, M.Phil student, Serfaj Govt. Arts College, Thanjavur	30.11.2011
19	Analytical Challenges in Unraveling the Environment Proxies from the Antarctic Ice Samples	Prof. A. Rajkumar Dept. of Chemistry, IIT Kharagpur Kharagpur.	12.12.2011
20	Recent Trends in the Visible Light Assisted Photo Catalysis for Environment Remediation	Prof. A. Rajkumar Dept. of Chemistry, IIT Kharagpur Kharagpur.	13.12.2011
21	Chemical Sensors for Monitoring the Heavy Metals, Anions and Drugs	Prof. V.K. Gupta Dept. of Chemistry, IIT Roorkee, Roorkee.	14.12.2011
22	Nanoscale Materials for Electrochemical and Optical Sensing	Prof. C.R. Raj Dept. of Chemistry, IIT Kharagpur Kharagpur.	19.12.2011
23	Energy Transfer to Nanoparticles, graphene and Nanotubes	Prof. K.L. Sebastian, Indian Institute of Science, Bangalore.	21.12.2011
24	Chemistry our Life, our Future: Chemistry for Sustainable Development	Prof. S. Chandrasekaran Honorary Dept. of Organic Chemistry, Indian Institute of Science, Bangalore.	22.12.2011
25	IPR Awareness Programme on "Patinformatics for Research and Business Planning"	Dr. R. R. Hirwani, Head, URDIP, Pune.	23.12.2011



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Know-how transferred during the period 2011 - 2012

S.No.	Name of Technology/Knowhow	Name & address of Licensee	Terms and Condition
1	CPCC system for corrosion protection of reinforcing steel.	Mahavir Chemicals, Mumbai	L.P - Rs. 10,00,000/- + 10.3% S.T R.R - 2.5 % on sales N.L - Non- Exclusive P.L - 7 Years
2	Electrochemical defluoridation of drinking water	Nagpur Awuatch P. Ltd., Nagpur	L.P - Rs. 3,00,000/- + 10.3% S.T R.R - 2.5 % on sales N.L - Non- Exclusive P.L - 7 Years
3	PEM electrolyzers for hydrogen	Eastern Electrolysers Ltd., New Delhi	L.P - Rs. 10,00,000/- + 10.3% S.T R.R - 5% on Sales N.L - Non- Exclusive P.L - 10 Years
4	High performance Epoxy - PAP coating system	Krishnan Conchem Products Pvt. Ltd., Mumbai	L.P - Rs. 15,00,000/- + 10.3% S.T R.R - 2.5% Sales N.L - Non- Exclusive P.L - 7 Years
5	A novel eco-friendly technology for de-rusting of iron and steel components	Larsen Toubro, EEC Division, Puducheery	L.P - Rs. 2,00,000/- + 10.3% S.T R.R - NIL N.L - Non- Exclusive P.L - 7 Years
6	Natural Paint removing Jelly	VSSC, Department of Space, Thiruvananthapuram	L.P - Rs. 5,00,000/- + 10.3% S.T R.R - NIL N.L - Non- Exclusive P.L - 5 Years
7	Electrochemical De- fluoridation of drinking water	Speciality Products, 37, Geeta Nagar Near Podmvat colony Indore - 452 001	L.P - Rs. 6,00,000/- + 10.3% S.T R.R - 2.5% on Sales N.L - Non- Exclusive P.L - 7 Years
8	Epoxy polyurethane coating system	Anish Colourchem P. Ltd., Mumbai	L.P - Rs 6,00,000/- + S.T. R.R - Nil N.L - Non-exclusive P.L - Seven years



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List of Papers

S.No.	Authors	Title	Journal Abbreviation	Volume	Issue	Page start	Page end
1	Jafarzadeh-S, Thormann-E, Ronnevall-T, Arindam Adhikari, Sundell-PE, Pan-JS, Claesson-PM	Toward Homogeneous Nanostructured Polyaniline/Resin Blends	ACS Appl. Mater. Interfaces	3	5	1681	1691
2	Sathish Kumar-S, Amutha-R, Palaniappan-A, Sheela Berchmans	Synthesis of Gold Nanoparticles: An Ecofriendly Approach Using Hansenula anomala	ACS Appl. Mater. Interfaces	3	5	1418	1425
3	Kottakkat-T, Sahu-AK, Bhat-SD, Pitchumani-S, Sridhar-P	Catalytic activity of dendrimer encapsulated Pt nanoparticles anchored onto carbon towards oxygen reduction reaction in polymer electrolyte fuel cells	Appl. Catal., B	110		178	185
4	Gopal Ram-SD, Ravi-G, Athimoolam-A, Mahalingam-T, Anbu Kulandainathan-M	Aqueous chemical growth of free standing vertical ZnO nanoprisms, nanorods and nanodiskettes with improved texture co-efficient and tunable size uniformity	Appl. Phys. A: Mater. Sci. Process.	105	4	881	890
5	Vedalakshmi-R, Thangavel-K	Reliability of Electrochemical Techniques to Predict the Corrosion Rate of Steel in Concrete Structures	Arab. J. Sci. Engg.	36	5	769	783
6	Sridharan-D, Manoharan-SP, Palaniswamy-N	Redox behavior of biofilm on glassy carbon electrode	Bioelectrochemistry	82	2	135	139
7	Eashwar-M, Subramanian-G, Palanichamy-S, Rajagopal-G	The influence of sunlight on the localized corrosion of UNS S31600 in natural seawater	Biofouling	27	8	837	849
8	Christy-M, Jisha-MR, Kim-AR, Nahm-KS, Yoo-DJ, Suh-EK, Sri Devi Kumari-T, Prem Kumar-T, Manuel Stephan-A	Lithium Insertion Behavior of Nanoscopic Co ₃ O ₄ Prepared with Avian Egg Membrane as a Template	Bull. Kor. Electrochem. Soc.	32	4	1204	1208
9	Selvarani-G, Selvaganesh-SV, Sridhar-P, Pitchumani-S, Shukla-AK	Pt-Au/C cathode with enhanced oxygen-reduction activity in PEFCs	Bull. Mater. Sci.	34	2	337	346
10	Ramesha-K, Prakash-AS, Sathiya-M, Madras-G, Shukla-AK	Synthesis of new (Bi, La)(3)MSb(2)O(11) phases (M = Cr, Mn, Fe) with KSbO(3)-type structure and their magnetic and photocatalytic properties	Bull. Mater. Sci.	34	2	271	277
11	Manu-R, Sobha Jayakrishnan	Influence of polymer additive molecular weight on surface and microstructural characteristics of electrodeposited copper	Bull. Mater. Sci.	34	2	347	356
12	John Berchmans-L, Karthikeyan-R, Helan-M, Sheela Berchmans, Sepelak-V, Becker-KD	Mechanochemical synthesis and electrochemical characterization of nano crystalline calcium ferrite	Catal. Lett.	141	10	1451	1457
13	Sivakumar-C, Phani-KLN	Nanocatalyst U reagent-on-a-polymer film: a new polymer-supported system for (electro-) catalytic reactions	Chem. Comm.	47	12	3535	3537
14	Sinhamahapatra-A, Sutradhar-N, Pahari-SK, Pal-P, Bajaj-HC, Jayachandran-M, Panda-AB	Allylic and benzylic oxidation over Cr(III)-incorporated mesoporous zirconium phosphate with 100% selectivity	ChemCatChem	3	9	1447	1450
15	Gomathi Priya-G, Ahmed Basha-C, Ramamurthi-V	Removal of Ni(II) Using Cation Exchange Resins in Packed Bed Column: Prediction of Breakthrough Curves	Clean - Air, Soil Water	39	1	88	94
16	Parande-AK, Ramesh Babu-B, Pandi-K, Karthikeyan-MS, Palaniswamy-N	Environmental effects on concrete using Ordinary and Pozzolana Portland cement	Constr. Build. Mater.	25	1	288	297



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17	Subramanian-B, Jayachandran-M	Preparation of chromium oxynitride and chromium nitride films by DC reactive magnetron sputtering and their material properties	Corros. Eng. Sci. Technol.	46	4	554	561
18	Vedalakshmi-R, Rajagopal-K, Palaniswamy-N	Durability performance of rebar embedded in chloride admixed blended cement concretes	Corros. Eng. Sci. Technol.	46	3	256	270
19	Subramanian-B, Ananthakumar-R, Jayachandran-M	Effect of substrate temperature on the properties of reactively sputtered TiN/NbN multilayers	Cryst. Res. Technol.	46	12	1273	1282
20	Syed Ahamed Basheer-MG, Rajni-KS, Vidhya-VS, Swaminathan-V, Thayumanavan-A, Murali-KR, Jayachandran-M	Structural, optical, electrical and luminescence properties of electron beam evaporated CdSe:In films	Cryst. Technol. Res.	46	3	261	266
21	Vidhya-VS, Malathy-V, Balasubramanian-T, Saaminathan-V, Sanjeeviraja-C, Jayachandran-M	Influence of RF power on the growth mechanism, preferential orientation and optoelectronic properties of nanocrystalline ITO films	Curr. Appl. Phys.	11	3	286	294
22	Subramanian-B, Swaminathan-V, Jayachandran-M	Micro-structural and optical properties of reactive magnetron sputtered Aluminum Nitride (AlN) nanostructured films	Curr. Appl. Phys.	11	1	43	49
23	Gunasekaran-S, Arunachalam-S, Maruthamuthu-S, Nagendran-T, Anandkumar-B, Karthikeyan-MS, Palaniswamy-N, Narayanan-G	Use of open access journals by Indian researchers	Curr. Sci.	101	10	1287	1295
24		Microbiologically influenced corrosion on rails	Curr. Sci.	100	6	870	880
25	Vasudevan-S, Lakshmi-J, Sozhan-G	Studies on the Al-Zn-In-alloy as anode material for the removal of chromium from drinking water in electrocoagulation process	Desalination	275	40911	260	268
26	Boopathi-S, Senthil Kumar-S, James Joseph, Phani-KLN	Selective deposition of zinc hexacyanoferrate on the metal impurity sites of a SWCNT/glassy carbon electrode	Electrochem. Comm.	13	3	294	297
27	Minakshi-M, Sharma-N, Ralph-D, Appadoo-D, Kalaiselvi-N	Synthesis and Characterization of Li(Co _{0.5} Ni _{0.5})PO ₄ Cathode for Li-Ion Aqueous Battery Applications	Electrochem. Solid State Lett.	14	6 A86	A89	
28	Thirunakaran-R, Ravikumar-R, Vanitha-S, Gopukumar-S, Sivashanmugam-A	Glutamic acid-assisted sol-gel synthesis of multi-doped spinel lithium manganate as cathode materials for lithium rechargeable batteries	Electrochim. Acta	58	1	348	358
29	Firoz Babu-K, Sivasubramanian-R, Noel-M, Anbu Kulandainathan-M	A homogeneous redox catalytic process for the paired synthesis of L-cysteine and L-cysteic acid from L-cystine	Electrochim. Acta	56	27	9797	9801
30	Karpakam-V, Kamaraj-K, Sathiyarayanan-S, Venkatachari-G, Ramu-S	Electrosynthesis of polyaniline-molybdate coating on steel and its corrosion protection performance	Electrochim. Acta	56	5	2165	2173
31	Kamaraj-K, Karpakam-V, Sathiyarayanan-S, Syed Azim-S, Venkatachari-G	Synthesis of tungstate doped polyaniline and its usefulness in corrosion protective coatings	Electrochim. Acta	56	25	9262	9268
32	Sathyamoorthi-S, Velayutham-D, Suryanarayanan-V, Noel-M	Voltammetric investigations on the transition between dissolution, passivation and deposition characteristics of Ni, Cu and their alloys in fluorine based ionic liquid	Electrochim. Acta	56	20	7012	7021



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34	Harish-S, James Joseph, Phani-KLN	Interaction between gold (III) chloride and potassium hexacyanoferrate (II/III)- Does it lead to gold analogue of Prussian blue?	Electrochim. Acta	56	16	5717	5721
35	Venkatraman-MS, Cole-IS, Bosco Emmanuel	Model for corrosion of metals covered with thin electrolyte layers: pseudo-steady state diffusion of oxygen	Electrochim. Acta	56	20	7171	7179
36	Hwang-SW, Umar-A, Kim-SH, Al-Sayari-SA, Abaker-M, Al-Hajry-A, Manuel Stephan-A	Low-temperature growth of well-crystalline Co(3)O(4) hexagonal nanodisks as anode material for lithium-ion batteries	Electrochim. Acta	56	24	8534	8538
37	Sathe-BR, Balan-BK, Vijayamohanan Pillai-K	Enhanced electrocatalytic performance of interconnected Rh nano-chains towards formic acid oxidation	Energy Environ. Sci.	4	3	1029	1036
38	Saravanan-M, Ambalavanan-S	Failure analysis of cast-on-strap in lead-acid battery subjected to vibration	Eng. Fail. Anal.	18	8	2240	2249
39	Neelavannan-MG, Ahmed Basha-C	Thin wetted film cylindrical flow photo reactor for the degradation of Procion blue H-B dye over TiO ₂ and ZnO	Environ. Technol.	32	8	825	835
40	Remona-AM, Phani-KLN	Study of Methanol-tolerant Oxygen Reduction Reaction at Pt-Bi/C Bimetallic Nanostructured Catalysts	Fuel Cells	11	3	385	393
41	Selvaganesh-SV, Selvarani-G, Sridhar-P, Pithcumani-S, Shukla-AK	Graphitic Carbon as Durable Cathode-Catalyst Support for PEFCs	Fuel Cells	11	3	372	384
42	Maruthamuthu-S, Kumar-BD, Ramachandran-S, Anandkumar-B, Palanichamy-S, Chandrasekaran-M, Subramanian-P, Palaniswamy-N	Microbial corrosion in petroleum product transporting pipelines	Ind. Eng. Chem. Res.	50	13	8006	8015
43	Radhakrishnan-S, Muthukannan-R, Kamatchi-U, Rao-CRK, Vijayan-M	Performance of phosphoric acid doped polyaniline as electrode material for aqueous redox supercapacitor	Indian J. Chem. A	50	7	970	978
44	Challaraj Emmanuel-ES, Vignesh-V, Anandkumar-B, Maruthamuthu-S	Bioaccumulation of cerium and neodymium by Bacillus cereus isolated from rare earth environments of Chavara and Manavalakurichi, India	Indian J. Microbiol.	51	4	488	495
45	Florence-F, Nisha, Rajendran-S, Srinivasan-KN, John-S	Studies on electrodeposition of copper from methanesulphonic acid bath	Int. J. ChemTech. Res.	3	3	1318	1325
46	Mary Delphine-S, Jayachandran-M, Sanjeeviraja-C, Almusallam-AW	Study on (Mo/W) Se ₂ layered compound semi conductors useful for photoelectrochemical solar cells	Int. J. ChemTech. Res.	3	2	846	852
47	Mohamed Sharif-M, Senthil Kumar-P, Murthy-KSN, Vijayanand-S, Ambalavanan-S	Influence of Process Parameters on Paste Morphology in Lead-Acid Battery Cured Plates	Int. J. Electrochem. Sci.	6	1	91	102



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49	Bhuvaneswari-D, Gangulibabu, Doh-CH, Kalaiselvi-N	Role of iron dopant and carbon additive in improving the ionic transport and electrochemical properties of $\text{LiFe}_x\text{Mn}_{1-x}\text{PO}_4$ ($x=0.25$ and 0.75) solid solutions	Int. J. Electrochem. Sci.	6	9	3714	3728
50	Balaji-R, Senthil-N, Vasudevan-S, Ravichandran-S, Mohan-S, Sozhan-G, Madhu-S, Kennedy-J, Pushpavanam-S, Malathy Pushpavanam	Development and performance evaluation of Proton Exchange Membrane (PEM) based hydrogen generator for portable applications	Int. J. Hydrogen Energy	36	2	1399	1403
51	Parande-AK, Karthikeyan-MS, Kumar-K, Deepthi-V, Palaniswamy-N	Performance of pre-tensioned concrete member and the level of deterioration due to acid rain exposure	Int. J. Mater. Struct. Integr.	5	1	46	57
52	Seetharaman-S, Sozhan-G, Ravichandran-S, Vasudevan-S, John Davidson-D	Sulfonated poly (ether ether ketone)-based composite proton-exchange membrane for energy production	Int. J. Polym. Mater.	60	10	742	753
53	Ahamed-MAR, Azarudeen-RS, Jeyakumar-D, Burkanudeen-AR	Terpolymer Chelates: Synthesis, Characterization, and Biological Applications	Int. J. Polymer. Mater.	60	2	124	143
54	Angappan-S, Helan-M, Visuvasam-A, John Berchmans-J, Ananth-V	Electrolytic preparation of CaB_6 by molten salt technique	Ionics	17	6	527	533
55	Rangarajan-TM, Velayutham-D, Noel-M	Anodic oxidation of alkane carboxylates and perfluoroalkane carboxylates at platinum and graphite anodes: Product selectivity and mechanistic aspects	Ionics	17	9	827	833
56	Murali-KR, Shanmugavel-A, Srinivasan-K	Photoelectrochemical characteristics of pulse electrodeposited CuInS_2 films	Ionics	17	2	157	162
57	Angulakshmi-N, Sabu Thomas, Nahm-KS, Manuel Stephan-A, Elizabeth-RN	Electrochemical and mechanical properties of nanochitin-incorporated PVDF-HFP-based polymer electrolytes for lithium batteries	Ionics	17	5	407	414
58	Sathiyaraj-K, Gangulibabu, Bhuvaneswari-D, Kalaiselvi-N	Effect of reaction temperature on morphology and electrochemical behavior	Ionics	17	1	49	59
59	Sannasi-V, Sundararaj-BG, Meenakshi-S, Jeyakumar-D	Synthesis, characterization and optical properties of poly(4,4'-dioctyloxy-3,3'-biphenylene vinylene) copolymers	Iran. Polym. J.	20	8	633	644
60	Radhakrishnan S, Jagannathan-R, Vidhya-VS, Murali-KR, Subramanian-B, Manisankar-P, Sanjeeviraja-C, Jayachandran-M	Charge growth, dispersion in europium manganite (EuMnO_3 -delta) ceramics revealed using opto-impedance probe	J. Alloys Compd.	509	20	6009	6014
61		Photoluminescent studies on porous silicon/tin oxide heterostructures	J. Alloys Compd.	509	6	2842	2845
62	Vijayakumar-J, Mohan-S, Yadav-SS	Effects of primary dicarboxylic acids on microstructure and mechanical properties of sub-microcrystalline Ni-Co alloys	J. Alloys Compd.	509	40	9692	9695



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64	Sathiya-M, Prakash-AS, Ramesha-K, Tarascon-JM, Shukla-AK	V(2)O(5)-anchored carbon nanotubes for enhanced electrochemical energy storage	J. Am. Chem. Soc.	133	40	16291	16299
65	Shinde-BD, Debgupta-J, Kushwaha-A, Aslam-M, Vijayamohan Pillai-K	Electrochemical Unzipping of Multi-walled Carbon Nanotubes for Facile Synthesis of High-Quality Graphene Nanoribbons	J. Am. Chem. Soc.	133	12	4168	4171
66	Rajakumar-S, Thirunakaran-R, Sivashanmugam-A, Yamaki-J, Gopukumar-S	Synthesis and characterization of 5 V LiCo 3) Niy Mn2-x-y O4 (x = y=0.25) cathode materials for use in rechargeable lithium batteries	J. Appl. Electrochem.	41	2	129	136
67	Padmavathy-P, Ananthakumar-R, Subramanian-B, Ravidhas-C, Jayachandran-M	Structural and electrochemical impedance spectroscopic studies on reactive magnetron sputtered titanium oxynitride (TiON) thin films	J. Appl. Electrochem.	41	6	751	756
68	Radhakrishnan-S, Rao-CRK, Vijayan-M	Performance of Conducting Polyaniline-DBSA and Polyaniline-DBSA/Fe(3)O(4) Composites as Electrode Materials for Aqueous Redox Supercapacitors	J. Appl. Polym. Sci.	122	3	1510	1518
69	Manuel Stephan-A, Prem Kumar-T, Angulakshmi-N, Salini-PS, Sabarinathan-R, Srinivasan-A, Thomas-S	Influence of Calix[2]-p-benzo[4]pyrrole on the Electrochemical Properties of Poly(ethylene oxide)-Based Electrolytes for Lithium Batteries	J. Appl. Polym. Sci.	120	14	2215	2221
70	Kirubakaran-AMK, Palraj-S, Selvaraj-M, Rajagopal-G	Synthesis and Characterization of High Temperature Resistance Interpenetrating Polymer Network	J. Appl. Polym. Sci.	119	4	2339	2344
71	Maruthamuthu-S, Ramachandran-S, Kumar-BD, Shatish-V, Palanichamy-S, Kumar-BA, Subramanian-P, Sah-SP, Anbezhil-A, Palaniswamy-N	Microbial corrosion in aviation turbine fuel (Jet A 1) transporting pipeline	J. ASTM Int.	8	6	JA103451	
72	Kanagasabapathy-M, Sobha Jayakrishnan	Textural and morphological studies on zinc-iron alloy electrodeposits	J. Chem. Sci.	123	3	357	364
73	Rajalakshmi-R, Sathiya-M, Ramesha-K, Prakash-AS, Giridhar Madras, Shukla-AK	Photocatalytic properties of KBiO(3) and LiBiO(3) with tunnel structures	J. Chem. Sci.	123	4	517	524
74	Manokaran-A, Vijayakumar-R, Thomman-TN, Sridhar-P, Pitchumani-S, Shukla-AK	A self-supported 40W direct methanol fuel cell system	J. Chem. Sci.	123	3	343	347
75	Vasudevan-S, Suresh Kannan-B, Lakshmi-J, Mohanraj-S, Sozhan-G	Effects of alternating and direct current in electrocoagulation process on the removal of fluoride from water	J. Chem. Technol. Biotechnol.	86	3	428	436
76	Khomane-RB	Microemulsion-mediated sol-gel synthesis of mesoporous rutile TiO(2) nanoneedles and its performance as anode material for Li-ion batteries	J. Colloid Interface Sci.	356	1	369	372



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78	Naresh Kumar-T, Ananthi-A, Mathiyarasu-J, James Joseph, Phani-KLN, Yegnaraman-V	Enzyme less creatinine estimation using poly(3,4-ethylenedioxythiophene)-beta-cyclodextrin	J. Electroanal. Chem.	661	2	303	308
79	Kumar-AVN, Harish-S, James Joseph, Phani-KLN	Ni(x)-Fe((1-x))Fe(CN)(6) hybrid thin films electrodeposited on glassy carbon: Effect of tuning of redox potentials on the electrocatalysis of hydrogen peroxide	J. Electroanal. Chem.	659	2	128	133
80	Narmadha-M, Noel-M, Suryanarayanan-V	Relative deactivation of boron-doped diamond (BDD) and glassy carbon (GC) electrodes in different electrolyte media containing substituted phenols - Voltammetric and surface morphologic studies	J. Electroanal. Chem.	655	2	103	110
81	Manivel-A, Velayutham-D, Noel-M	Electrochemical behaviour of tetra-n-butylammonium nonaflate as an ionic liquid and as a supporting electrolyte in aprotic solvents: A comparative study	J. Electroanal. Chem.	655	1	79	86
82	Kumaravel-A, Chandrasekaran-M	A biocompatible nano TiO ₂ /nafion composite modified glassy carbon electrode for the detection of fenitrothion	J. Electroanal. Chem.	650	2	163	170
83	Alwin-S, Bhat-SD, Sahu-AK, Jalajakshi-A, Sridhar-P, Pitchumani-S, Shukla-AK	Modified-Pore-Filled-PVDF-Membrane Electrolytes for Direct Methanol Fuel Cells	J. Electrochem. Soc.	158	2 B91	B98	
84	Tintula-KK, Sahu-AK, Shahid Anwar, Pitchumani-S, Sridhar-P, Shukla-AK	Directed Synthesis of MC-PEDOT Composite Catalyst-Supports for Durable PEFCs	J. Electrochem. Soc.	158	6 B622	B631	
85	Nishanth-KG, Sridhar-P, Pitchumani-S, Shukla-AK	A DMFC with Methanol-Tolerant-Carbon-Supported-Pt-Pd-Alloy Cathode	J. Electrochem. Soc.	158	8 B871	B876	
86	Karpakam-V, Kamaraj-K, Sathiyarayanan-S	Electrosynthesis of PANI-nano TiO ₂ composite coating on steel and its anti-corrosion performance	J. Electrochem. Soc.	158	12 C416	C423	
87	Shahid Anwar-M, Sudalai Muthu-K, Ganesh-V, Lakshminarasimhan-N, Mohanapriya-S, Sahu-AK, Bhat-SD, Pitchumani-S, Sridhar-P, George-C, Chandrakumar-N, Shukla-AK	A comparative study of electrochemical capacitive behavior of NiFe 2O ₄ synthesized by different routes	J. Electrochem. Soc.	158	8 A976	A981	
88		Bio-composite membrane electrolytes for direct methanol fuel cells	J. Electrochem. Soc.	158	11 B1319	B1328	
89	Rangarajan-TM, Sathyamoorthi-S, Velayutham-D, Noel-M, Singh-RP, Raju Brahma	Products formed at intermediate stages of electrochemical perfluorination of propionyl and n-butyryl chlorides. Further evidence in support of NiF ₃ mediated free radical pathway	J. Fluorine Chem.	132	2	107	113
90	Remona-AM, Phani-KLN	Methanol-Tolerant Oxygen Reduction Reaction at Pt-Pd/C Alloy Nanocatalysts	J. Fuel Cell Sci. Technol.	8		Art. No. 1 11001	



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92	Maruthamuthu-S, Dhanibabu-T, Veluchamy-A, Palanichamy-S, Subramanian-P, Palaniswamy-N	Electrokinetic separation of sulphate and lead from sludge of spent lead acid battery	J. Hazard. Mater.	193		188	193
93	Vasudevan-S, Lakshmi-J, Sozhan-G	Effects of alternating and direct current in electrocoagulation process on the removal of cadmium from water	J. Hazard. Mater.	192	1	26	34
94	Devadas-A, Vasudevan-S, Epron-F	Nitrate reduction in water: Influence of the addition of a second metal on the performances of the Pd/CeO ₂ catalyst	J. Hazard. Mater.	185	40942	1412	1417
95	Balasubramanian-V, Palanichamy-S, Rajaram-R	Effects of certain seaweed extracts on the primary bio-film forming bacteria	J. Mar. Biol. Ass. India	53	1	104	110
96	Armél-V, Velayutham-D, Sun-J, Howlett-PC, Forsyth-M, MacFarlane-DR, Pringle-JM	Ionic liquids and organic ionic plastic crystals utilizing small phosphonium cations	J. Mater. Chem.	21		7640	7650
97	Thirumoorthy-P, Murali-KR	Characteristics of pulse electrodeposited PbS thin films	J. Mater. Sci. Mater. Electron.	22	1	72	76
98	Nagarethinam-VS, Ahamed-MGSB, Vijayakumar-K, Amalraj-L, Balu-AR, Thayumanavan-A, Murali-KR, Sanjeeviraja-C, Jayachandran-M	Structural, optical and electrical properties of ZnTe _{1-x} Se (x) thin films	J. Mater. Sci. Mater. Electron.	22	6	607	613
99	Vijayakumar-K, Vidhya-VS, Murali-KR, Amalraj-L, Jayachandran-M	Photoluminescence studies on ZnSe(1-x)Te (x) films	J. Mater. Sci. Mater. Electron.	22	7	785	789
100	Vidhya-VS, Vatsala Rani-J, Ratheesh Kumar-A, Thangamuthu-R, Murali-KR, Jayachandran-M	Electrodeposition and properties of nanocrystalline ZnO films prepared in the presence of anionic surfactant SDS and ionic liquid 1-butyl-3-methylimidazolium methylsulfate	J. Mater. Sci. Mater. Electron.	22	9	1460	1465
101	Vijayakumar-K, Sanjeeviraja-C, Jayachandran-M, Amalraj-L	Characterization of Tin disulphide thin films prepared at different substrate temperature using spray pyrolysis technique	J. Mater. Sci. Mater. Electron.	22	8	929	935
102	Vidhya-VS, Padmavathy-P, Murali-KR, Sanjeeviraja-C, Manisankar-P, Jayachandran-M	Development of porous silicon matrix and characteristics of porous silicon/tin oxide structures	J. Non-Cryst. Solids	357	41067	1522	1526
103	Do-C, Hatfield-J, Patel-S, Vasudevan-D, Tirla-C, Mills-NS	Dications of benzylidenefluorene and diphenylmethyldiene fluorene: The relationship between magnetic and energetic measures of antiaromaticity	J. Org. Chem.	76	1	181	187
104	Subrata Kundu, Liang-H	Photo-induced formation of size-selective Ag nanoparticles and their interactions with Escherichia coli	J. Photochem. Photobiol., A	222	1	25	33
105	Kulkarni-BS, Sailaja Krishnamurty, Sourav Pal	Size- and shape-sensitive reactivity behavior of Al(n)(n=2-5, 13, 30, and 100) clusters toward the N(2) molecule: A first-principles investigation	J. Phys. Chem. C	115	30	14615	14623



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107	De-HS, Sailaja Krishnamurthy, Deepti Mishra, Soural Pal	Finite Temperature Behavior of Gas Phase Neutral Au(n) ($3 \leq n \leq 10$) Clusters: A First Principles Investigation	J. Phys. Chem. C	115	35	17278	17285
108	Sutradhar-N, Sinhamahapatra-A, Pahari-S, Jayachandran-M, Subramanian-B, Bajaj-HC, Panda-AB	Facile Low-Temperature Synthesis of Ceria and Samarium-Doped Ceria Nanoparticles and Catalytic Allylic Oxidation of Cyclohexene	J. Phys. Chem. C	115	15	7628	7637
109	Suresh-B, Maruthamuthu-S, Khare-A, Palaniswamy-N, Muralidharan-VS, Ragunathan-R, Kannan-M, Pandiyaraj-KN	Influence of thermal oxidation on surface and thermo-mechanical properties of polyethylene	J. Polym. Res.	18	6	2175	2184
110	Ganesh-V, Farzana-S, Sheela Berchmans	Nickel hydroxide deposited indium tin oxide electrodes as electrocatalysts for direct oxidation of carbohydrates in alkaline medium	J. Power Sources	196	23	9890	9899
111	Manokaran-A, Pushpavanam-S, Sridhar-P, Pitchumani-S	Experimental analysis of spatio-temporal behavior of anodic dead-end mode operated polymer electrolyte fuel cell	J. Power Sources	196	23	9931	9938
112	Manikandan-P, Ananth-MV, Prem Kumar-T, Raju-M, Periasamy-P, Manimaran-K	Solution combustion synthesis of layered $\text{LiNi}_{0.5}\text{Mn}_{0.5}\text{O}_2$ and its characterization as cathode material for lithium-ion cells	J. Power Sources	196	23	10148	10155
113	Nithya-C, Thirunakaran-R, Sivashanmugam-A, Gopukumar-S	Microwave synthesis of novel high voltage (4.6V) high capacity $\text{LiCu}_x\text{Co}_{1-x}\text{O}_{2+\delta}$ cathode material for lithium rechargeable cells	J. Power Sources	196	16	6788	6793
114	Jayaprakash N, Kalaiselvi N, Gangulibabu, Bhuvaneswari-D	Effect of mono- (Cr) and bication (Cr, V) substitution on LiMn_2O_4 spinel cathodes	J. Solid State Electrochem.	15	6	1243	1251
115	Selvaraj-R, Suresh Kumar-A, Rex Dhivakar Arockia Raj-J, Sahaya Nicova Naveena-C	Optimisation and characteristic study on cellular mortar with aluminium powder	J. Struct. Eng.	38	1	101	105
116	Saraswathy-V, Muralidharan-S, Balamurugan-L, Kathirvel-P, Sekar-ASS	Evaluation of composite cements using cyclic polarization techniques	KSCE J. Civil. Eng.	15	8	1415	1418
117	Prasad Belavalli-E, Vishnu Kamath-P, Vijayamohanan Pillai-K	Anion exchange reaction potentials as approximate estimates of the relative thermodynamic stabilities of Mg/Al layered double hydroxides containing different anions	Langmuir	27	22	13539	13543
118	Vedalakshmi-R, Saraswathy-V, Yong-AK	Performance evaluation of blended cement concretes under MgSO_4 attack	Mag. Concr. Res.	63	9	669	681
119	Harish-S, Sabarinathan-R, James Joseph, Phani-KLN	Role of pH in the synthesis of 3-aminopropyl trimethoxysilane stabilized colloidal gold/silver and their alloy sols and their application to catalysis	Mater. Chem. Phys.	127	40910	203	207
120	Ananthi-A, Naresh Kumar-T, Mathiyarasu-J, James Joseph, Phani-KLN, Yegnaraman-V	A novel potentiometric hydrogen peroxide sensor based on pK_a changes of vinylphenylboronic acid membranes	Mater. Lett.	65	23-24	3563	3565



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121	Helan-M, John Berchmans-L	Low-temperature synthesis of lithium manganese oxide using LiCl-Li ₂ CO ₃ and manganese acetate eutectic mixture	Mater. Manuf. Processes	26	11	1369	1373
122	Amalajyothi-K, John Berchmans-L, Visuvasam-A, Angappan-S	Electrosynthesis of Cerium Hexaboride Using Lithium Tetra Borate Melt	Mater. Manuf. Processes	26	5	792	795
123	Sivashanmugam-A, Gopukumar-S, Thirunakaran-R, Nithya-C, Prema-S	Novel Li ₄ Ti ₅ O ₁₂ /Sn nano-composites as anode material for lithium ion batteries	Mater. Res. Bull.	46	4	492	500
124	Khomane-RB, Prakash-AS, Ramesha-K, Sathiya-M	CTAB-assisted sol gel synthesis of Li ₄ Ti ₅ O ₁₂ and its performance as anode material for Li-ion batteries	Mater. Res. Bull.	46	7	1139	1142
125	Helan-M, John Berchmans-L, Syamala Kumari-VS, Ravi Sankar-R, Shanmugam-VM	Molten salt synthesis of LiGd _{0.01} Mn _{1.99} O ₄ using chloride-carbonate melt	Mater. Res. Innovations	15	2	130	134
126	Ragavendran-K, Chou-HL, Lu-L, Lai-MO, Hwang-BJ, Kumar-RR, Gopukumar-S, Bosco Emmanuel, Vasudevan-D, Sherwood-D	Crystal habits of LiMn ₂ O ₄ and their influence on the electrochemical performance	Mater. Sci. Eng., B	176	16	1257	1263
127	Ramesha-K, Prakash-AS, Sathiya-M, Giridhar Madras, Shukla-AK	Synthesis and photocatalytic properties of Ag[Li _{1/3} Ru _(2/3)]O ₂ : A new delafossite oxide	Mater. Sci. Engg. B	176	2	141	146
128	Subramanian-B, Ananthakumar-R, Vidhya-VS, Jayachandran-M	Influence of substrate temperature on the materials properties of reactive DC magnetron sputtered Ti/TiN multilayered thin films	Mater. Sci. Engg. B	176	1	1	7
129	Arockiam-SI, John Berchmans-L, Angappan-S, Visuvasam-A, Mani-V	Synthesis of lanthanum nickelate and praseodymium substituted compounds by molten salt technique	Mater. Sci. Forum	699		67	78
130	Sheeba-RAJR, Saravanan-R, John Berchmans-L	A theoretical estimation of the charge density distribution in the diluted magnetic semiconductors of Si _{1-x} Mx and Ge _{1-x} Mx (M = V, Mn, Co)	Mater. Sci. Forum	699		167	183
131	Nagarani-S, Jayachandran-M, Sanjeeviraja-C	Review on gallium zinc oxide films: Material properties and preparation techniques	Mater. Sci. Forum	671		47	68
132	Nehru-LC, Swaminathan-V, Jayachandran-M, Sanjeeviraja-C	Nanomaterial preparations by microwave-assisted solution combustion method and material properties of SnO ₂ powder-A status review	Mater. Sci. Forum	671		69	120
133	Kalaivanan-A, Perumal-S, Pillai-NN, Murali-KR	Characteristics of GZO thin films deposited by sol-gel dip coating	Mater. Sci. Semi-conduct. Process.	14	2	94	96
134	Soundarrajan-C, Saraswathi-K, Asiyarparvin-A	Piperidone synthesis using amino acid: A promising scope for green chemistry	Microchemical J.	98	2	204	206
135	Deepti Mishra, Sourav Pal, Sailaja Krishnamurty	Understanding the molecular conformations of Na-dimyristoylphosphatidylglycerol (DMPG) using DFT-based method	Mol. Simul.	37	11	953	963
136	Gangulibabu, Bhuvaneswari-D, Kalaiselvi-N	Modified sol-gel synthesis to prepare nanocrystalline LiCo _{1/3} Ni _{1/3} Mn _{1/3} O ₂ cathode suitable for rechargeable lithium batteries	Nanosci. Nanotechnol. Lett.	3	5	717	722
137	Nithya-C, Syamala Kumari-VS, Gopukumar S	Synthesis of high voltage (4.9 V) cycling LiNi _x CoyMn _{1-x-y} O ₂ cathode materials for lithium rechargeable batteries	Phys. Chem. Chem. Phys.	13	13	6125	6132



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S.No.	Authors	Title	Journal Abbreviation	Volume	Issue	Page start	Page end
138	Kannan-R, Bipinlal-U, Kurungot-S, Vijayamohan Pillai-K	Enhanced electrocatalytic performance of functionalized carbon nanotube electrodes for oxygen reduction in proton exchange membrane fuel cells	Phys. Chem. Chem. Phys.	13	21	10312	10317
139	Selvaganesh-SV, Selvarani-G, Sridhar-P, Pitchumani-S, Shukla-AK	Durable electrocatalytic-activity of Pt-Au/C cathode in PEMFCs	Phys. Chem. Chem. Phys.	13	27	12623	12634
140	Debgupta-J, Kakade-BA, Vijayamohan Pillai-K	Competitive wetting of acetonitrile and dichloromethane in comparison to that of water on functionalized carbon nanotube surfaces	Phys. Chem. Chem. Phys.	13	32	14668	14674
141	Kannadasan-T, Sivakumar-V, Ahmed Basha-C, Parwate-AV, Senthilkumar-K, Kannan-K	COD reduction studies of paper mill effluent using a batch recirculation electrochemical method	Pol. J. Chem. Technol.	13	3	37	41
142	Suresh-B, Maruthamuthu-S, Kannan-M, Chandramohan-A	Mechanical and surface properties of low-density polyethylene film modified by photo-oxidation	Polymer J.	43	4	398	406
143	Manokaran-A, Jalajakshi-A, Sahu-AK, Sridhar-P, Pitchumani-S, Shukla-AK	Design and development of a self-supported polymer electrolyte fuel cell system with anodic dead-end operation	Proc. Inst. Mech. Eng.	225	A2	175	182
144	Kanagasabapathy-M, Sobha Jayakrishnan	Phase Structure and Morphology of Zinc-Iron Alloy Electrodeposits	Russ. J. Electrochem.	47	1	26	33
145	Kumaravel-A, Chandrasekaran-M	Electrochemical determination of imidacloprid using nanosilver Nafion (R)/nanoTiO ₂ (2) Nafion (R) composite modified glassy carbon electrode	Sens. Actuators B	158	1	319	326
146	Sheela Berchmans, Karthikeyan-R, Gupta-S, Poinern-GEJ, Issa-TB, Singh-P	Glassy carbon electrode modified with hybrid films containing inorganic molybdate anions trapped in organic matrices of chitosan and ionic liquid for the amperometric sensing of phosphate at neutral pH	Sens. Actuators B	160	1	1224	1231
147	Thangamuthu-R, Pan-YC, Chen-SM	Electrocatalytic reduction of hydrogen peroxide and its determination in antiseptic and soft-glass cleaning solutions at phosphotungstate-doped-glutaraldehyde-cross-linked poly-L-lysine film electrodes	Sens. Actuators B	151	2	377	383
148	Vasudevan-S, Lakshmi-J	Effects of alternating and direct current in electrocoagulation process on the removal of cadmium from water - A novel approach	Sep. Purif. Technol.	80	3	643	651
149	Seetharaman-S, Ravichandran-S, John Davidson-D, Vasudevan-S, Sozhan-G	Polyvinyl alcohol based membrane as separator for alkaline water electrolyzer	Sep. Sci. Technol.	46	10	1563	1570
150	Aravindan-V, Vickraman-P, Madhavi-S, Sivashanmugam-A, Thirunakaran-R, Gopukumar-S	Polyvinylidene fluoride-hexafluoropropylene based nanocomposite polymer membranes containing lithium bis(oxalato)borate by phase inversion for lithium batteries	Solid State Sci.	13	5	1047	1051
151	Thanjam-S, Philips-MF, Komathi-S, Manisankar-P, Sivakumar-C, Gopalan-A, Lee-KP	Course of poly(4-aminodiphenylamine)/Ag nanocomposite formation through UV-vis spectroscopy	Spectrochim. Acta A	79	5	1256	1266
152	Gopal Ram-SD, Ravi-G, Manikandan-MR, Mahalingam-T, Anbu Kulandainathan-M	Controlled hydrothermal growth of ZnO nanostructures by sequestering the Zn metal ions with the chelating agent EDTA	Superlattices Microstruct.	50	4	296	302



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S.No.	Authors	Title	Journal Abbreviation	Volume	Issue	Page start	Page end
153	Subramanian-B, Ananthakumar-R, Jayachandran-M	Structural and tribological properties of DC reactive magnetron sputtered titanium/titanium nitride (Ti/TiN) multilayered coatings	Surf. Coat. Technol.	205	11	3485	3492
154	Subramanian-B, Muraleedharan-CV, Ananthakumar-R, Jayachandran-M	A comparative study of titanium nitride (TiN), titanium oxy nitride (TiON) and titanium aluminum nitride (TiAlN), as surface coatings for bio implants	Surf. Coat. Technol.	205	21-22	5014	5020
155	Selvam-M	Colouring of anodised aluminium by electroless method	Surf. Eng.	27	9	711	718
156	Mohan-S, Rajasekaran-N	Influence of electrolyte pH on composition, corrosion properties and surface morphology of electrodeposited Cu-Ni alloy	Surf. Engg.	27	7	519	523
157	Srinivasan-KN, Selvaganapathy-T, Meenakshi-R, John-S	Electroless deposition of nickel-cobalt-phosphorus nanoalloy	Surf. Engg.	27	1	65	70
158	Vijayakumar-J, Mohan-S	Comparative study of microstructure and corrosion properties in 3.5% NaCl solution of electrodeposited nickel obtained from various baths	Surf. Engg.	27	1	32	36
159	Mohan-S, Saravanan-G, Renganathan-NG	Comparison of chromium coatings and electrochemical behaviour with direct current and pulse current deposition in trivalent chromium formate urea bath as alternative to conventional Cr coatings	Surf. Engg.	27	10	775	783
160	Ramesh Babu-B, Savarimuthu-S, Saravanan-KR, Murugan-NV	Treatment of engine oil effluent by electrooxidation and aerobic biological degradation	Sustain. Environ. Res.	21	2	109	116
161	Srinivasan-R, Ramesh Babu-GNK	Characterisation of nickel deposits from nickel acetate bath	Trans. Inst. Met. Finish.	89	5	275	280
162	Subramanian-B, Ananthakumar-R, Kobayashi-A, Jayachandran-M	Effect of nitrogen ion implantation on structural and microstructural properties of reactive magnetron sputtered TiN thin films	Trans. Inst. Metal Finish.	89	1	28	32
163	Rajasekaran-N, Mohan-S	Effect of bath temperature on corrosion resistance and structure of Cu-Ni alloy electrodeposited by brush plating method	Trans. Inst. Metal Finish.	29	2	83	88
164	Vasudevan-S, Lakshmi-J	Studies relating to electrochemically assisted coagulation for the removal of chromium from water using zinc anode	Water Sci. Technol.: Water Supply	11	2	142	150
165	Ravichandran-S, Balaji-R, B.S. kannan, S. Elamathi, Sangeetha-D, Lakshmi-J, Vasudev-S, Sozhan-G	Sulfonated Polystyrene-Block-(Ethylene-Ran-Butylene)-Block-Polystyrene (SPSEBS) Membrane for Sea Water Electrolysis to Generate Hydrogen	ECS Trans.	33	27	157	166
166	Iyayaraja-N, Radha Krishnan-S, Ravindran-G, Renganathan-N.G	NMR studies of complexes of Fluorides of Triethylamine	Open. Spectro. J	5		26	36



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Sponsored Projects undertaken during 2011-2012

S.No	Project code	Title	Sponsoring Agency	Project Leaders	Duration in months
1	SSP 01/11	Improvement in or relating to an electrochemical preparation of ammonium, sodium and potassium persulphates	Posh Chemicals P Ltd., Hyderabad	S. Vasudevan	6
2	SSP 02/11	Studies on corrosion behavior of surface treated SS 304 L welded tubes	LPSC, ISRO, Trivandrum	G. T. Parthiban	4
3	SSP 03/11	Development of suitable protective coating system for SME for NLC, Neyveli	NLC, Neyveli	S. Muthukrishnan	24
4	SSP 05/11	Development of wear and corrosion resistant electroless nickel plating process for high strength titanium alloy Ti-10-2-3	Aeronautical Development Agency, Bangalore	K. N. Srinivasan	24
5	SSP 07/11	Atmospheric Corrosion of steel in 3 locations at new four lane elevated road from Chennai port to Maduravoyal (NH-4) in TN.	Soma Enterprise Ltd., Chennai.	M. Natesan and M. Selvaraj	12
6	SSP 09/11	Development of Wear & Corrosion Resistant Internal Plating Scheme for Actuator Components for Tejas	ADA, Bangalore	K. N. Srinivasan and M. Selvam	18
7	SSP 12/11	Durability studies with respect to corrosion resistance of AGNI TMT steel rods with CRS property in comparison with AGNI TMT steel rods without CRS property, which is to be used in reinforced concrete construction	AGNI Steels Pvt., Ltd., SF 562, Kavandanur Road, Ingur – 638 058, Erode Dist.	K. Saravanan and N. Palanisamy	12
8	SSP 15/11	Studies on corrosion behavior of aluminium alloys	DMRL, Hyderabad	G. T. Parthiban	36



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Consultancy projects under taken during 2011 - 2012

S.No	Project code	Title	Sponsoring Agency	Project Leaders	Duration in months
1	CNP 01/11	Corrosion survey of rehabilitated zirconium spongy plant	Nuclear Fuel Complex, Department of Atomic Energy, Hyderabad	K. Thangavel	6
2	CNP 02/11	Advice on electropolishing of AISI 304 stainless steel baskets	Aadhavan Industries, Palani	S. Mohan	6
3	CNP 03/11	Advice on hard anodizing of aluminium alloys	WABCO TVS Ltd., Chennai	S. Mohan	6
4	CNP 04/11	To design, fabricate and install a 2 kA rating pilot electrolyser suitable for the electrolytic production of caustic soda-chlorine-hydrogen	Grasim Industries Ltd., Naqda	K. Asokan	4
5	CNP 04/11	To Design Fabricate and Install a 2 KA rating pilot Electrolyser suitable for the Electrolytic production of Caustic soda-Chlorine-Hydrogen at M/s. Grasim Industries, Nagda.	Grasim Industries Ltd., Nagda	K. Asokan and K. Subramanian	4
6	CNP 05/11	Advise on Sputter of Titanium Nitride into Nickel Chrome Plated Stainless Steel Needles.	Nano Marker's, Trichy	B. Subramanian and M. Jayachandran	6
7	CNP 06/11	Corrosion control for brazed joints on copper tubes	Faiveley Transport India Ltd., Hosur	G.T. Parthiban and N. Palanisamy	2
8	CNP 07/11	To suggest suitable coating to protect the steel components of radial gates and other parts – Phase II	Sardar Sarovar Nigam Ltd., Kevadia	M. Selvaraj and S. Ramu	12



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Collaborative projects undertaken during 2011-2012

S.No	Project code	Title	Sponsoring Agency	Project Leaders	Duration in months
1	CLP 16/11	Generation, Storage and Distribution of solar hydrogen	DST, New Delhi	S. Ravichandran and G. Sozhan	24
2	CLP 10/11	Energy conversion reactions: Fine tuning of electro catalytic activity through surface manipulation guided by in-situ spectroscopic and microscopic studies	DST, New Delhi	KLN. Phani and S. Senthilkumar	36

Grant-in-aid projects undertaken during 2011-2012

S.No	Project No	Title	Agency	Project Leader	Months
1	GAP 04/11	National hub for healthcare instrumentation development (NHHID)	DST, New Delhi	K.L.N. Phani	36
2	GAP 06/11	Development of polymer-in-ceramic nano-composite electrolytes for energy devices	Department of Atomic Energy, Mumbai	A. Manuel Stephan	36
3	GAP 08/11	Developing H ₂ gas sensor based on conducting polymer nano-composite materials	DST, New Delhi	M. Paramasivam and S. Ambalavanan	24
4	GAP 11/11	Development of customized organic coatings for corrosion protection of special mining equipments at Neyveli Lignite mines-NLC, Neyveli	CMPDI Ltd., Ranchi	S. Muthukrishanan and M. Selvaraj	36
5	GAP 13/11	First principles study on local atomic structure magnetic ordering and interface effects in exchange coupled multilayer system	DRDO, New Delhi	P. Murugan and N. Lakshminarasimhan	36
6	GAP 14/11	On the dual electrode behavior of Li _y MXO ₄ (X=Sn, P) compounds: An explorative attempt on a new concept	SERC, DST, New Delhi	N. Kalaiselvi and P. Periasamy	36



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Technical service projects undertaken during 2011-2012

S.No	Project code	Title	Sponsoring Agency	Project Leaders	Duration in months
1	TSP01/2011	Testing of 2V/500 Ah VRLA cells as per IRS: S93/96A	HBL Power Systems Ltd., Kothur, AP.	S. Sekar	12
2	TSP02/2011	Testing of CPCC coated reinforcement rods and chemicals as per CECRI code of practice	GR, MS, KT (JV), Kerala	R. Vedalakshmi	3
3	TSP03/2011	Testing of CPCC coated reinforcement rods and chemicals as per CECRI code of practice	Soma Enterprise Ltd, Chikhli, Gujarat	R. Vedalakshmi	3
4	TSP04/2011	Intergranular corrosion test on 301 L stainless steel	BEML, Bangalore	S. Ramu	6
5	TSP05/2011	Testing of 2V/800 Ah cells as per the specification 1651-1991	Microtex Energy P. Ltd., Bengaluru	S. Sekar	12
6	TSP06/2011	Testing of 2V/500Ah LM cells as per IRS:S 88/2004	Mysore Thermo Electric P. Ltd., Bengaluru	S. Sekar	24
7	TSP07/2011	To coat 16 numbers of titanium mesh anode for the production of tetra alkyl ammonium hydroxide	Tatva Chintan Pharma Chemicals P. Ltd., Ankleshwar	K. Asokan	6
8	TSP08/2011	Testing of anticorrosive treated rods supplied by P & C Constructions P. Ltd.	P & C Constructions P. Ltd., Chennai	S. Saravanan	2
9	TSP09/2011	Testing of anticorrosive treated rods supplied by P & C Constructions P. Ltd.	P & C Constructions P. Ltd., Chennai	S. Saravanan	2



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Technical Service Projects undertaken during the period 2011-2012

S.No	Project code	Title	Sponsoring Agency	Project Leaders	Duration in months
10	TSP10/2011	Testing of water proofing chemicals supplied by M/S Tech-dry India P. Ltd., Bengaluru	Tech-dry India P. Ltd., Bengaluru	R. Vedalakshmi	3
11	TSP11/2011	Testing of CPCC coated reinforcement rods and chemicals as per CECRI code of practice	Soma Enterprise Ltd, Chikhli, Gujarat	R. Vedalakshmi	3
12	TSP12/2011	Evaluation of the performance of ten cathode active samples in lithium – ion batteries	Dow Chemical international Pvt. Ltd, Mumbai	T. Premkumar	2
13	TSP13/2011	Evaluation of 12V/120 Ah & 12V/150 Ah battery as per IS 13369-1992	Jayachandran Industries Pvt.Ltd, Bangaluru	S. Sekar	6
14	TSP14/2011	Testing and evaluation of steel for chemical properties as per IS 1786 and suggesting suitable anticorrosive treatment	High ways Dept, Sirkali	R. Vedalakshmi	2
15	TSP15/2011	Testing of samples for Tank bottom plate failure.	IOC Ltd, Jam Nagar, Gujarat	S. Maruthamuthu	6
16	TSP16/2011	Sample preparation by Electrochemical fluorination of Octanoyl Chloride	Gujarat Fluorochemicals Ltd, Gujarat	D. Velayutham	4
17	TSP17/2011	Testing of CPCC coated reinforcement rods and chemicals covered by the patent Nos. 481/DEL/93 and 259/DEL/92 as per CECRI code of practice (2 sets of samples)	Soma Enterprises Ltd., Chikhli, Gurajat	R. Vedalakshmi	3
18	TSP18/2011	Testing of organo & non-organophosphonate samples	NLC Ltd., Neyveli	S. Muralidharan	6



CECRI CLUB

CECRI SPORTS CLUB' in continuation of its activities for the past few decades, has conducted various activities of sports independent of 'cadres and categories' to induce sportiveness, encourage brotherly-hood and strengthen the feel of ONE-CSIR among our CECRI staff on par with other CSIR laboratories on important national contexts and annual meets. The sports involve occasions like Independence day, Republic day and Gandhi Jayanthi Day. Besides regular activities of sports and CECRI sports Club has organized this year 2010-2011 never before sports-fest SSBMT-Tournament during 27th-29th.

For the first time in recent years, Shanthi Swarup Bhatnagar Memorial Tournament (SSBMT) was conducted by CECRI Club with the help of CECRI Administration during 27-29th Dec 2011 in which 190 sports-men from different CSIR family laboratories participated with greater enthusiasm. Both the sports, Cricket and Volley Ball made a feast to the sportsmen around and it was a great achievement by CECRI despite routine and special types of hardships and hurdles. This mega event was conducted successfully where in almost all the talented CECRI members with expertise and dedication worked hand in hand and got special appreciation from different laboratories of CSIR.

List of Participating labs at SSBMT-CECRI

1. CCMB (Hyderabad)
2. CLRI (Chennai)
3. CDRI (Lucknow)
4. IMT (Chandigarh)
5. NISTADS (New Delhi)
6. CIMAP (lucknow)
7. NAL (Bangalore)
8. NISCAR (New Delhi)
9. NGRI (Hyderabad)



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CSIR Program on Youth for Leadership in Science

CPYLS was organized at CECRI during 5-7 March, 2012. Twenty five students who topped in the X standard public examination in Tamil Nadu participated with their teacher/parent/guardian. Prof. T. Pradeep, Dept. of Chemistry, IITM, Chennai delivered inaugural address and inspiring talk on "Chemistry: The everlasting Spring". Popular lectures in science, demo, hand holding experiments were organized. Dr. Vijayamohan K. Pillai, Acting Director, CSIR-CECRI delivered the valedictory address.



(c) One new P C was presented to the above school, for the exclusive use of rural students in the CSIR-CECRI foundation Day function held on 26th September 2011.



Professor M.S. Ananth, Former Director, IIT, Madras presenting PC to Mrs. S. Subbuthai, Headmistress.

(ii) Faculty Training and Motivation and Adoption of Schools and Colleges by CSIR Labs :

Coinciding with the celebration of IYC:

(a) Motivation Training Programme For Hr. Secondary Schools P.G Chemistry Teachers of Sivagangai District were organized during 12&13 December 2011. Seventy six teachers from various schools were participated. All the participants were provided with books on Understanding Chemistry, by CNR Rao. Lectures in the frontier areas of chemistry and demos were arranged, Prof A Rajkumar, IIT, Kharagpur delivered the key-note address.





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सीएसआईआर – केंद्रीय विद्युतरसायन अनुसंधान संस्थान, कारैकुडी-630 006 हिंदी माह समारोह – 2011

सीएसआईआर – केंद्रीय विद्युतरसायन अनुसंधान संस्थान, कारैकुडी में दि. 1 से 30 सितंबर, 2011 तक हिंदी माह मनाया गया। इस हिंदी माह के दौरान 11 प्रतियोगिताएँ आयोजित की गईं जिसमें संस्थान के कर्मचारियों के साथ दृ साथ अनुसंधान अध्येताओं ने भी उत्साहपूर्वक भाग लिया।

दैनिक प्रश्नोत्तरी प्रतियोगिता को पिछले वर्ष की सबसे अधिक सफल प्रतियोगिता थी, चूंकि कर्मचारियों ने इसी में सबसे अधिक प्रतिभागिता दर्ज की थी, पिछले वर्ष में इसकी सफलता को देखते हुए हिंदी माह का प्रारंभ ऑनलाइन दैनिक प्रश्नोत्तरी के साथ किया गया। प्रतिदिन इंटरनेट पर डेली बुलेटिन के माध्यम से राजभाषा हिंदी से सम्बंधित प्रश्न पूछे गए जिसका उत्तर प्रतिभागियों ने ई-मेल के माध्यम से भेजा। पूरे माह के दौरान कुल 20 कार्यालयीन दिवस के लिए प्रश्न प्रदर्शित किए गए। इस दौरान लगभग 450 से भी अधिक उत्तर प्राप्त हुए।

इस दौरान साप्ताहिक ऑनलाइन वर्ग – पहेली का आयोजन भी किया गया। इसमें हर सप्ताह इंटरनेट के हिंदी कॉलम में वर्ग पहेली प्रदर्शित की गई जिसका उत्तर कर्मचारियों ने निर्धारित तिथि तक दिया। पूरे माह में ऐसी चार वर्ग- पहेलियाँ प्रदर्शित की गईं और समेकित रूप से सबसे अधिक अंक प्राप्त करने वालों को क्रमशः प्रथम, द्वितीय एवं तृतीय तथा प्रोत्साहन पुरस्कार दिए गए।

दि. 06.09.11 को सुलेख प्रतियोगिता का आयोजन किया गया। अधिकारियों/कर्मचारियों ने इसमें भाग लिया और अपनी सुंदर लिखावट का नमूना पेश किया।

दि. 08.09.2011 को हिंदी टिप्पण एवं प्रारूपण प्रतियोगिता आयोजित की गई।



दि. 12.09.2011 को निबंध प्रतियोगिता आयोजित की गई। निबंध का विषय दृ भंडारण रसायनविज्ञान वर्ष, 2011 रखा गया।



दि. 14.09.11 को हिंदी दिवस के अवसर पर संस्थान के निदेशक ने सभी को हिन्दी में अधिकाधिक कार्य करने का संदेश दिया। हिन्दी दिवस के अवसर पर हिंदी प्रश्नोत्तरी प्रतियोगिता आयोजित की गई। इस प्रतियोगिता में सामान्य ज्ञान, खेल – कूद आदि से जुड़े प्रश्न पूछे गए। इसके अंतर्गत दृश्य-श्रव्य सत्र भी रखा गया।

दि. 16.09.2011 को हिंदी में हस्ताक्षर एवं स्लोगन प्रतियोगिता का आयोजन किया गया। इसमें संस्थान के वैज्ञानिक/तकनीकी तथा प्रशासनिक कर्मचारियों तथा बी.टेक के विद्यार्थियों ने पूरे उमंग और उत्साह से अपनी प्रतिभागिता दर्ज की। इसमें हर वर्ग से अर्थात् वैज्ञानिक वर्ग, तकनीकी वर्ग, प्रशासनिक वर्ग आदि प्रत्येक वर्ग से सबसे सुंदर हस्ताक्षर एवं नारा लिखने वाले एक व्यक्ति को पुरस्कृत किया गया।

दि. 20.09.2011 को चित्र-वर्णन प्रतियोगिता में सभी प्रतिभागियों को भ्रष्टाचार की स्थिति और वन संरक्षण को दर्शाते चित्र की प्रतियाँ दी गईं जिसमें से इच्छानुसार किसी एक का प्रतिभागियों ने अपनी-अपनी कल्पना के अनुसार वर्णन किया।

दि. 22.09.2011 को हिंदी वाचन प्रतियोगिता आयोजित की गई। इस प्रतियोगिता में अधिकारियों/कर्मचारियों के साथ-साथ अनुसंधान अध्येताओं ने भी बड़-चढ़ कर भाग लिया।



दि. 27.09.2011 को हिंदी गीत-गायन प्रतियोगिता आयोजित की गई। इस प्रतियोगिता में प्रतिभागियों ने पूरे उत्साह एवं हाव-भाव के साथ हिंदी फिल्मों के तथा देशभक्ति गीत गाए। इसमें उन्हें वाद्य यंत्रों का सहारा लेने की अनुमति नहीं थी।

दि. 28.09.2011 सामूहिक परिचर्चा प्रतियोगिता आयोजित की गई। इसमें चर्चा का विषय पर्यावरण एवं ऊर्जा रखा गया। संस्थान के अधिकारियों एवं कर्मचारियों ने इसमें भाग लिया और उक्त विषय पर जोशपूर्ण चर्चा की।



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हिंदी माह समापन एवं पुरस्कार वितरण समारोह

हिंदी माह, 2011 समापन एवं पुरस्कार वितरण समारोह दि. 04.10.2011 को शाम 4.00 बजे संस्थान के विज्ञान प्रेक्षागृह में आयोजित किया गया।

श्री. श्री हरीश कुमार नायर, प्रबंधक, पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड, कारैकुडी इस समारोह के मुख्य अतिथि थे।

हिंदी माह आयोजन समिति, 2011 के अध्यक्ष डॉ. वी. अनंत ने उपस्थित सभी का स्वागत किया।



संस्थान के निदेशक डॉ. विजयमोहनन के. पिल्लै ने इस समारोह की अध्यक्षता की। डॉ. विजयमोहनन के. पिल्लै, निदेशक, सीईसीआई ने समारोह के मुख्य अतिथि श्री. श्री हरीश कुमार नायर, प्रबंधक, पावर ग्रिड, कारैकुडी, का शॉल एवं पुष्प गुच्छ से स्वागत किया। तदुपरांत, निदेशक ने अपने अध्यक्षीय भाषण में कहा कि किसी भी भाषा को तकनीक से दूर रख कर आगे नहीं बढ़ा जा सकता। गूगल ट्रांसलेशन एवं ट्रांसलिटरेशन तथा अन्य ऑनलाइन सुविधाएं जैसे की शब्दकोश व लीला हिन्दी प्रशिक्षण आदि से हम हिन्दी भाषा का कुशलता से प्रयोग कर सकते हैं। उन्होंने यह वैज्ञानिकों से भी अनुरोध किया कि वे विज्ञान और प्रौद्योगिकी की जानकारी देश की आम जनता तक उसकी अपनी भाषा में पहुंचाएं, जिससे कि इसका लाभ आम आदमी तक पहुंच सके।



श्री सोमेश्वर पाण्डेय, हिंदी अधिकारी ने हिंदी माह की रिपोर्ट के अंतर्गत पूरे हिंदी माह के दौरान आयोजित प्रतियोगिताओं की प्रस्तुति के माध्यम से संक्षिप्त जानकारी दी। उन्होंने यह आशा व्यक्त की कि अगले वर्ष संस्थान में हिंदी में काम करने वालों तथा हिंदी माह के दौरान आयोजित प्रतियोगिताओं में भाग लेने वाले प्रतिभागियों की संख्या में निश्चित रूप से और अधिक वृद्धि होगी।

श्री. श्री हरीश कुमार नायर, मुख्य अतिथि ने अपने भाषण में संस्थान के उच्च अधिकारियों से अपील की कि वे अधिकाधिक काम हिंदी में करने की प्रयास करें कि जब उच्च अधिकारी हिंदी में काम करने लगेंगे तो अधीनस्थ कर्मचारी भी हिंदी में काम करने के लिए प्रोत्साहित होंगे। उन्होंने विजेताओं/प्रतिभागियों को बधाई दी और उपस्थित सभी को समय मिलने पर पावर ग्रिड के दौरे का निमंत्रण भी दिया।



तत्पश्चात विभिन्न प्रतियोगिताओं के पुरस्कार विजेताओं को पुरस्कार प्रदान किए गए तथा इन प्रतियोगिताओं के निर्णायकों एवं संचालकों (बाह्य एवं स्थानीय) को उनके योगदान के लिए सम्मानित किया गया।

अंत में, श्री के. मुरलीधरन, प्रशासन अधिकारी द्वारा धन्यवाद प्रस्ताव के साथ समारोह सम्पन्न हुआ।

इस समारोह का संचालन श्रीमती जी कलैवाणी, हिंदी अनुवादक ने किया।



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माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा संस्थान का निरीक्षण

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दि. 09.05.2011 को रामेश्वरम में सीएसआईआर-केंद्रीय विद्युतरसायन अनुसंधान संस्थान में हिंदी के कार्यान्वयन की स्थिति का निरीक्षण किया गया।

आदरणीय श्री सत्यव्रत चतुर्वेदी, सांसद(राज्य सभा) एवं उपाध्यक्ष ने इस निरीक्षण बैठक की अध्यक्षता की तथा उनके साथ निम्नलिखित माननीय सदस्य भी उपस्थित थे :

डॉ. प्रसन्न कुमार पाटसाणी, सांसद(लोक सभा)
डॉ. निर्मल खत्री, सांसद(लोक सभा)
श्री किशनभाई वी. पटेल, सांसद(लोक सभा)
श्री वाई.पी. त्रिवेदी, सांसद(राज्य सभा)
श्री ब्रजेश पाठक, सांसद(राज्य सभा)
डॉ.(श्रीमती) बोचा झांसी लक्ष्मी, सांसद(लोक सभा)
श्रीमती पूनम जुनेजा, सचिव

संस्थान के निम्नलिखित प्रतिनिधि इस निरीक्षण बैठक में उपस्थित हुये थे :

डॉ. विजयमोहनन के. पिल्लै कार्यकारी निदेशक, सीईसीआरआई, कारैकुडी
डॉ.वी. अनंत, वैज्ञानिक पट.5इए सीईसीआरआई, कारैकुडी
श्री मेन्युल थॉमस, प्रशासन नियंत्रक, सीईसीआरआई, कारैकुडी
श्री.डी.पी.मारेट, वित्त एवं लेखा अधिकारी, सीईसीआरआई, कारैकुडी
श्री के. मुरलीधरन, प्रशासन अधिकारी, सीईसीआरआई, कारैकुडी
श्री. एन. कालिदास, वरिष्ठ तकनीकी अधिकारी(2), सीईसीआरआई, कारैकुडी
डॉ. जी.एन.के. रमेश बापु, वैज्ञानिक पट.5इए सीईसीआरआई, कारैकुडी
श्री. सोमेश्वर पाण्डेय, हिंदी अधिकारी, सीईसीआरआई, कारैकुडी

निरीक्षण की कुछ झलकियाँ



निरीक्षण के दौरान आयोजित प्रदर्शनी की झलकियाँ



सीएसआईआर मुख्यालय की ओर से इस निरीक्षण के दौरान डॉ. यू. एस. टंडन, वरिष्ठ वैज्ञानिक श्री रवीन्द्र मेंहमी, हिंदी अधिकारी उपस्थित थे।

सर्वप्रथम डॉ. विजयमोहनन के. पिल्लै, कार्यकारी निदेशक ने चंदन माला, शॉल एवं पुष्पगुच्छ से सभी संसदीय सदस्यों का स्वागत किया। निदेशक महोदय ने संस्थान में हो रहे अनुसंधान एवं विकास कार्य और दैनिक कार्यों में हिंदी के प्रयोग के सम्बंध में तथा तत्संबंधी किए जा रहे प्रयासों की विस्तृत जानकारी माननीय समिति को दी। माननीय समिति के उपाध्यक्ष श्री सत्यव्रत चतुर्वेदी ने हिंदी के कार्यान्वयन में और अधिक गति लाने की सलाह दी। निदेशक महोदय ने समिति द्वारा दिए गए आदेशों के अनुपालन का आश्वासन दिया। इस अवसर पर समिति अध्यक्ष श्री सत्यव्रत चतुर्वेदी द्वारा निदेशक को संसदीय समिति के आदेशों के अद्यतन संकलन की प्रति भी भेंट की गई।

इस अवसर पर संस्थान की राजभाषा हिंदी सम्बंधी गतिविधियों एवं उपलब्धियों की एक छोटी सी प्रदर्शनी का आयोजन भी किया गया था।

माननीय समिति का स्वागत





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नगर राजभाषा कार्यान्वयन समिति, कारैकुडी

Town official language implementation committee, Karaikudi

यह संस्थान नगर राजभाषा कार्यान्वयन समिति, कारैकुडी का कार्य भी देखता है। वर्ष 2011-12 के दौरान नगर राजभाषा कार्यान्वयन समिति, कारैकुडी की गतिविधियों की संक्षिप्त रिपोर्ट निम्नानुसार है :

छमाही बैठकें
8वीं छमाही बैठक

नराकास कारैकुडी की आठवीं छमाही बैठक डॉ. यज्ञरामन, अध्यक्ष, नराकास तथा निदेशक, सीईसीआरआई की अध्यक्षता एवं डॉ. वी. बालकृष्णन, प्रतिनिधि, राजभाषा विभाग की विशेष उपस्थिति में दि. 27.4.2011 को अपराह्न 3.00 बजे आयोजित की गई। इस दौरान नराकास, कारैकुडी के तत्वावधान में आयोजित संयुक्त हिंदी प्रतियोगिता दृ 2010.11 के पुरस्कार वितरित किए गए तथा आयोजक कार्यालयों को सम्मानित किया गया। इस अवसर पर डॉ. वी. बालकृष्णन ने नराकासए कारैकुडी द्वारा तैयार सदस्य कार्यालयों के उपयोगार्थ विभिन्न स्रोतों से संकलित उपयोगी राजभाषा सामग्री की एक सीडी का भी विमोचन किया गया।



इन प्रतियोगिताओं में सदस्य कार्यालयों के अधिकाधिक कर्मचारियों ने पूरे जोश और उत्साह के साथ भाग लिया। इन प्रतियोगिताओं के अंतर्गत वैयक्तिक तथा सामूहिक प्रतियोगिताएँ आयोजित की गई थीं। इन प्रतियोगिताओं के परिणाम निम्नानुसार रहे:-

9वीं छमाही बैठक

नराकास, कारैकुडी की 9वीं छमाही बैठक दि. 22.11.2011 को सीईसीआरआई के अलगप्पा सम्मेलन कक्ष में डॉ. विजयमोहनन के.पिल्लै, कार्यकारी निदेशक, सीईसीआरआई तथा अध्यक्ष नराकास, कारैकुडी की अध्यक्षता में अपराह्न 4.00 बजे सम्पन्न हुई। इसमें कारैकुडी स्थित कुल 19 कार्यालयों ने भाग लिया। इस बैठक में राजभाषा विभाग के प्रतिनिधि के रूप में श्री पी. विजय कुमारए सहायक निदेशक, क्षेत्रीय कार्यान्वयन कार्यालयए कोच्चिन भी उपस्थित थे। उन्होंने उपस्थित सदस्यों का राजभाषा नीति एवं कार्यान्वयन संबंधी मार्गदर्शन भी किया। संयुक्त हिंदी प्रतियोगिताएँ 2011-12

नराकास कारैकुडी के तत्वावधान में संयुक्त हिंदी प्रतियोगिताएँ आयोजित की गई। इसमें कुल 08 प्रतियोगिताओं का आयोजन किया गया। नराकास, कारैकुडी के निम्नलिखित सदस्य कार्यालयों ने निम्नानुसार प्रतियोगिताओं का आयोजन किया:-

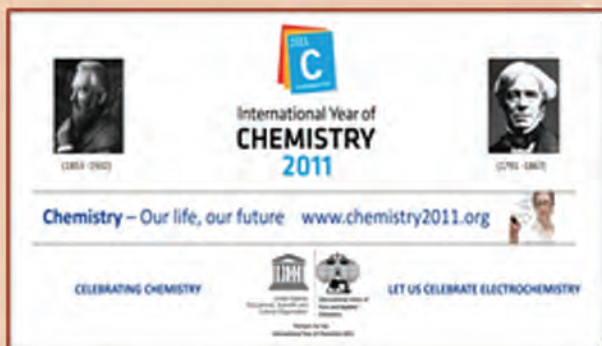
आई ओ बी	निबंध लेखन
केंद्रीय विद्यालय	अंत्याक्षरी
बीएसएनएल	शब्द निर्माण
पावर ग्रिड	काव्य पाठ
सीईसीआरआई	प्रश्नोत्तरी
सीईसीआरआई	चित्रवर्णन
भारतीय स्टेट बैंक	समाचार वाचन
न्यू इंडिया एश्योरेंस	गीत गायन

दिनांक-प्रतियोगिता-आयोजक कार्यालय	पुरस्कार विजेता
15.02.2012 समाचार वाचन 3रा. स्टेट बैंक	प्रथम - श्रीमती जानकीएसबीआई, श्री भावेक वसन्ती(के.वि.) द्वितीय- श्रीमती आरएम् विजयलक्ष्मी(सीईसीआरआई) तृतीय -श्री रघु (लाक)
16.02.2012 चित्र वर्णन सीईसीआरआई	प्रथम - श्री नजीब (सीईसीआरआई) द्वितीय- श्रीमती अरुणा रामन(के.वि.) तृतीय -श्री सतीश(के.वि.), श्री आरि कुमार(के.वि.)
17.02.2012 गीत गायन न्यू इंडिया एश्योरेंस	प्रथम - श्रीमती कोण्माज्जी(के.वि.) द्वितीय- श्री एस. कुम्जन(सीईसीआरआई), श्री सीधी प्रभाकर(एनआईए) तृतीय -श्रीमती एम गीता (के.वि.) प्रोत्साहन-श्री तमिलमणि, एनआईए
20.02.2012 काव्य पाठ पावर ग्रिड	प्रथम - श्रीमती पीपीएलियम्मा(सीईसीआरआई) द्वितीय- श्री एस. शम्भुसुन्दरम(सीईसीआरआई) तृतीय - श्री एस. जम्बुलिंगम(सावर फिट)
21.02.2012 निबंध लेखन आईओबी	प्रथम - श्री लक्ष्मीनारायणन सुंदर(सीईसीआरआई) द्वितीय- श्रीमती अरुणा रामन(के.वि.), श्री आनंद भारती(सीईसीआरआई)
22.02.2012 अंत्याक्षरी (सामूहिक) केंद्रीय विद्यालय	प्रथम श्रीमती गीता, श्रीमती अरुणा, श्रीमती कोण्माज्जी(केंद्रीय विद्यालय) द्वितीय- श्री सिंगारेलु, श्री पीवीअनीश(पावर ग्रिड) प्रतिभाषिता- डॉ. डी. वासुदेवन, श्री चंद्रमोहन (सीईसीआरआई)
23.02.2012 प्रश्नोत्तरी(सामूहिक) सीईसीआरआई	प्रथम श्री एस.कुम्जन, श्री वॉमिस एलेक्सैंडर, श्री एवारकुमल(सीईसीआरआई) द्वितीय- श्री सीधी प्रभाकर(न्यू इंडिया एश्योरेंस) प्रतिभाषिता- श्री मुकेश पाते, श्री एम.जाजी, श्री प्रवीण(के.वि.)
24.02.2012 काव्य निर्माण भा सं नि नि	प्रथम श्री सी सिंगारेलु (पावरग्रिड) द्वितीय-श्री आनंद भारती, श्री एवारकुमल(सीईसीआरआई) तृतीय -श्री आर.छगनलै (विजय बैंक) प्रोत्साहन- श्री आरुण तिरुवेल्लय्या स.नि.नि)



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International Year of Chemistry



The International Year of Chemistry 2011 was a worldwide celebration of the achievements of chemistry and its contributions to the well-being of mankind. It coincided with the 100th anniversary of the Nobel Prize awarded to Marie Curie—an opportunity to celebrate the contributions of women in science. The year was also the 100th anniversary of the founding of the International Association of Chemical Societies. The goals of IYC2011 were to increase public appreciation of chemistry in meeting world needs, to encourage interest in chemistry among young people, and to generate enthusiasm for the creative future of chemistry.

IYC-2011 at CECRI was celebrated on the following lines:

Awareness/motivation program for school students
Motivation program for chemistry teachers in schools and science teachers in colleges



Competitive programs for PhD scholars
Workshops/seminars on CSIR's core areas
Lectures by eminent personalities

Posters of IYC cropped up and a festive fragrance filled the campus. Even whispers in the corridors centred on Marie Curie, Michael Faraday, C.V. Raman, Alfred Nobel, Albert Einstein The year-long celebrations were inter-laced with lectures, motivation/ training/awareness programs, scholar seminars, competitions, tips & tricks, etc.

A three-day Faculty Training and Motivation Program under CSIR-HRDC's scheme of Faculty Training & Motivation and Adoption of Schools & Colleges marked the beginning of IYC-2011 celebrations at CECRI. College teachers of chemistry and physics from the district participated in this event.





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Dr. K.L.N. Phani, Senior Principal Scientist, CECRI kickstarted the IYC lecture series with a talk on Chemistry-2011-IYC: Celebrating Chemistry on April 4, 2011. Moving on, to assess the scholastic skills, a competitive In-house Scholar Seminar was conducted in April, 2011. The scholars spoke on topics selected by lots. A preliminary round was conducted during April 18-20, 2011 and the final on April 27, 2011. All the participants were provided with educational kits and books. The prize winners were suitably rewarded.

As a part of CSIR-CECRI's Hindi Month Celebrations, an essay competition in Hindi on International Year of Chemistry was organized on September 12, 2011.

On September 27, 2011, Dr. Anil Kumar of IIT-Mumbai gave a captivating Lecture Demonstration in Chemistry. He also performed some mind-boggling scientific magic tricks, leaving the audience spell-bound and in awe. After every trick, he removed the veil of secrecy by explaining science behind it.

On November 15, 2011, Prof. P. Gautam of Anna University, Chennai delivered a lecture on AFM Studies of *Pseudomonas aeruginosa* Biofilms on Porous Silicon. It was an intoxicating cocktail of chemistry and biology. Prof. A.K. Ganguli of IIT-Delhi delivered a lecture on Controlled Synthesis of Nanostructures using Microemulsions on November 30, 2011. He dealt with nanostructured micellar units that are precursors to nanoscopic products.

A one-day Science Motivation Program was organized on December 9, 2011 by CECRI Ladies Forum at the Government Higher Secondary School, Ariyakudi. The forum donated basic science books to the school library.

Prof. A. Rajakumar of IIT-Kharagpur gave a lecture on Analytical Challenges in Unraveling the Environmental Proxies from the Antarctic Ice Samples on December 12, and another on Recent Trends in the Visible Light Assisted Photocatalysis for Environmental Remediation the next day.



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A two-day Motivation Program for Chemistry Teachers was organized by CSIR-CECRI on December 12 and 13, 2011. Teachers from all over the district participated in this event and updated themselves on developments in the chemical sciences.

Prof. V.K. Gupta of IIT-Roorkee gave a lecture on Chemical Sensors for Monitoring Heavy Metals, Anions and Drugs on December 14, 2011. Prof. Amala Dass of the University of Mississippi gave a lecture on Gold Nanomolecules: Gold Nanoparticles of Molecular Definition the next day. On December 19, 2011, Prof. C.R. Raj of IIT-Kharagpur gave a lecture on Nanoscale Materials for Electrochemical and Optical Sensing.

A one-day workshop on Open Source Drug Discovery (OSDD) was organized on December 20, 2011. Experts from all over the country participated in this event, which provided a platform for collective effort.



Dr. R.R. Hirwani of CSIR-URDIP, Pune gave a lecture on Patinformatics for Research and Business Planning on December 23, 2011. He also inaugurated the CSIR-CECRI's Repository in CSIR Central, an open access initiative of CSIR for its publications. He stressed the significance of IPR through patents and open access, which enlarged the vision of CSIR-CECRI researchers.

The IYC-2011 wrapping-up lectures were delivered by Prof. S. Chandrasekaran of IISc, Bangalore, who spoke on Chemistry: Our Life, Our Future; Chemistry for Sustainable Development on December 22, 2011 and by Prof. Sabu Thomas of Mahatma Gandhi University, Kottayam, who spoke on Viscoelastic Phase Separation Process and the Development of Micro and Nanomorphologies in Epoxy Based Blends on December 29, 2011. Both the lectures were blended with sustainable futuristic thoughts most suited for the betterment of our life and future—CHEMISTRY!





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RETIREMENT

- | | |
|-------------------------------|------------------------|
| 1. Dr. V. Yegnaraman | Director |
| 2. Shri. K. Thiyagarajan | Private Secretary |
| 3. Dr. N. Mani | Chief Scientist |
| 4. Dr. S. Madhu | Chief Scientist |
| 5. Shri. K. R. Subashchandran | Assistant (F & A) Gr.I |
| 6. Dr. V. Ananth | Chief Scientist |

TECHNICAL RESIGNATION

- | | |
|--------------------------|-----------------|
| 7. Shri Sushil Khodwekar | Section Officer |
|--------------------------|-----------------|

VOLUNTARY RETIREMENT

- | | |
|-------------------------|---------------------------|
| 8. Shri. V. Palanimuthu | Assistant (G) Gr.I (MACP) |
|-------------------------|---------------------------|

DEATH:

- | | |
|----------------------------|----------|
| 9. Late Shri. P. Murugesan | Gr.I (4) |
|----------------------------|----------|

NEW APPOINTMENTS

- | | |
|------------------------------|----------------------|
| 10. Shri Anand Bharti | Section Officer |
| 11. Miss C. Ramya | Assistant (G) Gr.III |
| 12. Dr. Shailendra Kumar Jha | Scientist |
| 13. Dr. Subhendu Kumar Panda | Scientist |

TRANSFERS (JOINED)

- | | |
|-------------------------|--------------------------|
| 14. Shri. D.P. Maret | F & AO |
| 15. Shri. P. Venkat Rao | F & AO |
| 16. Dr. S.M. Rajendran | Principal Scientist |
| 17. Shri. M. Esakimuthu | Assistant (F & A) Gr.III |

TRANSFERS (LEFT)

- | | |
|-------------------------------|---------------------------|
| 18. Shri. K. Asokan | Daftry |
| 19. Smt. Lucy Paul | Technical Officer (2) |
| 20. Shri, N. Gopalan | Assistant (G) Gr.I (MACP) |
| 21. Smt. S. Jothilakshmi | Assistant (F & A) Gr.III |
| 22. Smt. S. Thulasi | Assistant (F & A) Gr.III |
| 23. Shri. C. Venkatesh | Technical Officer |
| 24. Smt Kamalabai Prabhakaran | Assistant (F & A) Gr.I |





Centre for Innovation in Energy Research

An amount of Rs 70 lakh was allotted for the construction of a 5400 sq.ft. building for housing new facilities to be established for the Inter-Agency Project on lithium-ion batteries (IAP-04) sanctioned under the XI Five Year Plan. The new laboratory became functional in early 2010. However, it was formally inaugurated as the Centre for Innovation in Energy Research (CIER) by His Excellency Dr. A.P.J. Abdul Kalam, former President of India on May 6, 2012. The centre is dedicated to developing electrochemical technologies for a sustainable energy future. The focus is to demonstrate electrochemical energy technologies with higher efficiencies and lower environmental impact. The strategy hinges on converging on the efforts of rather disparate teams at this institute working on energy harvesting, conversion and storage technologies. The new initiatives will fine-tune existing technologies and embark on emerging and novel system-level technologies for clean energy management.

Broad areas of interest are high-energy batteries, fuel cells, supercapacitors, hydrogen production and storage, solar energy (solar thermal and solar photovoltaics), and nanostructured materials as applied to these applications. Technology development will be grounded on our strengths in the fundamental aspects of electrochemical charge-transfer processes; thermal, photovoltaic, solid-state diffusion and electrical properties; and heat and mass transport phenomena. The idea is to coordinate a fusion of expertise in electrochemical science and technology with those in nano and surface sciences, instrumentation, computation, and system analysis and modeling.

Over the decades, CECRI scientists have showcased critical battery technologies for everyday applications, including for railway signaling, sonobuoys, and uninterrupted power supplies. However, today the emphasis is on high-energy lithium-based systems, zinc-bromine flow batteries, and looking beyond to futuristic systems such as sodium- and magnesium-based batteries, all-organic and air-depolarized batteries. One of the goals of the battery program is a high-energy traction battery. This application also requires high-power devices (for acceleration and hill climbing) such as supercapacitors, which is again another area that CECRI is engaged in. Fuel cell research at CECRI has for the first time led to a polymer electrolyte membrane fuel cell prototype that has been licensed. A related activity is electrochemical hydrogen production and storage. Nickel-metal hydride batteries based on hydrogen storage alloys is yet another notable activity. Pressurized hydrogen production modules have also been developed. A new development is to use solar energy for electrolytic production of hydrogen. CECRI also is engaged in developing solar thermal and photovoltaic materials and devices. Organic and dye-sensitized solar cells are another major activity pursued by CECRI scientists. The above programs are enabling activities for expanding renewable energy sources with minimal carbon footprints.

The burden of fuel import and the associated geopolitics call for a paradigm shift in the way we generate and use energy. The imperative of tapping into renewable forms of energy such as solar energy needs no emphasis. Fortunately, India is geographically well located to harvest solar energy. Unfortunately, however, the Indian electricity market poses unique challenges to energy planners because the country is littered with about 6,40,000 villages that are even today unconnected from the main grid. This calls for a special mix of grid connectivity and stand-alone energy generating stations based on the wind and the sun. In tune with the June 30, 2008 announcement by Prime minister Dr. Manmohan Singh of a National Plan for Climate Change that envisages a National Solar Mission, the new centre is poised to mission-mode its activities for clean, efficient and inexpensive technologies for energy harvesting and storage.

Given the increasingly stringent demands being placed on devices such as batteries that must support an ever-burgeoning array of applications, it is obvious that mere incremental progress in existing technologies will not pay. Thus, any breakthrough must rely on new materials and concepts. The new research centre is expected to push the limits of clean energy technologies and encourage the materials community at CECRI to work in tandem under a single canopy. Towards this end, out-of-the-box multi-disciplinary activities, such as the following, across a wide spectrum of materials and components will be undertaken for next-generation energy technologies:



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- * High-energy lithium-ion batteries
- * Supercapacitors
- * Emerging lithium systems based on silicon, sulfur and oxygen as active materials
- * Polymer electrolyte membrane fuel cells
- * Solar concentrators
- * Photo-voltaic assemblies
- * Water electrolyzers
- * Organic and dye-sensitized solar cells
- * Nano architectures for improved energy conversion/storage
- * Biogenic active materials for batteries, fuel cell catalysts and solar cells





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