वार्षिक प्रतिवेदन
2009-2010
ANNUAL REPORT

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

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Karaikudi 630 006, Tamil Nadu, India.

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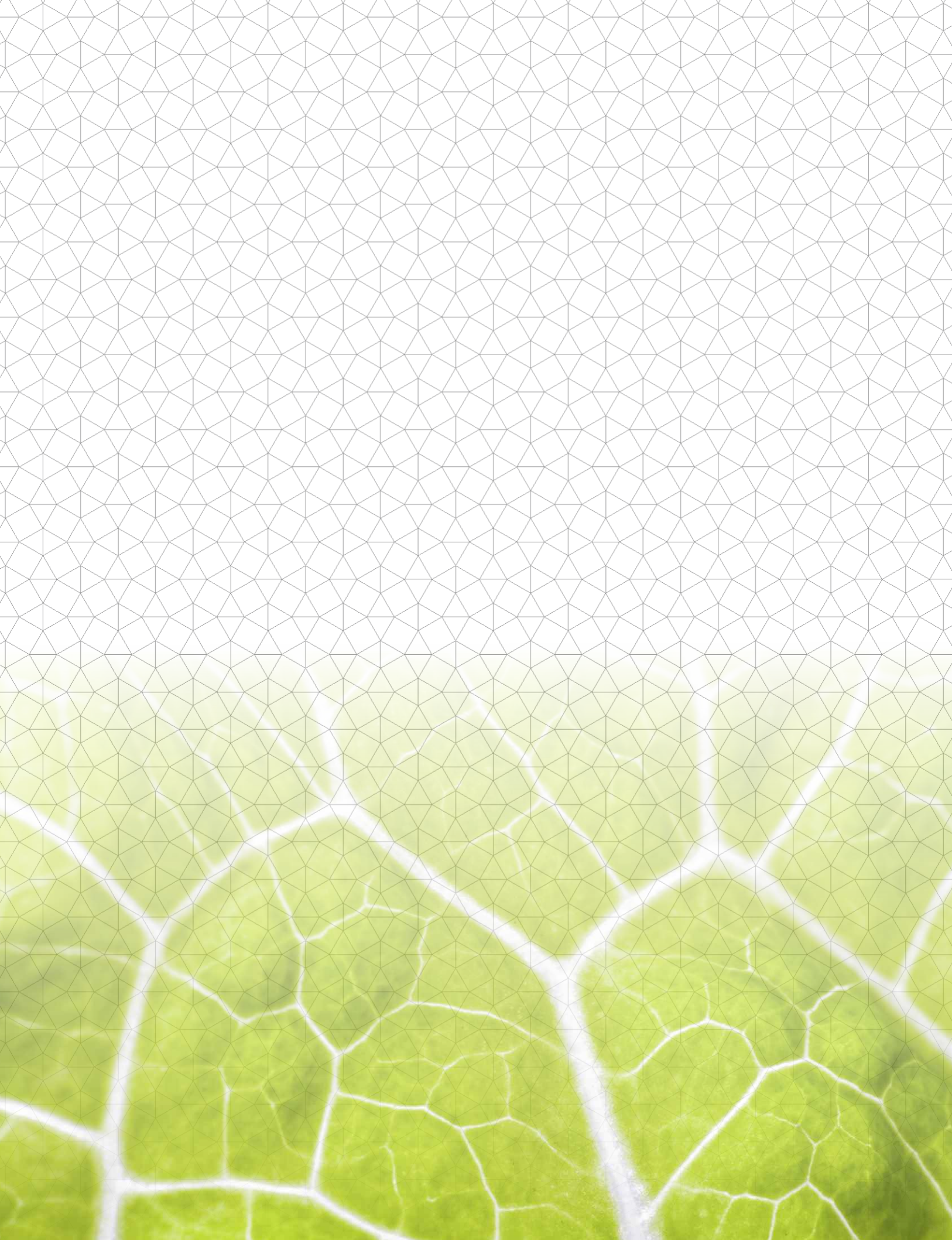
Preamble



निदेशक की ओर से

केंद्रीय विद्युतरसायन अनुसंधान संस्थान के वर्ष 2009–2010 के वार्षिक प्रतिवेदन को प्रस्तुत करते हुए मुझे अत्यंत हर्ष का अनुभव हो रहा है । संस्थान की गतिविधियों को संकलित करने की यह प्रक्रिया हमें उपलब्धियों को प्रस्तुत करने के साथ–साथ स्वयं की समीक्षा करने का अवसर भी प्रदान करती है । यह सभी पूर्वाधिकारियों की मेहनत एवं उनके अथक प्रयासों को याद करने का अवसर भी है जिनके कारण आज सीईसीआरआई विद्युतरसायन के क्षेत्र में दुनिया के सबसे बड़े अनुसंधान संस्थानों में अग्रणी बन पाया है।

गत वर्षों मैं सीईसीआरआई–भारतीय विद्युतरसायन उद्योग में बहुमुखी प्रौद्योगिकियों के अवतरण मंच के रूप में उभरा है । वर्ष 2009–10 के दौरान सीईसीआरआई के वैज्ञानिकों ने कुल 1 पेटंट फाइल किया है तथा औसत 2 के प्रभाव वाली पत्रिकाओं में 194 वैज्ञानिक एवं तकनीकी लेखों का योगदान दिया है । उन्होंने सरकारी, सार्वजनिक एवं निजी संगठनों के लिए तकनीक हस्तांतरण तथा संविदात्मक अनुसंधान एवं विकास, अनुदान प्राप्त परियोजनाएँ, परामर्शी तथा तकनीकी सेवाएँ आदि के माध्यम से बाह्य स्रोतों से रु. 37055480/– की निधि अर्जित की है । इस वर्ष के दौरान कुल 17 प्रायोजित परियोजनाएँ, 10 परामर्शी परियोजनाएँ तथा 7 तकनीकी सेवाओं पर कार्य किया गया ।

इ वर्ष के दौरान विकसित प्रौद्योगिकियों में हाइड्रोजन के निर्माण हेतु इलैक्ट्रॉड का विद्युतरसायन सक्रियन तथा मेम्बरेन इलैक्ट्रोलाइज़र के माध्यम से अनुवर्ती ब्रोमाइड से टेट्राअल्काइल अमोनियम हाइड्रॉक्साइड़ के उत्पादन के लिए विद्युतअपघटनी प्रक्रिया शामिल हैं । उद्योगों को 6 प्रौद्योगिकियों के लाइसेंस प्रदान किए गए। केंद्रीय उपकरण सुविधा में स्वस्थाने अध्ययन की सुविधा वाले एक एक्स–रे विवर्तन मापी, एक स्कैनिंग विद्युतरसायन सूक्ष्मदर्शी तथा नैनोस्तरीय विश्लेषक को शामिल किया गया है । सीईसीआरआई की केंद्रीय उपकरण सुविधाएँ केवल संस्थान ही नहीं अपितु देश के इस अंचल में स्थित अन्य शिक्षा संस्थानों तथा उद्योगों की विश्लेषण एवं मापन कार्यों र्सम्बंधी आवश्यक्ताओं को भी पूरा करती हैं । लगभग 20 करोड़ रुपए की लागत से स्थापित इन अत्याधुनिक उपकरण सुविधाओं के अंतर्गत स्पेक्ट्रोस्कोपी, सूक्ष्मदर्शिकी, पृष्ठीय विश्लेषण, ऊष्मीय विश्लेष्ण, तात्विक विश्लेषण, एक्स–रे विवर्तन, क्रोमैटोग्रैफी, विद्युरसायन प्रतिबाधा तथा विद्युतविश्लेषण आदि सेवाएँ महत्वपूर्ण हैं । कम्प्यूटर तथा नेटवर्किंग की टीम द्वारा ऑनलाइन क्रय माँगपत्र, टेलीफोन की मरम्मत के लिए ऑनलाइन शिकायत दर्ज करने, बैंक क्रेडिट आदि के लिए सॉफ्टवेयर विकसित किए गए ।

इस वर्ष के दौरान कई महत्वपूर्ण क्षेत्रों में सतत अनुसंधान एवं विकास कार्य किए गए । इनमें विशेष रूप से 11वीं पंच वर्षीय योजना के अंतर्गत हाइड्रोजन–आधारित ईंधन सेल तथा अत्याधुनिक लिथियम बैटरी और स्थायी प्रयोग हेतु पीईएफसी समूह आदि सम्बंधी परियोजनाएँ प्रमुख हैं ।

गत वर्ष के दौरान संस्थान द्वारा कुल 14 उद्योगोन्मुखी प्रौद्योगिकी पाठ्यक्रम चलाए गए जिनसे उद्योग जगत के 165 प्रतिभागी लाभान्वित हुए । मानव संसाधन एवं विकास कार्यक्रम के अंतर्गत सीईसीआरआई द्वारा अन्ना विश्वविद्यालय के बी.टेक (रसायन और विद्युतरसायन अभियांत्रिकी) पाठ्यक्रम भी चलाए जाते हैं । यह संस्थान शोधकर्ताओं के लिए पुस्तकालय और विश्लेषणातमक तथा मापन सुविधाएँ भी उपलब्ध कराता है । सीईसीआरआई द्वारा उक्त वर्ष के दौरान विज्ञान के प्रचार– प्रसार हेतु कई राष्ट्रीय तथा अंतर्राष्ट्रीय सम्मेलन आयोजित किए गए हैं । यह संस्थान उद्यमी विकास और सीएसआईआर युवा विकास कार्यक्रमों के माध्यम से अपने सामाजिक दायित्वों को भी पूरा कर रहा है ।

उक्त अवधि के दौरान हमारे कई वैज्ञानिकों को प्रतिष्ठित संस्थाओं से सम्मान प्राप्त हैं । मैं उन्हें बधाई देता हूँ तथा आशा करता हूँ कि यह सम्मान उन्हें तथा अन्य सभी को और नई ऊँचाइयों को पाने के लिए प्रोत्साहित करेंगे। कई विदेशी वैज्ञानिकों ने सीईसीआरआई का दौरा करते हुए व्याख्यान भी प्रस्तुत किए और अनुसंधान के लक्ष्यों के विस्तार पर भी चर्चा की ।

मैं अपने सहकर्मियों के प्रति आभार व्यक्त करना चाहूँगा, जिनका समर्थन एवं सहयोग हमें और आगे बढ़ने की शक्ति प्रदान करता है । इस अवसर पर मैं, सीएसआईआर मुख्यालय, अनुसंधान परिषद के सदस्य तथा प्रबंधन समिति के सदस्यों के प्रति उनके द्वारा दिए गए सहयोग के लिए आभार व्यक्त करना चाहूँगा । इस प्रतिवेदन को नया रूप प्रदान करने हेतु किए गए प्रयासों के लिए मैं संपादन समिति के प्रति आभार व्यक्त करता हूँ ।

वी. यज्ञरामन

(डॉ. वी यज्ञरामन)

From the Director's desk

It gives me great pleasure to present the 2009-2010 Annual Report of CECRI. This annual exercise of compiling the institute's activities presents an opportunity to project as well as assess ourselves. It is also an occasion to recall the untiring efforts of my predecessors in positioning CECRI as one of largest research establishments for electrochemistry in the world.

Over the years, CECRI has blossomed into a launching pad for a multitude of technologies for the Indian electrochemical industry. During 2009-10, CECRI scientists filed one patent and applied for another. As for publications, 194 scientific and technical papers were published in journals, with an average impact factor of 2. They also generated an external cash flow of ₹3,70,55,480 through technology transfer, contract R&D, grant-in-aid projects, consultancy and technical services carried out for government, public and private sector organizations. A total of 17 sponsored projects, 10 consultancy projects and 7 technical services were taken up during this year. Electrochemical activation of electrodes for hydrogen generation and electrolytic processes for the production of tetraalkyl ammonium hydroxides from the corresponding bromides by membrane electrolyzer were among technologies developed during this period. Six technologies were licensed to industries.

An X-ray diffractometer with provision for in situ studies, a scanning electrochemical microscope and a nanoscale particle analyzer were added to the central instrumentation facility. The facility continues to cater to demands for analytical and characterization services not only from the institute but also from educational institutions and industrial units in this part of the country. The facility lays emphasis on areas such as spectroscopy, microscopy, surface analysis, thermal analysis, elemental analysis, X-ray diffraction, chromatography, electrochemical impedance, and electroanalysis. It houses state-of-the-art equipment worth about ₹20 crore. The computer and networking team developed software for on-line purchase indenting, on-line registration of complaints for telephone faults, and for bank credit.

This year witnessed continued R&D activities several cutting-edge areas, particularly through eleventh five year plan projects concerning hydrogen-based fuel cells, next-generation materials for lithium-ion batteries and PEFC stacks for stationary applications.

During the year under review, the institute conducted 14 industry-oriented technology courses benefiting 165 participants mostly drawn from industrial houses. As part of its human resource development agenda, CECRI runs Anna University's BTech (Chemical & Electrochemical Engineering) program. The institute also makes available its library and analytical & characterization facilities to the research community at large. During the period under report, CECRI organized several national and international conferences for the dissemination of scientific knowledge. Activities such as entrepreneur development and CSIR's youth development program fulfil the societal obligations.

During the period under report, several of our scientists received awards/recognitions from prestigious societies. I heartily congratulate them and hope that the approbation would inspire them and others to scale greater heights. We also had a spate of visits by foreign scientists, who delivered lectures and deliberated with our scientists in furthering research goals.

I would like to acknowledge the contributions of all my fellow staff members, whose support and cooperation propel us to look beyond. I also take this opportunity to acknowledge the support received from CSIR headquarters, members of our Research Council and Management Council. My special thanks are due to the publication committee for the pains they took to bring out this report in a new format.

(V. Yegnaraman)

संकल्पना & मिशन /Vision & Mission

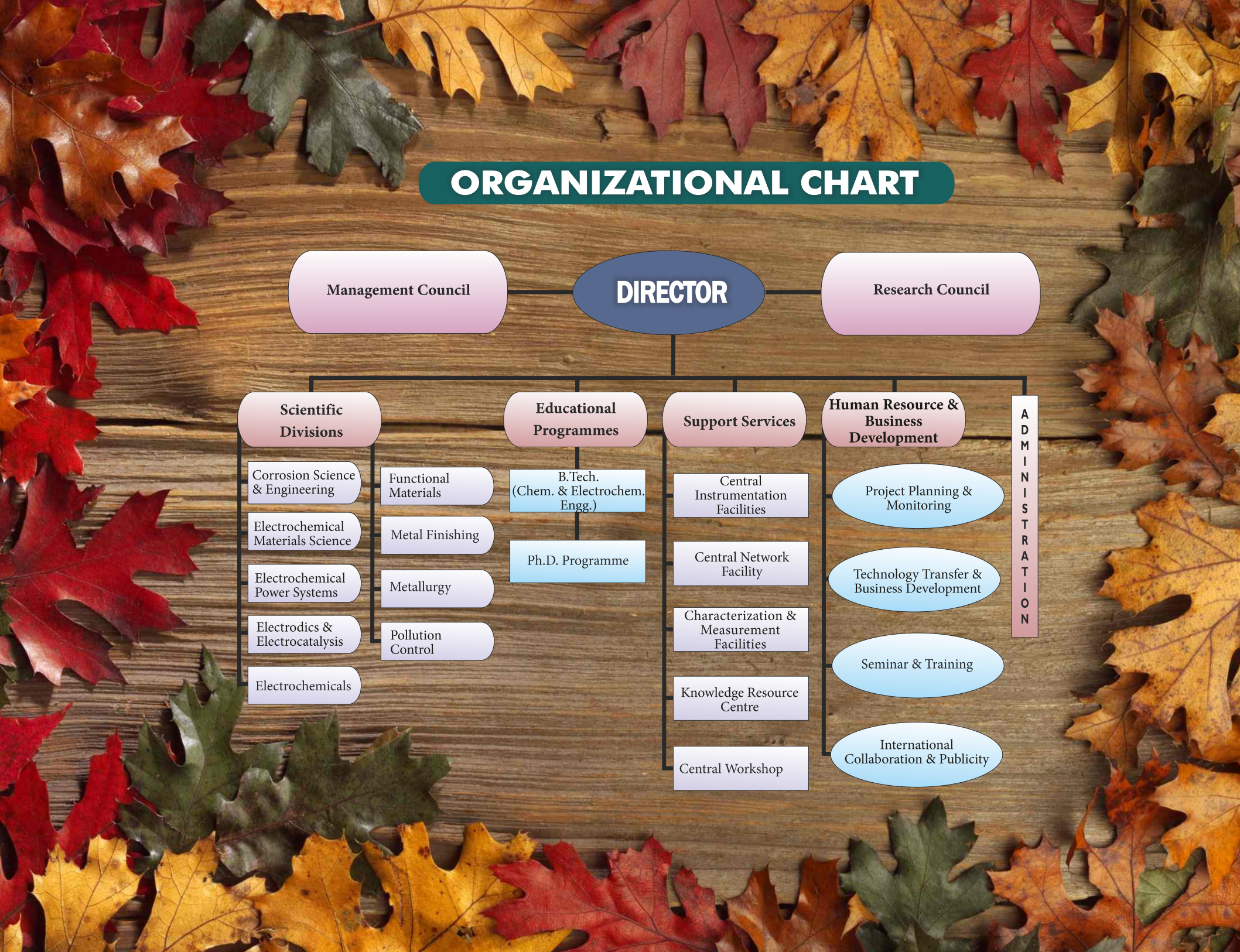
संकल्पना / Vision

संक्षारण विज्ञान एवं अभियांत्रिकी, ऊर्जा रूपांतरण एवं संचयन, प्रकार्यात्मक पदार्थ तथा पर्यावरण को समर्पित और सतत प्रयासों के द्वारा विद्युतरसायन विज्ञान और प्रौद्योगिकी के क्षेत्र में एक वैश्विक अनुसंधान एवं विकास केंद्र के रूप में सक्रिय रहना । To be a global R&D center for electrochemical science and technology through sustained and dedicated efforts focusing on corrosion science and engineering, energy conversion and storage, functional materials and environment.

थ्मशन / Mission

विद्युतरसायन विज्ञान एवं अभियांत्रकी के सभी पहलुओं में अग्रणी होना तथा ऊर्जा, पर्यावरण,स्वास्थ्य तथा पदार्थ संरक्षण में विश्व स्तरीय प्रतिस्पर्धात्मक और पर्यावरण–अनुकूल प्रैद्योगिकियों का विकास करना ।To excel in all aspects of electrochemical science and engineering, and to develop globally competitive and eco-friendly technologies in energy, environment, health and materials conservation.

ORGANIZATIONAL CHART



सीएसआईआर –सीईसीआरआई

केंद्रीय विद्युतरसायन अनुसंधान संस्थान (सीईसीआरआई) की स्थापना वर्ष 1948 में हुई । इसकी संकल्पना डॉ. आर एम अलगप्पा चेट्टियार तथा पंडित जवहरलाल नेहरू एवं डॉ. शांति स्वरूप भटनागर की राष्ट्रभक्ति एवं राष्ट्र के विकास की भावना की परिचायक है । डॉ. एस. राधाकृष्णन ने 14 जनवरी 1953 को सीएसआईआर की इस 12वीं राष्ट्रीय प्रयोगशाला को राष्ट्र को समर्पित कर इस संकल्पना को साकार किया । आज सीईसीआरआई 500 कर्मचारियों का एक गौरवमयी परिवार है, जिनमें 150 वैज्ञानिक हैं । कारैकुडी में स्थित यह संस्थान दक्षिण एशिया में विद्युतरसायन पर अनुसंधान हेतु स्थापित सबसे बड़े अनुसंधान केंद्र का प्रतिनिधित्व करता है । चेन्नै, मण्डपम तथा तूतीकोरिन में सीईसीआरआई के विस्तार केंद्र हैं । 10॰06 डिग्री अक्षांश तथा 78॰8 रेखांश में स्थित सीईसीआरआई, कारैकुडी मदुरै और तिरुची दोनों शहरों से लगभग 85 कि.मी. की दूरी पर है । सीईसीआरआई का वातावरण अनुसंधानात्मक कार्यों के लिए बिल्कुल अनुकूल है । सीईसीआरआई का परिसर अनोखे पक्षियों से पूर्ण और वातावरण काफ़ी हरा–भरा और शांत है ।

पंडित जवाहरलाल नेहरू ने संस्थान की आधारशिला की स्थापना के दौरान अपने अभिभाषण में कहा था कि मेरा यह विश्वास है कि ऐसी स्थापनाओं एवं विज्ञान को जनहित से जोड़ने से अधिकाधिक लोग प्रगति की ओर अग्रसर होंगे। उनके इन शब्दों को यथार्थ में बदलते हुए सीईसीआरआई – भारतीय विद्युतरसायन उद्योग में बहुमुखी प्रौद्योगिकियों के अवतरण मंच के रूप में उभरा है । ऐसे समय में जब विद्युतरसायन को विश्वविद्यालयों में भौतिक रसायन पाठ्यक्रम में दुसरे दर्जे पर रखा जाता था, यह डॉ.अलगप्पा चेट्टियार की लोक कल्याण की भावना एवं दूरदर्शिता ही थी, कि उन्होंने विशेष रुप से विद्युतरसायन के लिए समर्पित इस राष्ट्रीय प्रयोगशाला की स्थापना के लिए वर्ष 1948 में 300 एकड़ जमीन और 15 लाख रुपए की नकद राशि प्रदान की ।

अपनी स्थापना के उद्देश्य को पूरा करते हुए, यह संस्थान विद्युतरसायन विज्ञान एवं प्रौद्योगिकी के सभी पहलुओं, जैसे संक्षारण विज्ञान तथा अभियांत्रिकी, विद्युतरसायन पदार्थ विज्ञान, प्रकार्यात्मक पदार्थ तथा नैनोस्तरीय विद्युतरसायन, विद्युतरसायन ऊर्जा स्रोत, विद्युतरसासन प्रदूषण नियंत्रण, विद्युतरसायन, इलेक्ट्रॉडिक्स तथा इलेक्ट्रोकैटालाइसिस, विद्युत धातु–विज्ञान, औद्योगिक धातु परिष्करण तथा कम्प्यूटर नेटवर्किंग से सम्बंधित क्षेत्रों में कार्यरत है । सभी प्रकार की सुविधाओं से सम्पन्न इस संस्थान में विद्युरसायन के सभी पहलुओं पर शोध कार्य किए जाते है । सीईसीआरआई के सभी अनुसंधान कार्य सदैव विद्युतरसायन विज्ञान तथा प्रौद्योगिकी के क्षेत्र में नए आधुनिक उत्पादों, नई प्रणालियों तथा नवीन पद्धतियों के विकास की ओर केंद्रित होते हैं । भारत में तथा विदेशों में स्थित अन्य प्रयोगशालाओं के सहयोग से सीईसीआरआई द्वारा कई परियोजनाओं पर कार्य किया जा रहा है ।

श्न्यू मिल्लेनियम इंडियन टेक्नॉलॉजी लीडरशिपश की पहल के अंतर्गत हाइड्रोजन आधारित ईंधन सेल पर अनुसंधान एवं विकास कार्य के लिए सीईसीआरआई को वर्ष 2004 के दौरान एक केंद्रक प्रयोगशाला के रूप में चुना गया । चूंकि, हाइड्रोजन को भविष्य के प्रमुख ईंधन के रूप में देखा जा रहा है, अतः इस प्रकार के अनुसंधान एवं विकास कार्य राष्ट्र के लिए अत्यंत हितकारी सिद्ध होंगे । दो वर्ष की कम अवधि में सीईसीआरआई ने धारणा को उत्पाद में बदलने की अपनी क्षमता को स्पष्टतः सिद्ध करते हुए पोर्टेबल ऊर्जा के अनुप्रयोग के लिए स्थायी बहुलक इलेक्ट्रोलाइट ईंधन सेल समूह विकसित किए हैं । सीईसीआरआई को इस उल्लेखनीय योगदान के आधार पर 11वीं पंच वर्षीय योजना के अंतर्गत हाइड्रोजन आधारित ईंधन सेल तथा अत्याधुनिक लिथियम बैटरी आदि महत्वपूर्ण व अत्याधुनिक अनुसंधान और विकास कार्य सौंपे गए हैं ।

सीईसीआरआई परामर्शीय परियोजनाओं तथा सर्वेक्षणों के माध्यम से भारतीय उद्योग जगत को अपना सहयोग प्रदान करता है । इसके अतिरिक्त यह संस्थान उद्योग तथा शिक्षा के हितार्थ में अल्पकालिक पुनश्चर्या पाठ्यक्रम भी आयोजित करता है । सीईसीआरआई द्वारा मानव संसाधन विकास कार्यक्रम के अंतर्गत अन्ना विश्वविद्यालय के रसायन और विद्युतरसायन अभियांत्रिकी पर आधारित बी.टेक और एम.टेक पाठ्यक्रम भी चलाए जाते हैं । संस्थान में शोधकर्ताओं के लिए उत्कृष्ट पुस्तकालय सुविधा तथा अत्याधुनिक एवं अभिनव विश्लेषणात्मक और विशिष्ट – सुविधाएं उपलब्ध हैं । सीईसीआरआई, विज्ञान के प्रचार–प्रसार हेतु राष्ट्रीय और अंतर्राष्ट्रीय सम्मेलनों का आयोजन भी करता है । यह संस्थान अपने सामाजिक दायित्वों के प्रति भी जागरूक है तथा इसके अंतर्गत उद्यमी विकास और सीएसआईआर युवा विकास कार्यक्रम आदि में भी सक्रिय है । भारतीय उद्योग के हित में उल्लेखनीय सेवा के लिए सीईसीआरआई ने कई प्रौद्योगिकी – सम्मान प्राप्त किए हैं ।

वास्तव में केंद्रीय विद्युतरसायन अनुसंधान संस्थान भारत में विद्युतरसायन उद्योग का एक प्रमुख आधार है ।

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, 150 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: Corrosion Science and Engineering, Electrochemical Materials Science, Functional Materials and Nanoscale Electrochemistry, Electrochemical Power Sources, Electrochemical Pollution Control, Electrochemicals, Electrodics and Electrocatalysis, Electrometallurgy, Industrial Metal Finishing, and Computer Networking and Instrumentation. The institute provides a single and unique canopy under which all aspects of electrochemistry and related areas are researched in their dimensions. CECRI's activities are directed towards development of new and improved products and processes as well as novel innovations in electrochemical science and technology. CECRI runs several projects in collaboration with laboratories from within and outside India.

In the year 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 a 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.

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

अनुसंधान प्रभाग

क्लोर– क्षारं

संक्षारण संरक्षण

संक्षारण परीक्षण

विद्युतरसायन पदार्थ विज्ञान

विद्युतरसायन ऊर्जा स्रोत

इलैक्ट्रोडिक्स् तथा इलैक्ट्रोकैटालाइसिस

विद्युतजल धातु विज्ञान

विद्युतलेपन धातु परिष्करण प्रौद्योगिकी

विद्युत - धातु विज्ञान

विद्युत अकार्बनिक

विद्युत कार्बनिक

प्रकार्यात्मक पदार्थ

औद्योगिक धातु परिष्करण

उपकरण

Research Divisions

Chlor-Alkali

Corrosion Protection

Corrosion Testing

Electrochemical Materials Science

Electrochemical Power Systems

Electrodics & Electrocatalysis

Electrohydrometallurgy

Electroplating Metal Finishing Technology

Electropyrometallurgy

Electro-inorganic Chemicals

Electro-organic Chemicals

Electrochemical Pollution Control

Functional Materials

Industrial Metal Finishing

Instrumentation

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Chairman

Professor MS Ananth
Director
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Dr V Yegnaraman
Director
Central Electrochemical Research Institute
Karaikudi 630 006

प्रबंधन समिति
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अध्यक्ष / Chairman

डॉ वी यज्ञरामन, निदेशक / Dr. V. Yegnaraman, Director

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3. डॉ.वी.अनंत, वैज्ञानिक स.IV(5)/Dr. V. Ananth, Scientist Gr.IV (5)
4. डॉ.जी.सोलन, वैज्ञानिक स. IV (5)/Dr. G. Sozhan, Scientist, Gr.IV (5)
5. डॉ.एस. वासुदेवन, वैज्ञानिक स. IV (3)/Dr. S. Vasudevan, Scientist Gr. IV (3)
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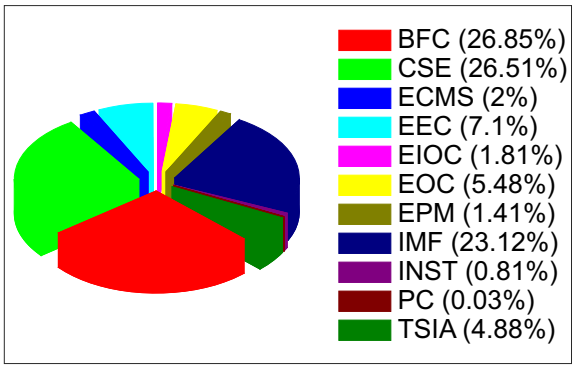
9. वित्त एवं लेखा अधिकारी / Finance and Accounts Officer
10. श्री मेन्युल थॉमस, प्रशासन नियंत्रक, सचिव / Shri Manuel Thomas, COA, Secretary

Financial performance indicators

EXTERNAL CASH FLOW (2009–2010)

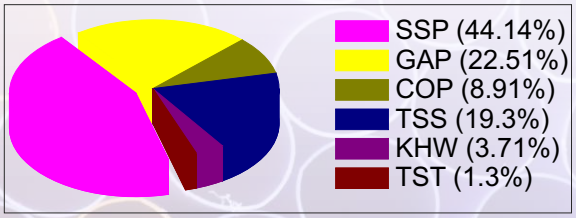
Corrosion Science & Engineering	₹ 9821588
Batteries & Fuel Cells	₹ 9950468
Electro-organic Chemicals	₹ 2029686
Electro-inorganic Chemicals	₹ 669529
Pollution Control	₹ 11030
Electro-Pyrometallurgy	₹ 522700
Instrumentation	₹ 300000
Titanium Substrate Insoluble Anode	₹ 1809936
Industrial Metal Finishing	₹ 8566390
Electrochemical Materials Science	₹ 742500
Electrodics & Electrocatalysis	₹2631653
Total	₹ 37055480



BFC - Batteries and Fuel Cells; CSE - Corrosion Science and Engineering; ECMS - Electrochemical Materials Science; EEC - Electrodics & Electrocatalysis; EIOC - Electro-Inorganic Chemicals; EOC - Electro-Organic Chemicals; EPM - Electro-Pyrometllurgy; IMF - Industrial Metal Finishing; Inst - Instrumentation; PC - Pollution Control; TSIA - Titanium Substrate Insoluble Anode

EXTERNAL CASH FLOW: PROJECT CATEGORY-WISE

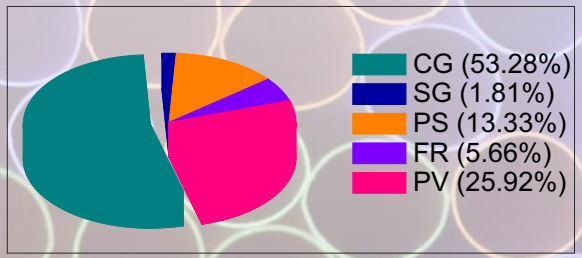
Sponsored Project	₹ 14140130
Grant-in-Aid Project	₹ 7209630
Consultancy Project	₹ 2854217
Technical Sevices	₹ 6181473
Know-How	₹ 1187844
Testing	₹ 457978



SSP - Sponsored Project; GAP - Grant-in-Aid Project; COP - Consultancy Project; TSS - Technical Services; KHW - Know-How; TST - Testing

SECTOR-WISE

Central Government	₹ 20851401
State Government	₹ 707575
Public Sector	₹ 5217410
Foreign	₹ 2214860
Private Sector	₹ 10144184

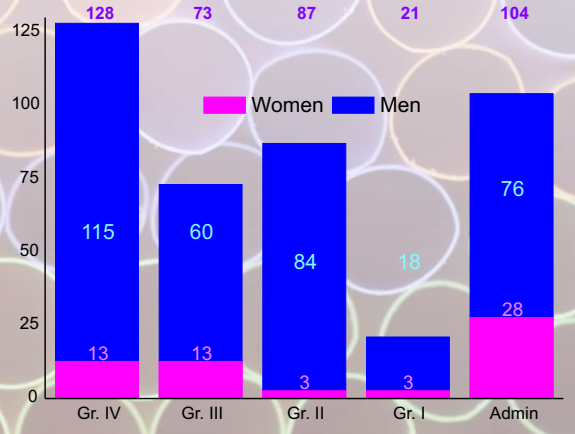


CG - Central Government; SG - State Government; PS - Public Sector; FR - Foreign; PV - Private Sector

Human resource indicators

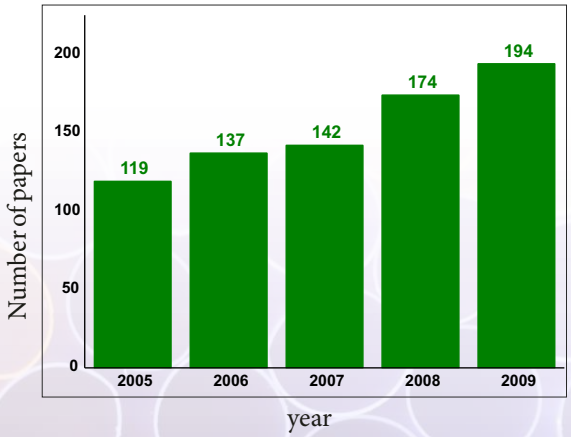
(as on 31.03.2010)

	Sanctioned	Men	Women	Total	Vacant
Gr. IV	180	115	13	128	52
Gr. III	110	60	13	73	37
Gr. II	130	84	3	87	43
Gr. I	40	18	3	21	19
Admin	135	76	28	104	31



Publication indicators

Year	No. of papers
2005	119
2006	137
2007	142
2008	174
2009	194



CSIR-CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE

Karaikudi 630006, Tamil Nadu, India

Founded in 1948, CECRI is one of the largest electrochemical laboratories in the world, carrying out R&D work in all branches of electrochemistry and allied fields viz. Chlor-Alkali, Corrosion, Electrochemical Materials Science, Electrochemical Power Sources, Electrodics & Electrocatalysis, Electrohydro Metallurgy, Electroplating Metal Finishing Technology, Electropyro Metallurgy, Electro Inorganic, Electro Organic, Functional Materials, Industrial Metal Finishing and Instrumentation. The Institute has an excellent library, computer centre, workshop and characterization & measurement laboratory. CECRI has three extension centres: at Thoothukkudi, Mandapam and Chennai.

CECRI undertakes

- sponsored and collaborative research projects
- feasibility studies
- analysis and testing of electrodeposits, coatings and batteries
- consultancy services (such as troubleshooting, modernization, scaling up etc.)

CECRI extends facilities

(Fee based)

- Providing S&T information
- Sample analysis using sophisticated instruments (XRD, SEM, TEM, TGA-DTA, NMR, FT Raman, FTIR, HPLC, SPM, AAS, EPR etc.)
- Dissertation work for MSc, MPhil, BE, BTech, ME, MTech
- Conducting refresher courses in different disciplines of electrochemistry for the benefit of industries and academic institutions.
- BTech programme in Chemical and Electrochemical Engineering.

For further details, please contact:

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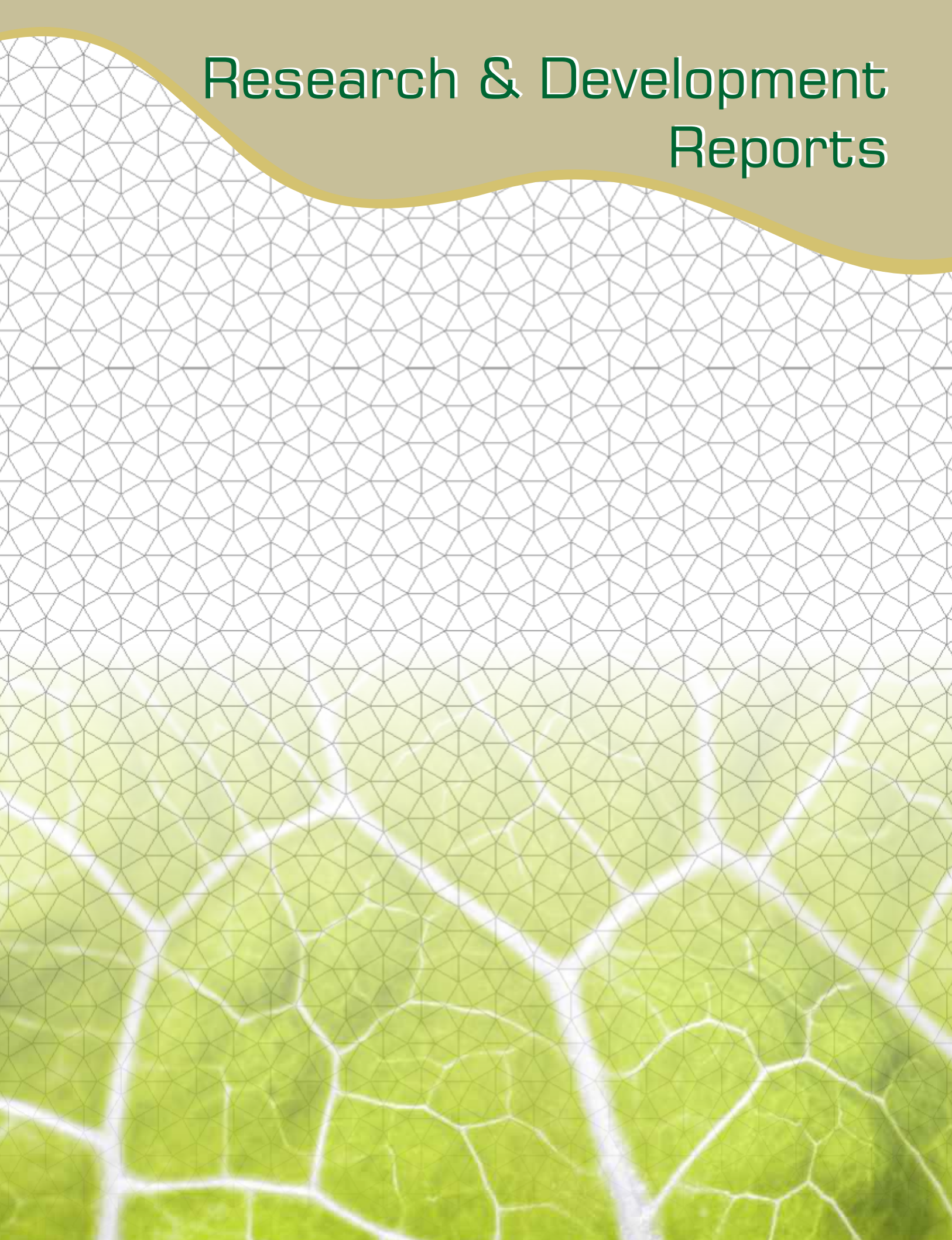
Research & Development Reports



SIP-18

Energy for cleaner and greener environment

(A supra-institutional project under the XI Five Year Plan)

Principal Investigator (CECRI): Dr. P. Sridhar
Sponsor: Council of Scientific and Industrial Research
Budget: ₹1400 lakh
Duration: 5 years (2007–2012)

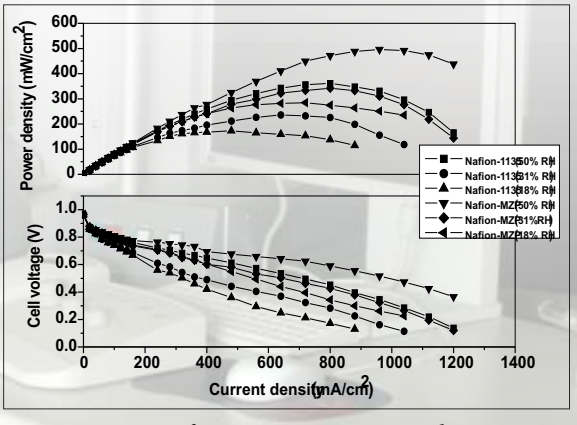
Polymer electrolyte fuel cells

A 1-kW PEFC stack operating on pure H_2 and air was designed and operated continuously. The required control and monitoring system was specifically developed to take care of the start up, continuous operation and safety of the system.

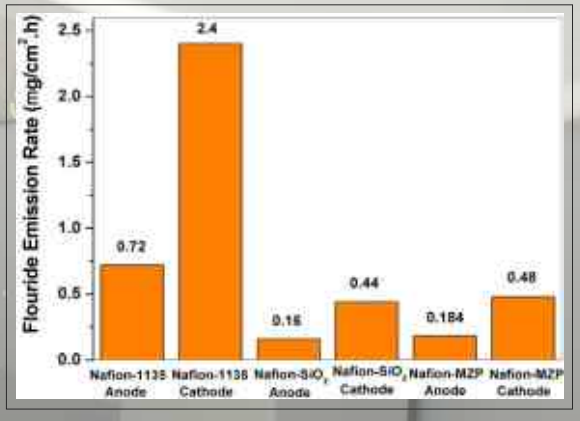
Functionally superior electrocatalysts and modified Nafion membranes were developed and demonstrated for enhanced performance of the PEFC, typical examples being Pt-RuO_2, Pt-TiO_2 and Pt-Au combinations by new preparative procedures, and Nafion-SiO_2, Nafion-MZP composite PEMs for low-humidity operation (18%) and high-temperature operations.

Alternative catalyst supports for high durability were developed and enhancement of PEFC performance was demonstrated. These include PEDOT-PSSA as support for Pt, MWNT-PEDOT-PSSA support for Pt and surface pre-treated MWNT for Pt. Use of metallic

1-kW *self-sustained PEFC stack.*



H_2/air performance at various RH values.



Fluoride-ion emission rates for Nafion, Nafion-SiO_2 and Nafion-MZP composite membranes after durability tests.

bipolar plate in place of graphite bipolar plate to reduce the weight of the PEFC stack was also demonstrated.

Direct methanol fuel cells

A 40-W self-supported DMFC system was developed. A control monitoring system was designed for recirculation of fuel feed at a desired dilution for effective functioning of the system as a stand-alone unit. To enhance its performance, functionally superior methanol electrocatalysts and impermeable PEMs were developed and evaluated as effective replacements in a real device configuration.

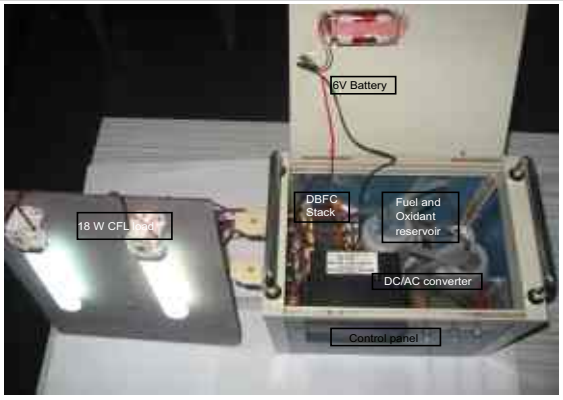
Methanol-tolerant electrocatalysts developed for enhanced performance of the DMFC are as follows: Pt-TiO_2, Pt-Pd and Pt-Au. Besides, conducting polymer support, namely, PEDOT-PSSA as an alternative support to carbon was demonstrated for the first time in the active mode of DMFC configuration with enhanced performance, mitigating corrosion associated with use of carbon support. A series of novel polymer electrolyte membrane with reduced methanol permeability was developed through new chemical processing, leading to the following combinations : organic-inorganic composite membrane (Nafion-MZP), mixed matrix membranes from natural polymers such as chitosan, bio-polymeric membrane from sodium alginate, and bridged mixed matrix membranes from synthetic polymers such as PVA. These were formulated through new material chemistry route and demonstrated as stable membrane electrode assemblies followed by subsequent demonstration in DMFC configuration with enhanced performance through reduced methanol permeability.

A direct borohydride-hydrogen peroxide fuel cell system

A self-supported 40-W DBFC with internal manifolds and a modified auxiliary control was designed. A critical cause and effect analysis for single cells and stacks was completed to prescribe optimum concentration of fuel and oxidant depending upon the operation time.

A customized PVA hydrogel membrane electrolyte was developed for enhanced utilization of fuel. Besides, estimation procedures for reaction products on the operation of the DBFC stack was standardized and calibrated. A manual for user was also made. With an eye on business promotion, DBFC systems were assembled and provided to a client. The performance of the DBFC was modeled using a mathematical software package. Simulated polarization curves showed qualitative behavior similar to the experimentally obtained data.

40-W DMFC system



Self-supported DBFC system

IAP-04

Development of lithium-ion batteries for multifarious applications

(An inter-agency project under the XI Five Year Plan)

Nodal Officer: Dr. T. Prem Kumar
Partners: CSIR-CECRI & Indocel Technologies Pvt. Ltd.
Sponsor: Council of Scientific and Industrial Research
Budget: ₹ 900 lakh
Duration: 5 years (2007–2012)

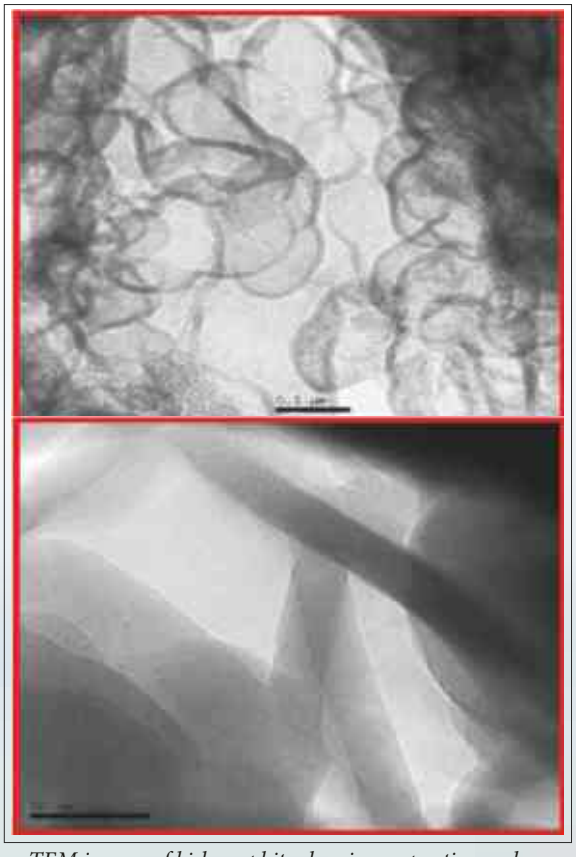
(1) Introduction of a new class of high-capacity, long-cycling anode materials based on kish graphites

The 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. LiV/Li, which means that devices based on these materials should deliver constant voltages from beginning to end of use.

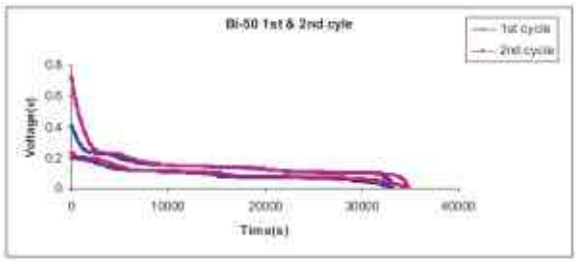
SEM image of kish graphite showing characteristic flaky morphology.

(2) Green routes to nanoscopic intermetallic anodes

A simple, convenient and eco-friendly biological route



TEM images of kish graphite showing serpentine carbon nanostructures.



Flat charge-discharge profiles of lithium-kish graphite coin cells. The flat profiles should translate into a device with a steady voltage from beginning to end of use.

to the preparation of nanometric intermetallic phases useful as lithium-insertion anode materials. Thus far, metals such as silver, lead, cobalt and nickel have been produced.

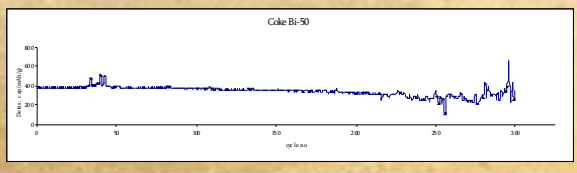
(a) Approach #1. With nitrate reducing bacteria as well as with enzyme extracts.

(b) Approach #2. With leaf extracts of plants such as tulsi and neem.

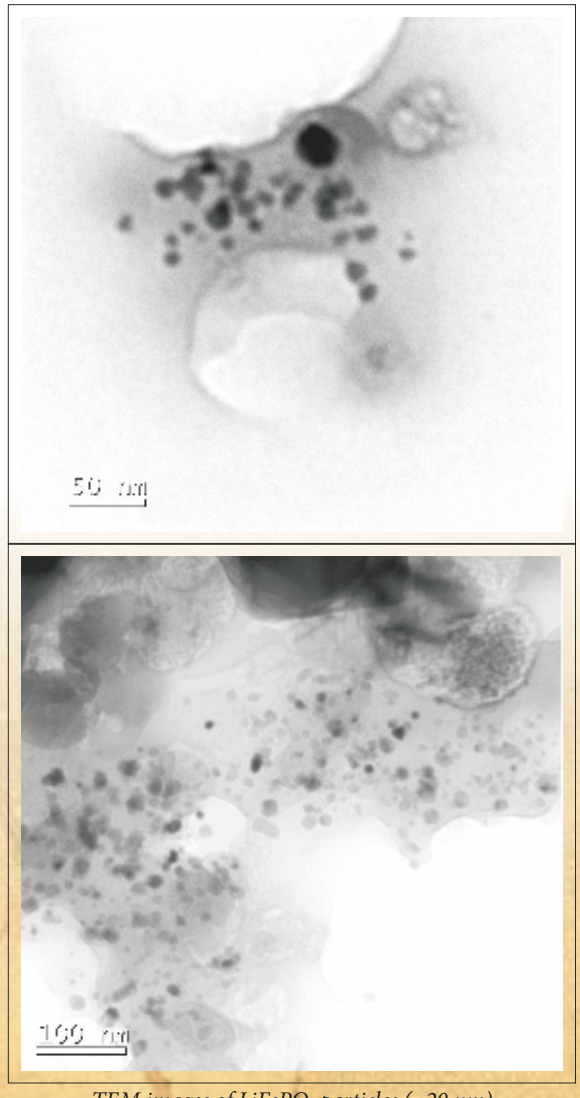
Reversible capacities of more than 230 mAh/g (C/10; 1.5000 - 0.005V) have been realized with the silver nanoparticulate products. The leaf extract route is less cumbersome and allows easy purification.

(3) Kish graphite-coated $LiFePO_4$ cathode

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 400 cycles so far. The novelty of the material is a network of conducting kish graphite that provides particle-to-particle electronic conductivity, enhancing performance.



Cycling behavior of a typical kish graphitic product (C/10 rate; 0.005 - 3.000 V).



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

FAC-06

CSIR Battery performance evaluation center

(A facility creation project under the XI Five Year Plan)

Principal Investigator: Mr. S. Ambalavanan

Sponsor: Council of Scientific and Industrial Research
Budget: ₹500 lakh
Duration: 5 years (2007–2012)

The following facilities have been created during this period

A. Computer-controlled vibration tester producing 1000 kgf peak sine force

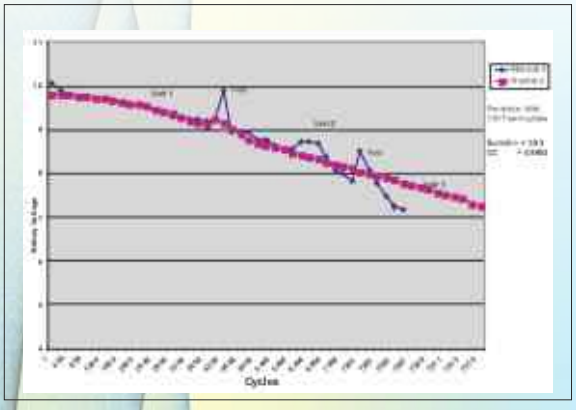
Evaluation Under Progress

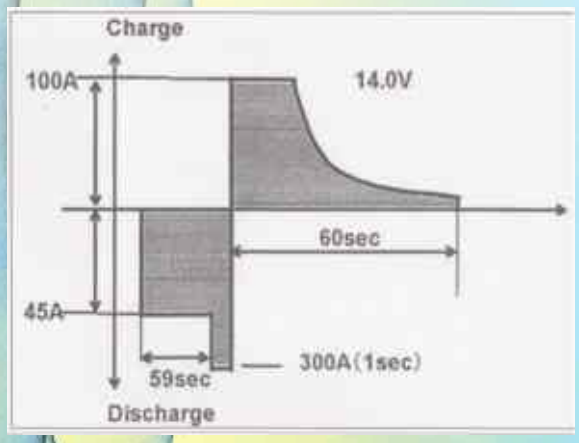
Sl.No.	Name of the Organization	Type of cell/Battery	Cell/Battery Specification	Specification followed	Cost of testing (lakhs)
1.	M/s Exide Industries, Kolkata	Flooded	2V/1285Ah 2V/2250Ah	IEEE535-1986	11.60525
2.	---do---	---do---	2V/1285Ah 2V/2250Ah	IEC896-1	4.38315
3.	M/s. Mysore Thermoelectric(p) Ltd, Bangalore	---do---	2V/80Ah 2V/200Ah	IRS S88/2004 with IS:1651	4.37100
4.	M/s.Amararaja Batteries, Tirupathi.	---do---	12V/43Ah	SAB 0101	2.10000
5.	M/s.Luminous Teleinfra Ltd, Hariyana	VRLA Cells	2V/300Ah 2V/400Ah 2V/600Ah	GR/BAT-01/03 Mar2004	10.83750

❖M/s. Bitrode corporation, USA has trained one of our scientists at their cost.

The equipment is used for testing of batteries under vibration. Suitable for automotive application.

B. Microcontroller based programmable environmental chamber





Batteries can be tested from –500C to +1400C, RH 95%.

C. Computer-controlled life cycle tester

(1) 100V / 400A (2) 400V / 100A (3) 12V / 7000A

Suitable for testing EV batteries and battery backup used in mobile towers and stationary applications.

D. Flammability tester

To investigate burning properties of non-metallic materials of the case/cover.

E. Spark test with a venting system IEC-61430

To evaluate the adequacy of protective features of the valve in VRLAB and associated flame barriers against ignition of gases within cells by an external spark source.

F. Life test [starts and stops using neural network]

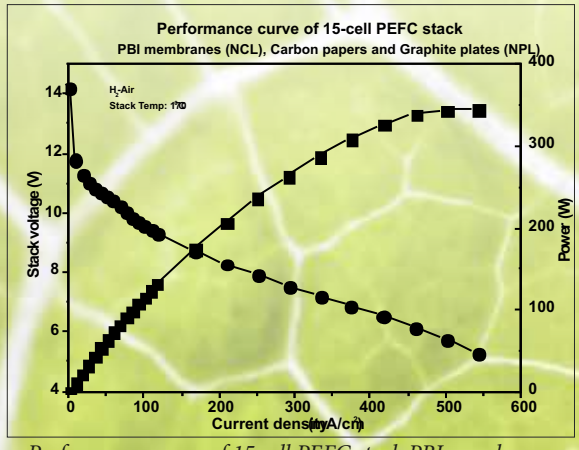
TLP-02/08

Development and demonstration of PEFC stacks for stationary application

(A project under CSIR's New Millennium Indian Technology Leadership Initiative with NCL, Pune; NPL, New Delhi; and RIL, Mumbai)

Principal Investigator: Dr. S. Pitchumani
Sponsor: Council of Scientific and Industrial Research
Budget: ₹640 lakh
Duration: 3 years (2008–2010)

Using a carbon paper of NPL and a PBI membrane of NCL, different combinations for single cells of PEFCs were first screened and performance levels benchmarked. The bipolar plate and carbon paper of NPL were found to be close to benchmarked performance. PBI membrane was investigated as a component of PEFC single cells and multi-cell stacks, and compared with branded PBI-based MEA. Based on these data a 15-cell PEFC stack with all in-house components was assembled and evaluated. A power output of 350 W on operation with H_2 and air at 170C was accomplished. A representative performance curve is shown here. This stack was demonstrated for lighting a set of bulbs at FUECETECH 2009 held at Mumbai. A dedicated proton conductivity measurement protocol for PBI membrane at 170 - 190°C was designed. Moreover, an experimental set up for through-plane resistivity measurements for bipolar plates was created. Bulk samples received from NPL and NCL were evaluated for corrective measures in their respective formulations at NPL and NCL. Single cell assembly with reduced Pt loading amenable for operation with CO-containing H_2 was optimized with electrode areas of 525 cm^2. MEA processing step using decal transfer process, initially standardized at NCL, was upscaled without sacrificing performance to 25 cm^2 at CECRI. Experimental protocols for corrosion studies of carbon paper and bipolar graphite plates developed in this program have been standardized and calibrated at CECRI.



Performance curve of 15 cell PEFC stack PBI membrane, carbon papers and graphite plates.

Demonstration of PEFC stack using components developed by CSIR.

NWP-10

Development of specialty inorganic materials for diverse applications

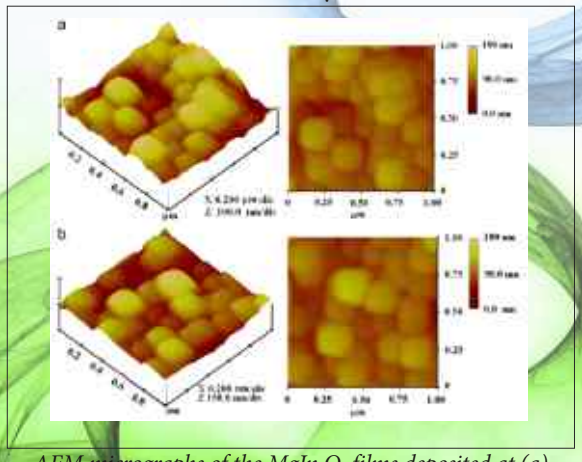
Nodal Officer from CECRI: Dr. M. Jayachandran
Category : CSIR Network Project
Nodal Laboratory: CSMCRI, Bhavanagar

Crystalline $MgIn_2O_4$ films: Chemically stable and highly crystalline $MgIn_2O_4$ films have been prepared using spray pyrolysis deposition technique on quartz substrates. The XRD studies revealed the cubic structure with a lattice constant of 8.884 A˚ which is very close to the standard value. The infrared spectrum is reasonably transparent and no absorption bands arising from free carrier absorption or reflection are seen. The atomic ratio of magnesium and indium in the film is 0.46 which is nearly the same as present in the precursor (Mg/In = 0.5).

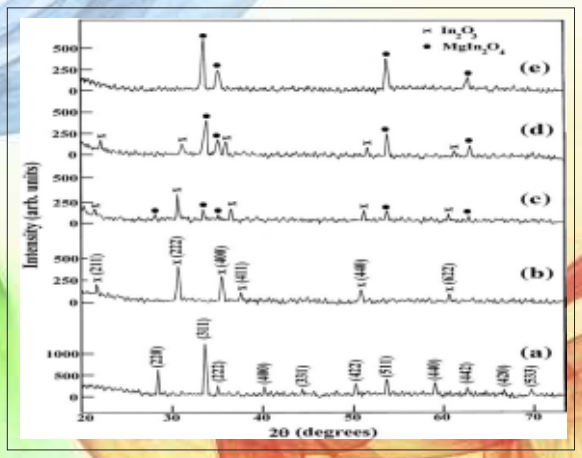
The temperature-dependent electrical conductivity exhibited three regions with different activation energies in the range of 30-150°C. The very low electrical conductivity (10^{-5} to 10^{-4} S cm^{-1}) is mainly due to the polaron type conduction which drastically decreased the carrier mobility value. Stoichiometric $MgIn_2O_4$ film shows an absorption edge at 310 nm corresponding to an optical band gap of 3.82 eV.

AFM image shows a pore-free morphology with spherical grains of uniform size distributed all over the surface. From the observed properties, it can be concluded that the $MgIn_2O_4$ films fabricated by the chemical spray pyrolysis technique under the optimized conditions are suitable for opto-electronic applications. Electrical conductivity can be improved by implanting lighter ions into the crystal lattice and the work is now in progress.

Electrochromic NiO films: Low resistivity NiO films, possessing anodic electrochromic properties, were deposited by the electron beam evaporation technique. Annealing at 500°C changed the less crystalline film to highly crystalline NiO with FCC



AFM micrographs of the $MgIn_2O_4$ films deposited at (a) 400°C and (b) 450°C.



XRD of (a) $MgIn_2O_4$ powder sample (b) Mg/In = 0.35 (c) 0.40 (d) 0.45 (e) 0.50.

Pulsed Laser Deposition facility

structure. Uniform surface morphology with fine grain structure was evident from AFM analysis. The anodic color change of the NiO film, from transparent to brown color, was observed by cyclic voltammetric studies.

Nanocrystalline Indium Tin Oxide (ITO) films: Nanocrystalline ITO film was deposited on a quartz substrate at room temperature using 13.56 MHz Radio Frequency (RF) Magnetron Sputtering system with 99.99% Sn-doped indium oxide (90:10 at%) ceramic target (5 cm diameter, 5 mm thickness) in argon atmosphere without the addition of oxygen. The deposition was carried out for 20-30 min with RF power varying between 50 and 350 W. Film thickness was maintained in the range 450-500 nm by adjusting the time as measured by the Stylus Profilometer (Mitutoyo). The optical band gap of ITO films initially increased with RF power, reaching a maximum of 3.69 eV at 250 W and then decreased. The sheet resistance (R_s) decreased with increasing RF power, the minimum Rs achieved was ~ 26.5 /square for the ITO film deposited with 250 W power.

TiN films: Developed TiN films of different thickness on low carbon steel substrates, CP Ti and Si (100) substrates. The XRD analysis revealed that the films are polycrystalline with cubic structure and having the lattice parameter a = 4.2314 nm. A dense columnar

Magnetron Sputtering facility

structure was observed from SEM analysis. The surface topography of these TiN thin films was studied using AFM. From the horizontal cross section analysis, the minimum and maximum globule size was estimated to be about 100 nm. Laser Raman Spectroscopic analysis of TiN films prepared by reactive sputtering showed characteristic peaks at 235, 320, 440 and 570 cm^{-1}, related to transverse acoustic (TA), longitudinal acoustic (LA), second-order acoustic (2A), and transverse optical (TO) modes of TiN respectively. Also it was found that the biofilm of calcium hydroxy apatite could be formed on the surface of TiN. Coated surfaces were studied for their cytotoxicity effects using the direct contact test on extract and agar overlay techniques as per ISO 10993: Part 5. L-929 mouse fibroblast cells were used. Elongated tear drop shape of the cells shows the morphology of good healthy cells and round ones are cells which got affected. All the tested samples were non cytotoxic.

Thin films of oxide semiconductors like ZnO, SnO_2, TiO_2 and hard coatings like TiN, TiAlN, TiO_2 have been prepared by pulsed laser deposition and reactive DC/RF Magnetron Sputtering facility created at ECMS division of CECRI

NWP-12

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

Nodal Officer from CECRI: Dr. S. Sathyanarayanan

Category: CSIR Network Project
Nodal Laboratory: NPL, Delhi

Corrosion resistant coating system based on polyaniline – mica composite for reinforcement steel in concrete environment:

Polyaniline–mica composite (PMC) was synthesized by chemical oxidative polymerization of aniline with mica. Characterisation of PMC was carried out by FTIR, UV-VIS, SEM and TGA methods. Paint formulation was made incorporating PMC as one of the pigments and the performance of the paint applied over steel reinforcement rod was evaluated by potential measurements, anodic polarization studies, electrochemical impedance spectroscopy (EIS) study, cathodic disbondment test and 'time to cracking' study. It has been found that PMC coated reinforcement rod was able to perform well in high alkaline medium like simulated concrete environment even after 90 days of exposure. It is also able to tolerate 1000 ppm of chloride in a highly aggressive test known as anodic polarization technique. The impedance studies reveal that the anticorrosive coating with PMC shows higher charge transfer resistance values even after 90 days of exposure in concrete environment. Also, it resists chloride permeation even in presence of high (7%) NaCl concentration in an aggressive test known as applied voltage technique. The anticorrosive coating with PMC is able to withstand more than 1800 hours for initiation of crack in concrete reinforced with the anticorrosive coated rebar even in presence of 3.5% NaCl in an aggressive test known as 'time to cracking' study. The coating system containing PMC is able to replace the conventional toxic pigment based coatings and will repassivate any defective areas on the rebar surface due to handling or bending. This development of PMC incorporated paint is being patented.

Broke-open concrete sample containing PMC coated reinforcement rod after 'time to cracking' study

Synthesis of corrosion inhibitor doped polyaniline and its corrosion protection performance in organic coating

Polyaniline (PANI) samples with corrosion inhibitor dopants like tungstate and molybdate were synthesized by chemical oxidative polymerization and characterized by FTIR, TGA and XRD. Corrosion protection efficacy of these inhibitor-doped PANI incorporated paint coating was evaluated by EIS in

Painted panels at CECRI Atmospheric Corrosion Testing Centre, Mandapam. (a) Initial (b) After 2 months

acid and neutral environments. It has been found that tungstate-doped PANI containing coating was able to offer 3 orders of higher corrosion protection in these media.

PANI incorporated Epoxy–Coal tar coating

The effect of PANI content (1 and 3%) in epoxy–coal tar coating on the corrosion protection of steel in 3% NaCl solution was studied by EIS. Both phosphate and chloride doped PANIs were prepared by chemical oxidative polymerization. EIS studies have shown that the resistance of the coatings containing 1 and 3% phosphate-doped PANI and 3% chloride doped PANI pigmented coatings is ~10^9 Ω cm^2 even after 90 days exposure to NaCl solution, which is two orders higher than that of conventional coal tar epoxy coatings. Besides, the conducting state of PANI is found to be decreased after exposure to NaCl solution due to redox property of PANI. XPS studies showed that PANI forms a complex layer with iron beneath the coating along with iron oxide.

Field exposure studies of developed coating systems

Panels coated with paints containing phosphate doped PANI / PANI–TiO_2 composite / PMC were exposed along with conventional industrial coating formulations at CECRI Atmospheric Corrosion Testing Centre at Mandapam. The superior integrity and corrosion protection performance of these coated panels were confirmed by EIS measurements at sight. Results of two months exposure showed no degradation of paint.

NWP-22

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

Nodal Officer from CECRI: Dr. G. Sozhan

Category: CSIR Network Project
Nodal Laboratory: NCL, Pune

The objective is to establish hydrogen production technology by electrolysis of water using Proton Exchange Membrane (PEM) as electrolyte. Initially, R&D efforts are focused on catalyst preparation and Membrane Electrode Assembly (MEA). Iridium oxide prepared by thermal decomposition of Iridium chloride was the anode catalyst. The cathode catalyst was either (a) platinum black prepared by borohydride reduction of chloroplatinic acid or (b) platinum supported on carbon prepared by thermal decomposition of chloroplatinic acid. Subsequently, MEA preparation was optimized. The influence of hot pressing temperature and the effect of anode/cathode catalyst loading on cell performance were investigated. Then studies were carried out to compare the efficacy of supported and unsupported cathode catalyst.

Based on the above optimized MEAs, hydrogen generator units with following capacities have been assembled – 1.0 Nm^3/hr (5 kW), 2.0 Nm^3/hr (10 kW) and 3.0 Nm^3/hr (15 kW). Hydrogen generator unit of 1.0 Nm^3/hr capacity was successfully integrated with PEM fuel cell. Durability of the MEA is an important parameter from the commercial point of view and currently durability test of the MEA in the water electrolysis cell stack of 1.0 Nm^3/hr capacity for 3000 hours is in progress.

Process Know-how for (i) Electrochemical activation of nickel electrodes for hydrogen generation and (ii)

Integration of 1.0 Nm^3/hr PEM Water Electrolyser and PEM Fuel cell

PEM Electrolyser of 2.0 Nm^3/hr capacity

Electrochemical method for hydrogen compression have been commercialized during this year

Sea water Electrolysis

Sea water electrolysis is one of the promising ways to produce hydrogen since it is available in plenty on the earth. However, in sea water electrolysis toxic chlorine evolution is the preferred reaction over oxygen evolution at the anode. In this work, research has been focused on the development of electrode materials with high selectivity for oxygen evolution over chlorine evolution. Selective oxidation in sea water electrolysis has been demonstrated by using a cation-selective polymer. We have used a perm – selective membrane (Nafion), which electro statically repels chloride ions (Cl^-) to the electrode surface and thereby enhances oxygen evolution at the anode. The efficiency and behavior of the electrode have been characterized by means of anode current efficiency and polarization studies.

PEM Electrolyser of 3.0 Nm^3/hr capacity

NWP-25

Fabrication of LED devices and systems for solid state lighting applications

Nodal Officer from CECRI: Dr. D. Jeyakumar
Category: CSIR Network Project
Nodal Laboratory: NPL, Delhi

The following activities were completed during this year.

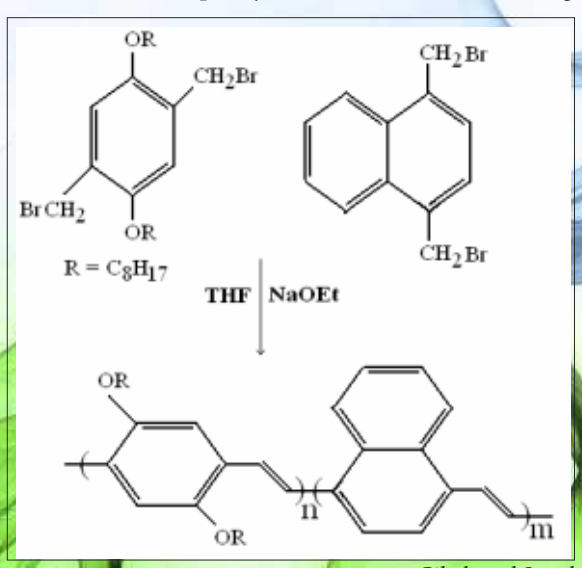
1. Preparation of Functional Monomers based on benzene, biphenyl and naphthalene.

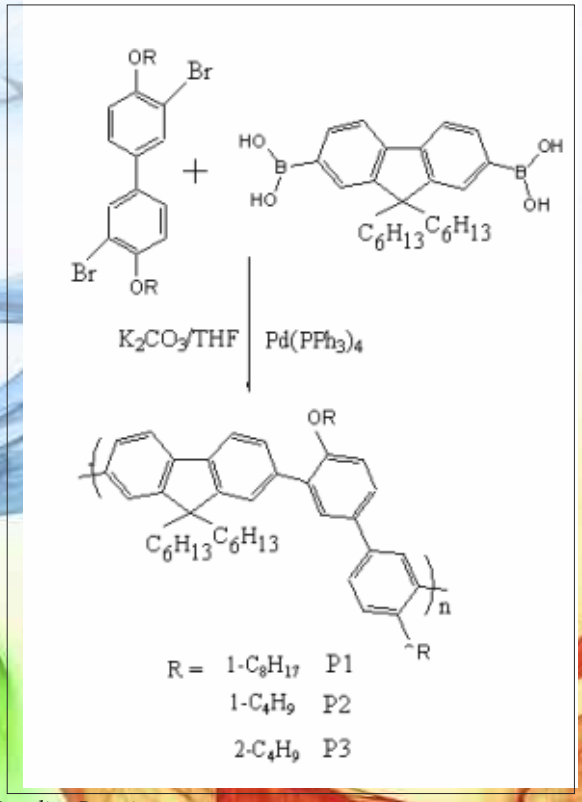
2. Synthesis of polymers bearing biphenyl and fluorene building blocks by Suzuki coupling reaction (Blue Emitter).

3. Gilsch reaction for the random copolymerization of naphthalene and phenylene building blocks (green emitter).

4. Block copolymerization of fluorene functional monomer with biphenyl functional monomer using Wittig's reaction (blue green emitter).

5. Characterization of the prepared functional monomers and synthesized polymers (P1, P2, P3) using 1H NMR, FTIR, Optical absorption and Emission spectral measurements.

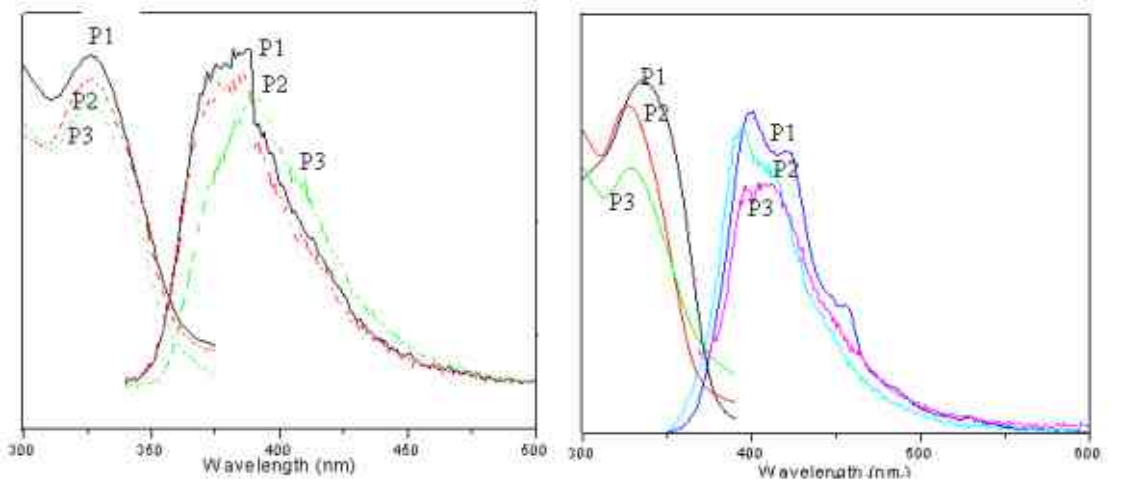




Gilsch and Suzuki Coupling Reactions

6. Three polymers {poly(naphthalene phenylene) vinylene} samples are being evaluated at NPL, New Delhi

7. Preparation of polymers for yellow to orange emitters is in progress



Optical absorption and emission spectra of polymers (P1, P2, P3)

Optical absorption and emission data of polymers (P1, P2, P3)

compound	λ_{abs} (soln.)	λ_{emiss} (soln.)	Φ_f	λ_{abs} (film)	λ_{emiss} (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

NWP-35

Nanomaterials and nanodevices in health and disease

Nodal Officer from CECRI: Dr. Sheela Berchmans
Category: CSIR Network Project
Nodal Laboratory: CCMB, Hyderabad

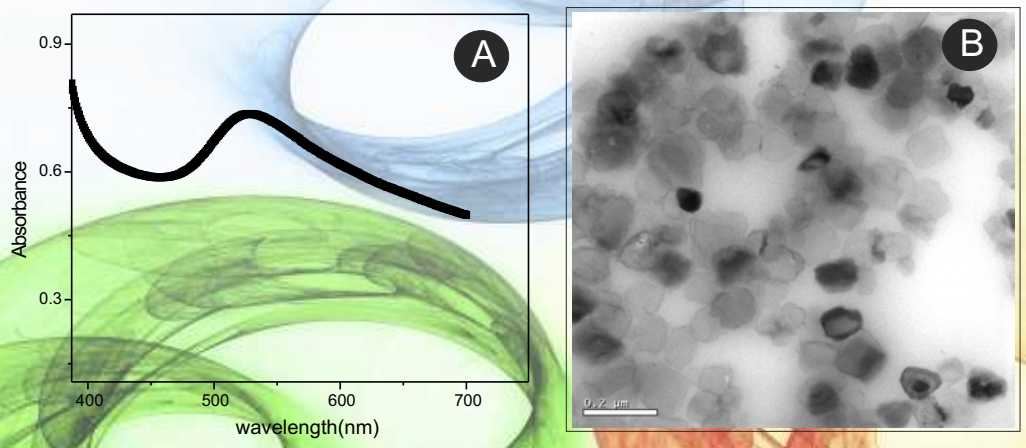
Preparation of functional Au nanoclusters:

Thiols with amino/carboxylic acid terminal groups [4-aminothiophenol(ATP), p-mercapto benzoic acid(MBA) and thiophene carboxylic acid(TCA)] were used as ligands to prepare monolayer protected Au nanoclusters.

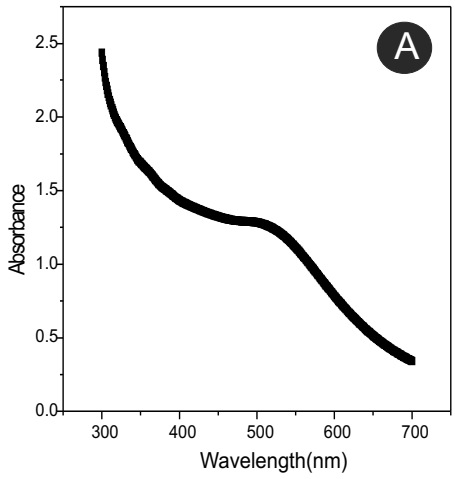
ATP-protected Au nanoclusters were prepared in THF medium using borohydride reduction. The formation of Au nanoclusters is indicated by the characteristic pink colour. The Au nanoclusters were characterized by TEM and UV-Vis spectrocopy. The UV-Vis spectrum of Au nanoclusters exhibits a plasmon resonance band characteristic of nano gold. TEM image confirms the formation of uniform Au nanoclusters.

TCA-protected Au nanoclusters were prepared by Brust procedure and the nanoclusters were separated from the organic phase. The Au nanoclusters were characterized by TEM and UV-Vis spectrocopy. The plasmon resonance band, characteristic of nano gold, is exhibited by the UV-Vis spectrum of the TCA-protected nanoclusters. TEM image confirms the formation of uniform Au nanoclusters.

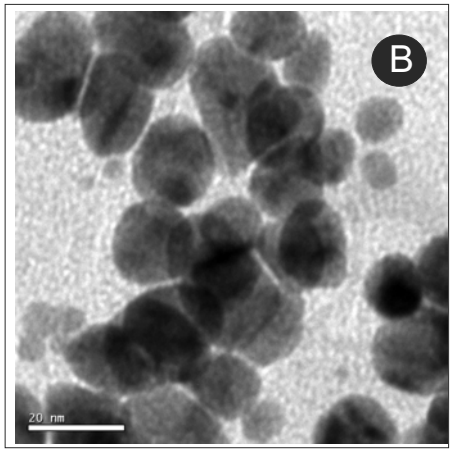
MBA-protected Au nanoclusters were synthesized by two routes. In the first route, the Au nanoclusters were prepared in single phase in alkaline medium (0.3M



A) UV Visible spectrum for ATP-protected Au nanoclusters
B) TEM image of the 4-aminothiophenol protected gold nanoclusters

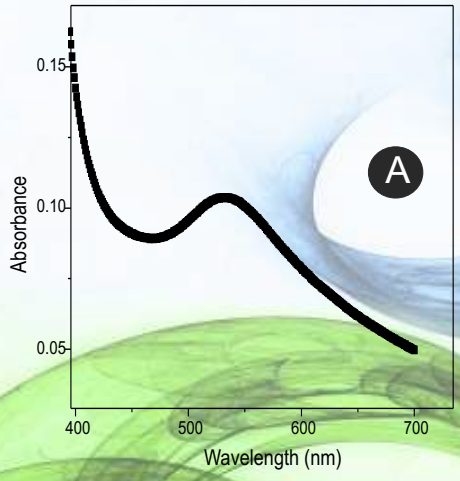


A) UV Visible spectrum for TCA-protected Au nanoclusters

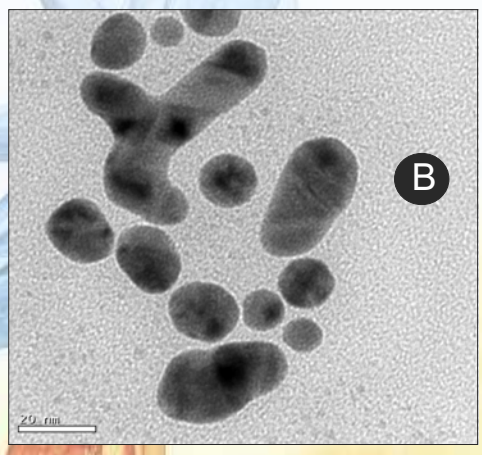


B) TEM image of TCA-protected Au nanoclusters

NaOH). MBA-stabilised Au nanoclusters always tend to aggregate and the aggregation is prevented by adding CTAB. In the other route, decane thiol (DT) protected gold nanoclusters were initially prepared by Brust procedure. Then these colloids protected by DT ligands were allowed to undergo place exchange with MBA as ligands. The resulting Au nanoclusters were characterized by TEM and UV-Vis spectrocopy. The plasmon resonance band, characteristic of nano gold, is exhibited by the UV-Vis spectrum of the MBA-protected nanoclusters. TEM image confirms the formation of uniform Au nanoclusters



A) UV Visible spectrum for MBA-protected Au nanoclusters, surrounded by CTAB



B) TEM image of MBA-protected Au nanoclusters, surrounded by CTAB

RSP-005

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

Nodal Officer: Dr.G.Sozhan
Category: CSIR - 800 Project
Nodal Laboratory: CECRI, Karaikudi

Towards fulfilling our national mission to improve the living standards of the North-East region by providing safe drinking water, R&D efforts are being made under this project to develop technologies for electrochemical de-fluoridation, electrochemical arsenic removal, hypochlorite generators using very dilute chloride solutions and solid polymer electrolyte based ozone generator.

1. A 100 litre/hour capacity electrochemical de-fluoridator has been designed, fabricated and operated.
2. A 100 litre/hour capacity electrochemical de-arsenator has been designed, fabricated and operated.
3. A 100 litre/hour electrochemical hypochlorinator unit is being developed.

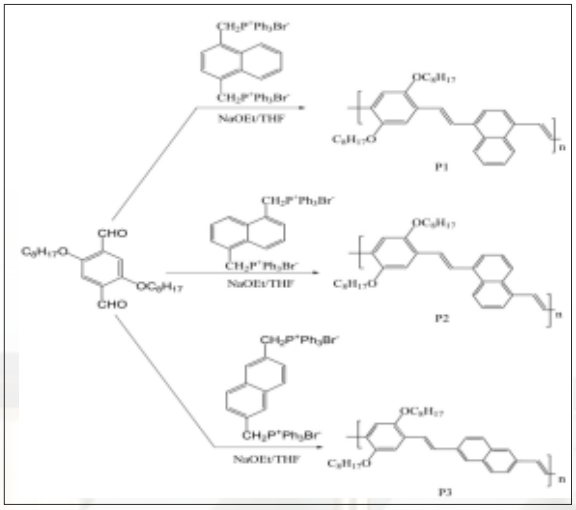
GAP 22/05

Polymer light emitting device (LED): Synthesis of molecularly designed polymers, design and development of LED

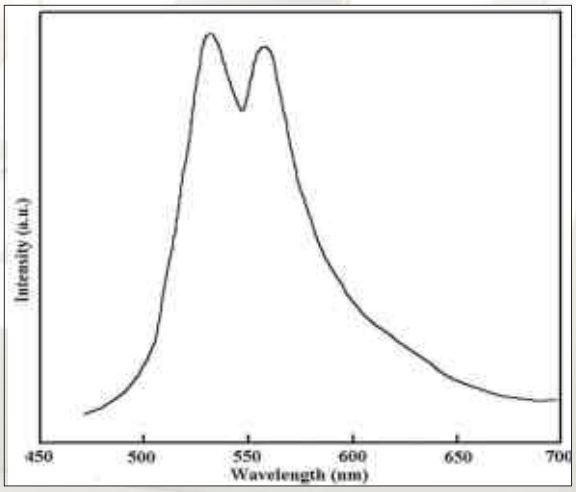
Investigators: Dr. M. Vijayan and Dr. D. Jeyakumar

Sponsor: Department of Science and Technology
Budget: ₹22.6 lakh
Duration: 2005–2009

Light emitting conjugated polymers are attractive owing to their application in new generation of display and solid state lighting devices. Polyphenylene vinylene exhibits an intense emission at 440 nm in solution and at 550 nm from its thin film, and exhibits electroluminescence. The advantage of light emitting polymers is that the emissive light as well as the efficiency of emission can be tuned by suitable chemical modification of polymer backbone. The project is aimed at the synthesis of polyarylene vinylenes, with varying aryl groups as block copolymers. Thiophene, phenyl, flourene and naphthalene were the aryl groups that were chosen. Furthermore, various functional groups were introduced [e.g., dialdehyde, *bis*-(triphenyl aryl phosphonium) salts]. Alternate block copolymers were synthesized using Wittig's reaction.



Similarly, copolymers with phenylene-*bis*-thiophene, phenylene-fluorene, *bis*-thiophene-fluorene, *bis*-thiophene-naphthalene, etc. were synthesized under the project. The products, with molecular weights between 3000 and 7000 Da, were characterized by TGA/DTA, NMR, FTIR, GPC and CHN analyses. Except the *bis*-thiophene based copolymers, all the products are stable up to 200°C. The poor thermal stability of the *bis*-thiophene based products is attributed to presence of the thiophene moiety. The integrity of the polymer was confirmed by CHN, FTIR



and NMR spectral analyses. Optical absorption and emission of the products in solution were studied. The absorption maxima of these materials are in the 340–450 nm range. Their emission maxima vary from 450 nm to 580 nm. The naphthalene and fluorene based polymers emit around 450–480 nm, whereas polymers with bis-thiophene building block emit around 560 nm. The emission characteristics of the products in the form of thin films were also studied. The emission maxima were red-shifted as compared to their solution counterparts due to strong inter-chain interaction in thin films. It was observed that the quantum efficiency of these polymers were moderate, ca. 0.35, for most of the polymers; for bis-thiophene, the value was around 0.10, which is rather poor.

PLEDs using single layer configuration were fabricated using poly(dioctoxyphenylene alt-2,6-naphthalene) vinylene as the emitting layer, ITO-PEDOT as hole injector and aluminum as cathode. The device exhibited electroluminescence with a turn-on voltage of 4.0 V. Electroluminescence was observed around 550 nm, showing a green emission. The i-V characteristics of the device were also studied.

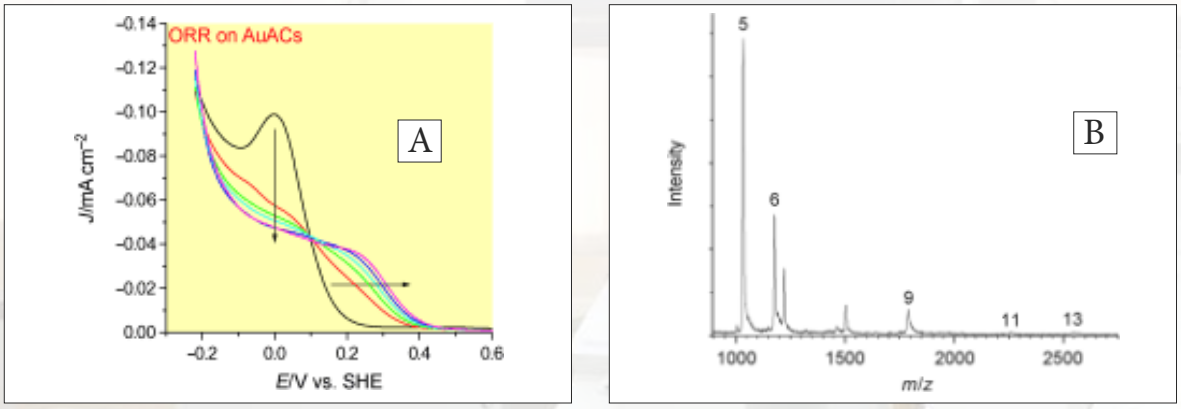
GAP-27/05

Selective electrocatalysts for mixed reactants direct methanol fuel cells

Principal Investigator: Dr. K.L.N. Phani

Sponsor: Department of Science and Technology
Budget: ₹17.22 lakh
Duration: 2005-2009

Gradual, yet a great leap: Electrosynthesized surfactant-stabilized gold atomic clusters (AuACs; Au_n, $5 \leq n \leq 13$) electrocatalyze oxygen reduction reaction (ORR) in acid solution at low overpotentials. Depending on the surfactant concentration, the ORR mechanism gradually transits from a direct four-electron to a two-electron pathway, which suggests the transformation of atomic clusters into nanoparticles. Most importantly, this mechanism changeover also points to a possible transformation of atomic clusters to nanoparticles, *an observation unprecedented in the literature of AuACs and electrochemical reactions* [published in Angew. Chem. Int. Ed. 49 (2010) 2925].



A: Successive linear-sweep voltammograms for ORR in oxygen-saturated 0.5M H_2SO_4 solutions on AuACs electrodeposited from 0.1mM CTAB solutions. Scan rate: 5 mV/s; scan direction: cathodic. Arrows indicate the direction of shift of current/potential.
B: MALDI-TOF mass spectrum of the gold-cluster sample (index numbers indicate n, the number of atoms per cluster).

GAP-19/06

Development of magnetron sputtered transition metal nitride coatings (CrN, ZrN, AlN) and evaluation of their structural, mechanical and corrosion properties

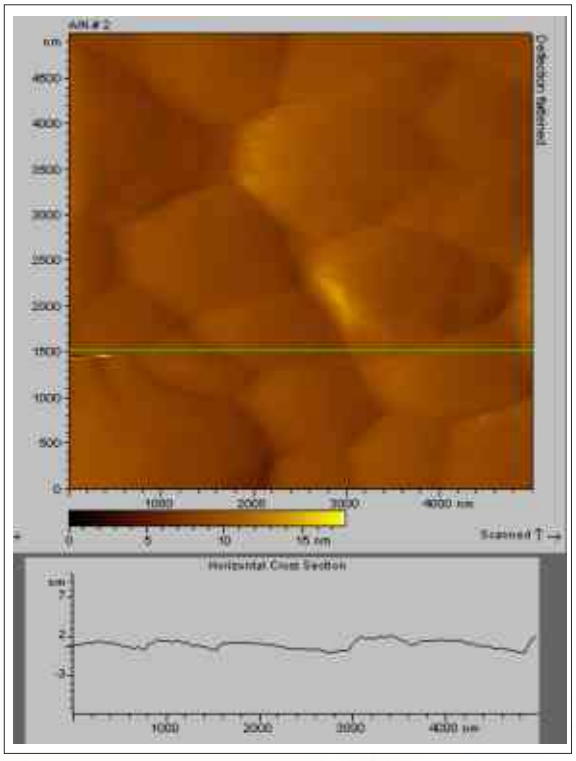
Principal Investigators: Dr. B. Subramanian (CECRI) / Dr. P. Kuppusamy (IGCAR)

Sponsor: Board of Research in Nuclear Sciences
Budget: ₹13.82 lakh
Duration: 2006-2009

Transition metal nitrides are characterized by high melting points (1500-3400°C), hardness (2030 Gpa), brittleness, and metallic conductivity. The bonding structure of these hard metals consists of a combination of localized metal-to-metal and metal-to-nonmetal interactions resembling both covalent and metallic bonding. Metal-to-nonmetal bonding is favored by an octahedral grouping of the metal atoms around a central carbon or nitrogen atom; however, the presence of the nonmetal also tends to increase the strength of metal-to-metal bonds. There also exists an electronic charge transfer from the metal to the nonmetal atoms, being greater in the nitrides than in the carbides, i.e., with increasing electronegativity of the nonmetal atom. Thus, the bonding arises from simultaneous contributions of covalent, metallic and ionic bonding to the cohesive energy.

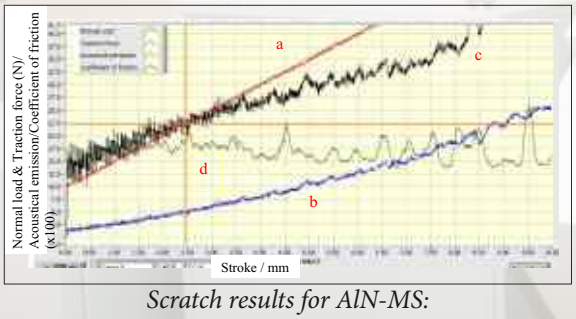
AlN, ZrN and CrN coatings were successfully prepared by reactive DC magnetron sputtering in a gaseous mixture of Ar and N_2 onto various substrates like mild steel, D9 steel, Si(100) wafers and glass substrates. XRD results showed some degree of polycrystallinity. The AlN films have wurtzite structure with (002) preferred orientation mixed with simple NaCl structure, whereas the ZrN and CrN coatings show only FCC structure. A strong absorption peak near 667 cm^{-1} was observed in the FTIR spectrum, which clearly confirmed that the deposited film was AlN. The presence of characteristic peaks observed from laser Raman analysis also indicated the formation of these films. The AlN films were transparent in the visible region with an average transmittance of 60%. Optical absorption studies gave a direct band gap of 5.2 eV. From XPS analysis, it was concluded that these films were composed of the pure phase mainly, on which a thin oxynitride surface layer was formed upon exposure of the films to the air after deposition. SEM and AFM observations of all the coatings (AlN, ZrN and CrN) showed smooth surfaces with continuous coverage of grains in the nanometer range.

The surface hardness values of bare MS and AlN coating on MS were observed with an average of minimum three readings taken at each load. The results of scratch tests, which were done to determine the adhesion strength of the hard coating to the substrate, are shown in the figure below. A change in the traction force curve and the coefficient of friction curve was observed at 4.8 mm stroke length, which may be attributed to the mild plastic deformation

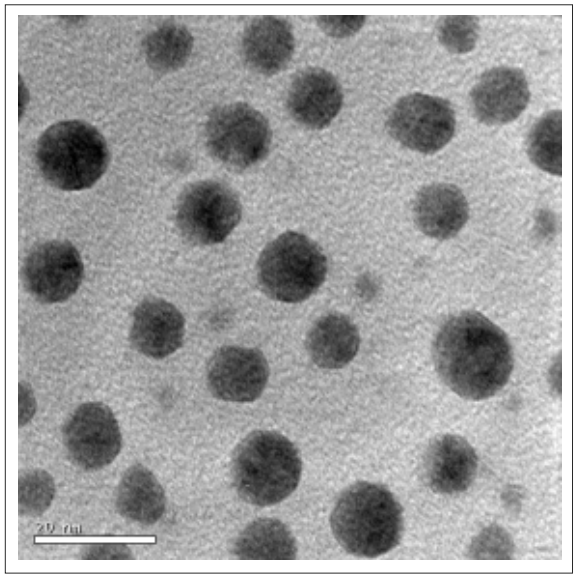


AFM image of sputtered aluminum nitride.

developed within the coating during the scratching test. The cohesive failure, i.e., failure within the coating occurred at 34 N critical load. An appreciable change in the traction curve at 7.5 mm stroke length and a similar change in the coefficient of friction curve were also observed. In addition, acoustic emission curve also significantly changes with respect to the coefficient of friction, which may be due to the



Scratch results for AlN-MS:
(a) normal force; (b) traction force;
(c) acoustic emission; and (d) coefficient of friction.



TEM image of sputtered aluminum nitride.

adhesive failure occurred between the coating-substrate interfaces. The coated layer was found to peel off at a critical load of 47.5 N.

Wear tracks formed on its surface are shown in the figure below. It is explicitly seen that the sample was mainly worn out abrasively and the agglomeration and plastic deformation of wear debris are clearly observed in the central region. Delamination of the coated layer can be attributed to the inability of the layer to sustain the same amount of elasto-plastic deformation of the softer substrate experienced during the cyclic loading

Optical micrographs of the worn surfaces of aluminum nitride coatings.

and unloading process.

The CrN films deposited at low nitrogen flow rate showed that the electrical resistivity corresponded to a metallic-like behavior and the films prepared at N_2 flow rate to 15 sccm and above showed a semi conducting behavior. The lower friction coefficient value observed for the coated specimen indicated that this stack had a better wear resistance than the bare substrate. The coatings with interlayer showed superior wear resistance because of the load support provided by the interlayer helps sealing the pores. Corrosion test was carried out in 3.5% NaCl solution by using potentiodynamic polarization and electrochemical impedance spectroscopy. A positive shift in E_{corr} values and a decrease in I_{corr} values for these specimens signified superior corrosion resistance. From electrochemical noise analysis, the current transient was found to decrease with increasing the immersion time for CrN coated substrate and potential noise shifted to the positive direction. The noise resistance was found to be higher for coated specimen than the bare substrate.

GAP-26/06

Development of eco-friendly trivalent chromium plating bath

Principal Investigator: Dr. S. Mohan

Sponsor: Department of Science and Technology
Budget: ₹14.32 lakh
Duration: 2007-2009

Development of eco-friendly trivalent chromium plating bath

Environmental pollution is an important aspect to be considered in chromium plating. Until now, the quasi totality of chromium plating is realized through hexavalent chromium solution. The maximum allowed pollution level is 0.05 mg/l for chromium(VI) whereas it is 3 mg/l for chromium(III). The aim of this project is to develop trivalent chromium plating baths that have better current efficiency, throwing power and deposits with better physical characteristics (microhardness, wear and corrosion resistance than those with hexavalent chromium deposits).

Using trivalent chromium plating bath in brush and pulse plating would be of great interest because (i) trivalent bath is less polluting and hence eco-friendly; (ii) brush plating would allow to use less quantities of solution; and (iii) pulse plating will improve the current efficiency, corrosion resistance and porosity.

Chromium plating is conventionally done from a chromic acid bath, containing the Cr^{6+} ion. This is now classified as a Class-I carcinogen, and strict environmental regulations have been reinforced. However, the hard chromium deposit has so many engineering applications, and it still has not effectively been replaced by any other coating. It provides a tarnish-resistant double surface finish. Deposited chromium has hardness up to 1100 Hv. Besides, the excellent wear resistance and naturally micro-cracked structure enable it to retain oil and other organic materials. Thus, the use of hexavalent bath is prevalent even today. However, the need for developing a non-toxic and eco-friendly bath has become mandatory.

From Cr(III)-urea-formate bath

(1) Amorphous/microcrystalline thick chromium coatings with acceptable quality were electrodeposited from trivalent chromium bath by DC and pulse current (PC) technique. From the results obtained we can conclude that PC deposition is better than DC technique.

(2) Annealing at 400°C resulted in the loss of hydrogen from amorphous/microcrystalline, which leads to the crystallization of chromium.

(3) Corrosion measurements showed that chromium deposited by DC and PC had better corrosion resistance than that of mild steel.

(4) SEM and AFM images of PC Cr deposits showed fine grained nodular crack-free deposits than that of DC Cr deposits.

From Cr(III)-DMF bath

The microstructure and corrosion behavior of electrodeposited chromium prepared at different peak current densities, duty cycles and frequency were studied. The grain size increased with decreasing peak

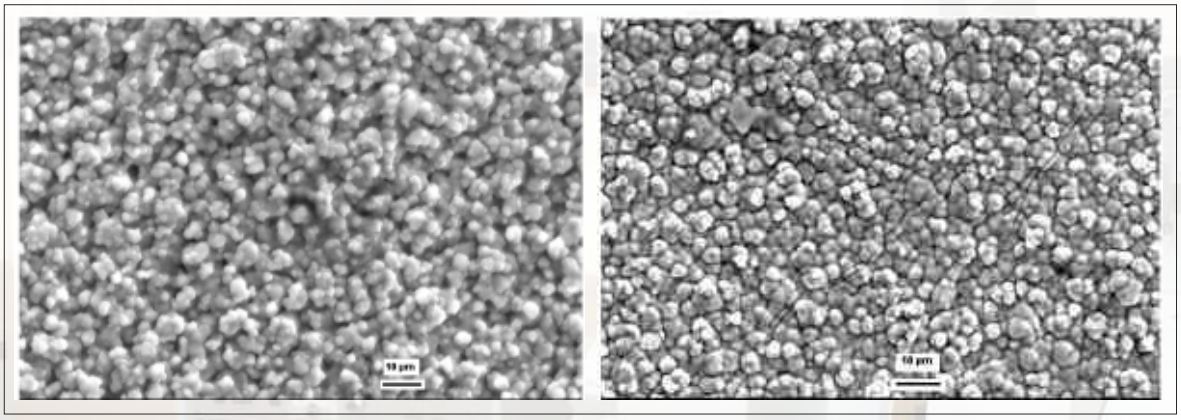
current density during electrodeposition. The maximum thickness, current efficiency and hardness of electrodeposited chromium were obtained at 40% duty cycle. All the chromium samples exhibited active passive polarization characteristics. Electrodeposited chromium prepared at 40% duty cycle showed the best corrosion resistance. The corrosion behavior of electrodeposited chromium in 3.5% NaCl solution is well described by the equivalent system of charge-transfer resistance (R_{ct}) and double layer capacitance (C_{dl}).

From Cr(VI) and Cr(III)-glycine electrolyte

Using potentiodynamic polarization studies the differences in the corrosion potentials (E_{corr}) of DC & PC deposits and substrate were determined. In all the cases the (E_{corr}) shifted to a more positive potential when the coatings were applied. The PC deposited substrate had a better corrosion resistance than DC and mild steel substrate. Corrosion properties of PC deposited chromium from Cr(III) bath differed only by 1.5 times (higher positive potential, lower corrosion current (I_{corr}) and lower corrosion rate) than those of PC deposited chromium from Cr(VI) bath.

EIS data for DC and PC deposited chromium from Cr(III) and Cr(VI) baths showed that the values of charge transfer resistance (R_{ct}) and double layer capacitance (C_{dl}) of PC deposited from Cr(III) were similar to those from the Cr(VI) bath.

The porosities of both DC and PC deposited chromium on the mild steel substrate from Cr(III) and Cr(VI) baths were quantitatively estimated. Among the porosity values, PC deposited chromium from Cr(III) bath differed only by 1.5 times from the other with respect to porosity. Therefore, the structure and corrosion properties of PC deposited chromium from Cr(III) bath is comparable from Cr(VI) bath. The development is a good alternative to the toxic, carcinogenic Cr(VI) bath. Development of trivalent chromium plating will lead to an eco-friendly technology.



SEM images of chromium deposits from Cr(III) bath (left) and Cr(VI) bath (right).

GAP-32/06

Fabric dyeing by redox mediated environment-friendly process

Principal Investigator: Dr. M. Anbukulanthainathan

Sponsor: Department of Science and Technology
Budget: ₹11.46 lakh
Duration: 2007-2010

Preliminary efforts were made to identify alternative ligands for relatively greener and cheaper ones than triethanolamine, leading to a new ferric-oxalate-gluconate mixed ligand system. Cyclic voltammetry was employed to study the mechanism involved. A low concentration of electrogenerated Fe(II)-oxalate was transformed into Fe(II)-gluconate, which acted as the reducing agent in the overall process. The influences of electrolyte medium, electrode material, nature of dye, dye concentration, material-to-liquor ratio and other related parameters were studied to arrive at the optimum experimental conditions. Copper cathode and stainless steel anode were the materials of choice. The optimum cathode current density was found to be 2.30 mA/cm$^{2.}$ Under the optimum conditions, both cotton fabric and yarn could be efficiently dyed using this electrochemical process. The electrolyte could also be recycled. Color intensity for different dyed materials was evaluated using K/S values according to the Kubelka-Munk equation. Pilot plant trials were made and demonstrated.

GAP-19/07

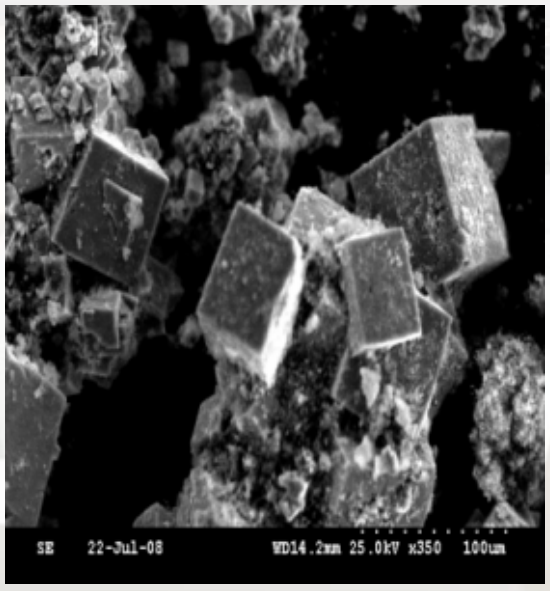
Electrochemical synthesis of lanthanum and europium hexaborides by molten salt technique

Principal Investigator: Dr. John Berchmans

Sponsor: Board of Research in Nuclear Science
Budget: ₹40.54 lakh
Duration: 2007–2010

The objective of this programme is to prepare lanthanum and europium hexaborides by molten salt technique. Lanthanum and europium hexaborides are of great technological importance as thermionic cathodes, which find applications in electron microscope, electron lithography and materials for nuclear technology. Experiments were carried out for the synthesis of lanthanum and europium hexaboride crystals by molten salt electrolysis. Laboratory-scale electrolytic cells were designed, operated and the electrolytic conditions were optimized for the preparation.

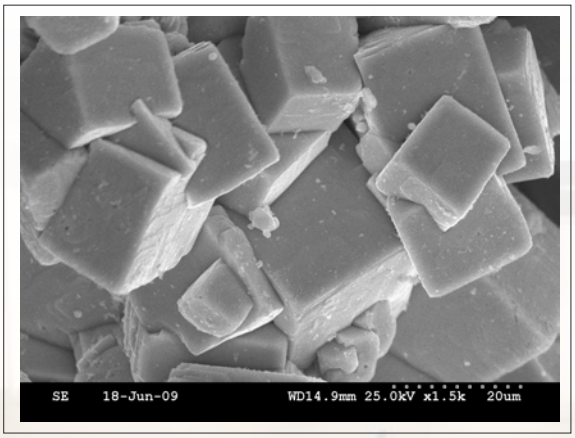
Stoichiometric amounts of the constituent metal oxides were mixed with molten boron trioxide, calcined in a controlled atmosphere and pressed into pellets. The electrolytic cell consisted of a high purity graphite crucible, which served both as a container as well as the anode for the electrolytic process. A molybdenum rod was used as the cathode. The graphite crucible and the cathode were kept in an inconel reactor, which had provisions for purging argon and also for circulating cooling water. The graphite crucible, filled with the pellets, was placed in the reactor and introduced into an electrical resistance furnace. The electrolyte consisted of varying compositions of LiF, B_2O_3 and La_2O_3 or Eu_2O_3, depending on the molar concentrations of La:B or Eu:B. The liquidus temperature of the melt was determined and the melt was kept 50°C above the liquidus point and the electrolysis was performed. An electro-polished molybdenum cathode was introduced into the melt. After a pre-electrolysis step, the electrolysis was performed at the desired current densities (0.5–1.5 A/cm^2) to produce LaB_6 and EuB_6 crystals. The deposits were cleaned with HCl solution followed by washing in triple distilled water. The shiny crystals were examined for the compound identification using XRD, AAS, CHNS and UV-vis spectral analyses.



SEM image of EuB_6 crystals obtained at 1.75 A/cm^2.

Deposition of LaB_6 on a molybdenum cathode.

Deposits of EuB_6 on molybdenum cathode



SEM image of LaB_6 at the best current density of 1.5 A/cm^2.

Crystals of LaB_6.

Crystals of EuB_6.

GAP-21/07

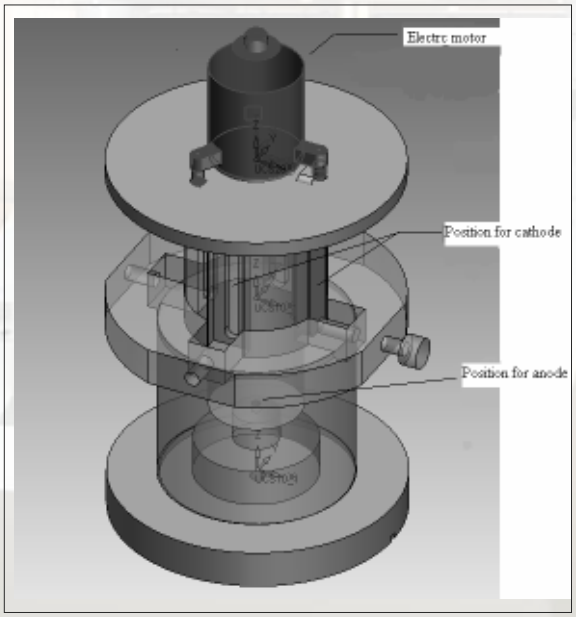
Development of pulse electroplated target for high current irradiation in cyclotron

Principal Investigator: Dr. S. Mohan

Sponsor: Board of Research in Nuclear Science
Budget: ₹6.88 lakh
Duration: 2007–2010

Radioisotopes have numerous applications in heath care, industry, agriculture and research. Nuclear reactors are the major source of radioisotopes. However, since the radioisotopes produced in reactors are mostly neutron-rich type, certain neutron-deficient radioisotopes are difficult to be produced in a nuclear reactor, if not impossible. These radioisotopes are produced in charged particle accelerators like cyclotron. Radioisotope production in cyclotron is much more complicated than that in nuclear reactors. For large scale radioisotope production in cyclotron, target materials are irradiated with high energy and high intensity accelerated particles like protons, deuterons, alphas etc. During irradiation of targets in cyclotron tremendous amount of heat is generated. Highly enriched target materials are often used in these irradiations. Therefore, minimum amount of enriched material needs to be irradiated to reduce the production cost. Target preparation for irradiation at high beam current for radioisotope production is an important aspect and requires special attention. Electroplating is the most important technique for preparation of high current solid targets for cyclotron production of radioisotopes. Pulse current electroplating technology is a method to get the desired quality of the electroplated target layer.

The physicochemical quality criteria of plated target one must achieve are: (i) The target layer should adhere strongly to the target carrier up to an irradiation temperature at least about 50°C below the melting point of the target metal; (ii) It should be smooth (not spongy and should be dendrite-free), dense (no occlusion or vacuoles), stress-free and homogeneous (±5%), and show a well defined thickness that may vary from few tens to several hundred microns, depending on the shape of the excitation curve and on the beam-target geometry, (iii) The metal deposit and the carrier layer interface should be free of traces of organic plating bath additives such as complexing reagents, surfactants or



Four-target cell.

stress reducing agents. Finally, for routine industrial production the standardized procedure should meet additional requirements such as: (a) The plating solution must be free of toxic anions (like CN^-) and suitable for repetitive plating (about 10 batches per cycle) by simple replenishment of metal content of the bach after each batch. At the end of a plating cycle any enriched material remaining in a partially depleted bath must be recovered quantitatively in a chemical form that can be reused for the preparation of a new plating solution; (b) Both the plating bath and the set-up must allow multi-target preparation (minimum four per batch), preferably at room temperature, and with a duty cycle allowing at least one batch per shift (7 h) to be finished.

The goal of the project is to optimize the plating technology for each of the target metal, which involves proper choice and standardization of the following components: plating method; composition of the plating bath; electromechanical set-up and temperature; and plating voltage waveform and current density. In this project we develop a (pulse) electroplating technology for Ni, Cd and Co for subsequent production of 64Cu 111In and 57Ni, by proton irradiation of respective electroplated metal target. These radioisotopes have important medical / R&D applications. The outcome of this project would lead to direct production of the above radioisotopes in the DAE Medical Cyclotron Facility in Kolkata.

The procedure and conditions for Ni, Cd and Co plating were standardized based on optimization of the plating method, which involved proper choice and standardization of the composition of plating bath, plating method, electrochemical set-up, temperature, plating current waveform, current density, etc. and testing the deposits for thermal stability by thermal shock test. A multi-target plating cell set up that gives homogeneous layer thickness all over the metal surface was fabricated at CECRI.

The pulse electrodeposited targets (Ni, Cd and Co) were prepared from electrolyte containing lower concentration of metal ions using a suitable multi-target electrolytic cell fabricated by CECRI. The Ni, Co and Cd baths were optimized for higher current efficiency and smooth surface by varying pH of the bath and concentration of buffer. From the optimized bath, the electrodeposited targets were prepared at various duty cycles and frequencies. All the targets from the optimized conditions were tested in TST.

The plating vessel was a hollow perspex cylinder fitted with an axial platinum anode wire mounted in the bottom by means of a tube end fitting. Four symmetrical windows (11.69 cm^2) in the vertical wall of the perspex cylinder allowed introduction and positioning of four copper target carriers. Each slot was provided with a window fitted with an O-ring, the geometrical shape of which determined the electro-deposition area. The bath was fitted with a motor stirrer assembly at the top. The stirrer was a hollow perforated PTFE cylinder mounted on the axis of a DC motor and surrounding the platinum anode. The rotation speed was adjustable up to 1300 rpm while the direction of rotation could be reversed after a predetermined time.

The homogeneity of the metal layer was optimized by quasi-homogeneous electric field all over the cathode surface area and by the bi-directional rotation mode of the stirrer. Concentration polarization and subsequent dendrite formation were further suppressed by the high rotation speed of the stirrer giving rise to a high linear velocity of the plating solution at the solution/cathode interface.

GAP-22/07

Novel nanocomposite polymer electrolytes for lithium batteries

Principal Investigator: Dr. A. Manuel Stephan

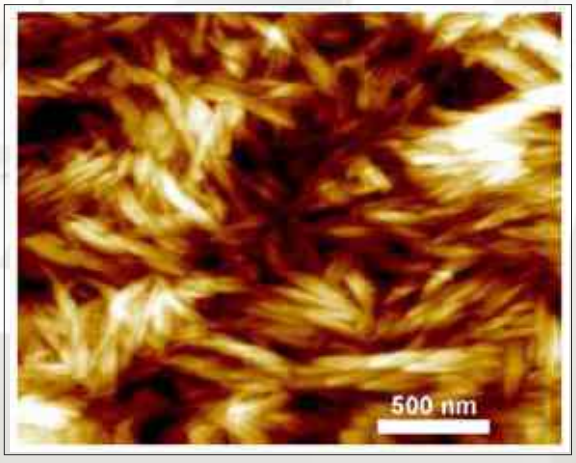
Sponsor: Department of Science and Technology
Budget: ₹20 lakh
Duration: 2007–2010

Energy consumption relying on fossil fuels is forecast to cause severe problems in world economy and ecology due mainly to depleting resources and increasing environmental concerns. Developing alternative energy storage or conversion devices with high power and energy densities is under serious consideration as a viable alternative. Lithium-ion batteries, fuel cells, and supercapacitors are considered major contenders for power source applications.

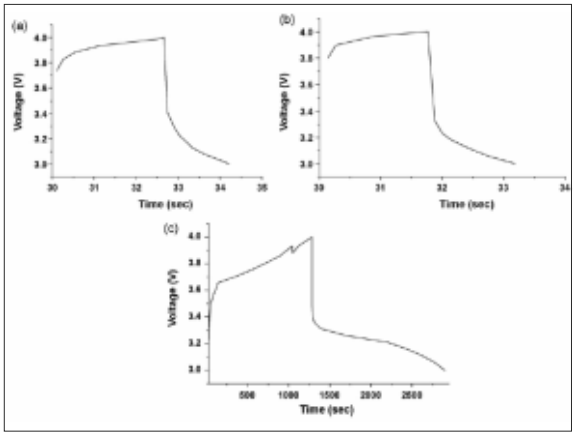
Although lithium batteries hold a leading position in the consumer market right from portable devices to hybrid electric vehicles (considering the evolution and their associated energy and power demands), new and improved battery components are required. In order to achieve this goal, various strategies have been employed. Among this, the replacement of conventional liquid electrolyte by an advanced polymer electrolyte has been identified as a most relevant procedure as far as safety and reliability are concerned. Also, liquid electrolytes with organic solvents are flammable. Such non-aqueous electrolytes can be replaced by polymer membranes, which act as both electrolyte and separator. Numerous attempts have been made with the incorporation of nanosized oxide fillers such as TiO_2, SiO_2, Al_2O_3, ZrO_2, etc. in the polymer matrix. In the present study, nanochitin has been incorporated as filler. Chitin, a biopolymer, has low toxicity, is biodegradable, antibacterial, and also possesses gel-forming properties.

Synthesis of nanochitin

Chitin purchased from local sources was boiled in a 5% aqueous solution of KOH for 6 h with constant stirring in order to remove most of the proteins. Subsequently, it was washed with distilled water and dried. This process was repeated three times. The sample was then bleached with 17 g of NaCl in 1 litre of water containing 0.3M sodium acetate buffer for 6 h at 80°C. The bleaching solution was changed every 2 h. The chitin suspension was then kept in 5% KOH for 72 h to remove any residual protein, centrifuged at 3000 rpm for 20 min, and hydrolyzed with 3N HCl under



AFM image of nanochitin.



Cycling behaviour of Li/NCPE/$LiFePO_4$ cells at 60, 70 and 80°C. Rate : C/10.

stirring for 1.5 h. After hydrolysis, the suspension was transferred to a dialysis bag and dialyzed for 24 h until its pH reached a value of 6. The pH of the suspension was adjusted to 3.5 with HCl. The dispersed whiskers were treated ultrasonically and were filtered to remove residual aggregates. The prepared nanochitin particles had a length of 400–500 nm and a diameter of 1 nm. The product was preserved in a refrigerator with sodium azoture as a protectant against microorganisms.

Cycling behavior of Li/$LiFePO_4$ polymer cells assembled with the nanocomposite membranes was studied at various temperatures. The polymer cell is capable of maintaining the same voltage almost during the entire discharge process which is a pre-requisite of a polymer battery system. Cycling studies at different temperatures and different current densities are under progress.

GAP-23/07

Degradation of dyes and refractory organic contaminate from textile and other organic industrial effluents

Principal Investigator: Dr. B. Ramesh Babu

Sponsor: Ministry of Environment and Forests
Budget: ₹12.03 lakh
Duration: 2007–2010

The objective of the present work is to develop an electrochemical treatment process for degradation of dye and refractory organic contaminants present in industrial effluents. The utility of the invention is in the treatment of organic effluent from pharmaceutical, petroleum, distillery, textile and other industries.

Refractory organic compounds present in industrial effluents were degraded by electro-oxidation: (a) industrial textile dye effluent obtained from Erode, Tamil Nadu; (b) effluent from pharmaceutical industries; and (c) pesticide industrial effluent. Continuous experiments were conducted using a regulated DC power supply. Ti/RuO_2 and SS were used as anode and cathode, respectively. Experiments were carried out at current densities of 2.5, 4 and 5 A/dm^2 with an NaCl concentration of 1–2 g/l as supporting electrolyte. Flow rate was adjusted to maintain the retention time. At regular intervals, samples were collected for COD, TOC/TN, UV-Vis, FT-IR, NMR and HPLC analyses. Percentage removal of color and COD were 95–99% and 80–91%, respectively, with different industrial effluents. Application of electro-oxidation for the degradation of non-refractory organic compounds present in effluents from the following industries will be undertaken: textile (Erode), pharmaceutical (Chennai) and pesticide (Madurai).

Non-biodegradable organic compounds can be degraded by electro-oxidation. In order to minimize treatment cost, biological processes may also be adopted once the effluent becomes bio-degradable. Moreover, different anodes may also be introduced in the reactor instead of Ru/TiO_2 to reduce treatment cost. Major advantages of electro-oxidation are reduction in color and a COD of about 96%. Further reduction of color is possible by activated charcoal treatment. A textile industry in Hyderabad has approached CECRI for implementation of the electro-oxidation process for treatment of their dye effluent.

GAP-25/07

Development of electro-analytical sensor for pesticide analysis

Principal Investigator: Dr. M. Chandrasekaran

Sponsor: Department of Science and Technology
Budget: ₹16.91 lakh
Duration: 2008–2011

Sensing of pesticides is important for protection of the environment. Electroanalytical sensors are faster, more sensitive and selective as well as cost-effective compared to other sensors. Methyl parathion, parathion, fenitrothion, imidacloprid and paraoxon were taken for the electrochemical studies. A problem associated with the electrochemical analysis is fouling of electrode by the adsorption of pesticide molecules. This problem was overcome by the use of modified electrodes to get reproducible electrochemical responses. Following modified glassy carbon electrodes were developed for the analysis of pesticides: (1) nanosilver/nafion composite-modified glassy carbon electrode; (2) nano TiO_2/nafion composite-modified glassy carbon electrode; and (3) nanosilver/nafion/TiO_2/nafion-modified glassy carbon electrode. The modified electrodes showed excellent electrocatalytic properties in the analysis of pesticides. Analytical parameters such as LOD, LOQ and linear dynamic range were estimated by using cyclic voltammetry, differential pulse voltammetry and amperometry. Recovery rates for spiked water samples were also estimated and compared with the analytical data obtained from HPLC. An instrument for pesticide analysis using the above sensing electrodes was designed, fabricated and tested.

GAP-28/07

Addressing novel applications of current generation using micro-organisms

Principal Investigator: Dr. Sheela Berchmans

Sponsor: Ministry of New and Renewable Energy
Budget: ₹24.67 lakh
Duration: 2008–2011

The objectives of this programme are: (a) screening and choosing microorganisms highly efficient for sugar industry effluents, beer waste and corn waste; (b) selection of suitable anode materials for channeling electrons generated during biodegradation, and identification of proper cathode reactions and cathode materials; and (c) construction of a prototype microbial fuel cells (MFC): (i) a lab-scale model of MFC for wastewater treatment – batch and flow type, and (ii) miniaturized MFCs for biomedical and domestic applications.

Progress has been made in the following areas: (a) identification of microorganisms for direct electron transfer; (b) development of alternative cathodes for microbial fuel cells; (c) fabrications of microbial cells with different configurations; and (d) demonstration of biodegradation cum current generation in the case of dye, potato waste and effluent from biscuit factory.

CSIR-CECRI publication in World News

In the field of 'Bio-electrochemistry', CECRI carries out research on bioelectrocatalysis, membrane potentials, electrochemistry and molecular recognition of bio-molecules leading to microbial and enzyme based biosensors. Recently, we initiated work

Bioelectrocatalysis of Acetobacter aceti and Gluconobacter roseus for Current Generation

R. Karthikeyan, K. Sathish kumar, M. Murugesan, Sheela Berchmans* and V. Yegnaraman
Electrodics and Electro Catalysis Division, CSIR-CECRI,
Central Electrochemical Research Institute, Karaikudi-630 006, India.

Environ. Sci. Technol., 2009, 43 (22), pp 8684–8689; DOI: 10.1021/es901993y;
Publication Date (Web): October 21, 2009;

Abstract: Acetobacter aceti and Gluconobacter roseus, which are known to be responsible for the spoilage of wine, are used for current generation in batch-type microbial biofuel cells and it has been shown for the first time that these two microorganisms do not require mediators for the transfer of electrons to the anode. Three biofuel cells were constructed with two cells containing the pure cultures of each of the microorganisms as the biocatalyst (A-MFC, G-MFC) and the third cell was constructed with the mixed culture of these two microorganisms as the biocatalyst (AG-MFC). The performance of the biofuel cells was evaluated in terms of open circuit voltage (OCV), fuel consumption rate, internal resistance, power output, and coulombic efficiency. The mixed culture cell (AG-MFC) exhibits a better overall performance compared to the other cells.

on electricity generation using MFCs, which are explored for novel low-power density applications. Our efforts towards fabrication of "mediatorless MFCs" have led to the identification of microorganisms, which facilitate effective electron transfer. These studies which appeared in the ACS journal, Environmental Science and Technology, have attracted the attention of international scientific community and has been reported in MSNBC News and Discovery Channel News.

NEWS WEBSITES

http:/news.discovery.com, www.msnbc.com, www.abc.net.au, www.cnwinenews.com

Bad wine makes for good energy by Eric Bland.

www.newkerala.com; www.sify.com

world news Dec16; Indian and American scientists use bad wine to make good energy.

Bad wine can produce good energy. http:/www.times of india, indiatimes.com, www.microbeworld.org, www.esciencenews.com,

www.greenlife.smartlifeworldpress.com, www.indiaenvironment.portal

EXCERPTS FROM THE NEWS

Bad Wine Makes for Good Energy

When good grapes make bad wine, the end result could be clean energy.

By Eric Bland | Tue Dec 15, 2009.

A bad bottle of wine could drop your electrical and gas bills. Using widely available microbes, scientists in the United States and India are turning the unused sugar and unwanted vinegar resulting from improper fermentation into electricity and hydrogen. The

Different configurations of MFCs developed at CSIR-CECRI.

technology could provide a new and cost effective way to clean wastewater from wineries and get some value out of a bad bottle of wine.

While Logan uses a microbial electrolysis cell to split water, a group of scientists from India recently developed a microbial fuel cell that uses wine to produce energy. "Sugars like glucose, alcohols and effluents containing sugars or alcohols can be used (to produce electricity)," said Sheela Berchmans, a professor at the Central Electrochemical Research Institute in India, who recently co-authored a paper in the journal Environmental Science and Technology. Two different bacteria can spoil wine, *Acetobacter aceti* and *Gluconobacter roseus*. The scientists from India created microbial fuel cells using single cultures of each bacterium as well as both together. A fuel cell with *A. aceti* or *G. roseus* produced a mild electrical current, about 213 milliwatts for the former and 395 milliwatts for the latter. Put them together, however, and the combination can generate 859 milliwatts of power. "The mixture of the cell cultures improves metabolic degradation," said Berchmans. *G. roseus* is great at breaking down the glucose into acetic acid but not great at creating electricity. *A. aceti* can't use sugar as well as *G. roseus* can, but it can turn acetic acid into electricity.

In other words, one bacterium's waste is another bacterium's food. However, the electricity produced is not much – at least not yet. The scientists hope that the technology could eventually be scaled up to produce more electricity or help to save electricity that would normally be used to treat wastewater.

GAP-29/07

Quality assurance of electrodeposited coating for reactor and reprocessing applications

Principal Investigator: Dr. P. Veeramani

Sponsor: Indira Gandhi Centre for Atomic Research
Budget: ₹15.03 lakh
Duration: 2008–2010

At present various coatings are employed for nuclear reactors including fast breeder reactors. Most reactors use 316L and 304L grade stainless steels as structural materials. These are severely exposed to corrosion because of environmental and operational sequences. To safeguard these structural materials, various types of coatings like nickel, copper, lead and chromium are to be applied on the surface. It was proposed to apply different coating thicknesses (10, 25, 50 and 75 micron) on SS 316L, SS 304L, mild steel and chromoly steel substrates. They would then be evaluated under various conditions at IGCAR, and a data bank generated on the suitability of electrodeposited coatings of metals such as nickel, copper, lead and chromium, and alloys such as nickel-tungsten, nickel-copper, nickel-zirconium for nuclear applications.

Quality manual and process procedure for the electro deposition of metals and alloys like nickel, copper and nickel alloys on various substrates SS 304L, SS 316L, chromoly steel of different thicknesses were made. Nickel coatings of 10, 25, 50 and 75 micron thicknesses were applied. For this, pre-treatment processes with different combinations of acids like hydrochloric acid, sulfuric acid, nitric acid and hydrofluoric acid were tried. Among these, sulfuric acid produced the best results for adherent nickel deposition on stainless steel 316L; and hydrochloric acid for adherent nickel deposition on stainless steel 304L. Only alkaline treatment was given to steel coupons. More than 80 electroplated specimens were supplied to IGCAR. Furthermore, for the provision of electroless nickel-boron and nickel-boron nitride coatings on the above base materials, conventional nickel coating of 10 micron thickness was provided by adopting pre-defined pre-treatment process.

The copper deposition was tried only on steel substrates. For this, pre-treatment processes with different combinations of electrolytes were tried. Alkaline copper deposition was carried out on steel plates to obtain adherent copper deposits. To achieve the required thickness, a further deposition was tried from the acid copper bath. More than 20 copper-deposited coupons of various thicknesses were prepared with steel plates. Lead deposition on SS304L substrates was tried. The bath was a fluoborate-based one. Lead deposition trials were carried out on SS coupons to obtain uniform thicknesses. 20 lead-plated specimens were delivered to IGCAR.

Specimen coating facility.

GAP-04/08

Development on conducting polymer rechargeable battery for consumer applications

Principal Investigator: Dr. M. Paramasivam

Sponsor: Department of Science and Technology

Budget: ₹18.05 lakh

Duration: 2008–2010

Weight of the battery: 55 g

Open circuit voltage: 1.344 V

Working voltage: 1.344–0.500 V

Cut-off voltage: 0.500 V

Capacity of the battery: 500 mAh

Product demonstrations: Investigators–Investors Meeting, 26th July 2009, S.D. College, Ambala Cantonment, sponsored by DST. Investigators–Investors Meeting, 24–25 April 2010, Center for Biotechnology, Anna University, Chennai, sponsored by DST.

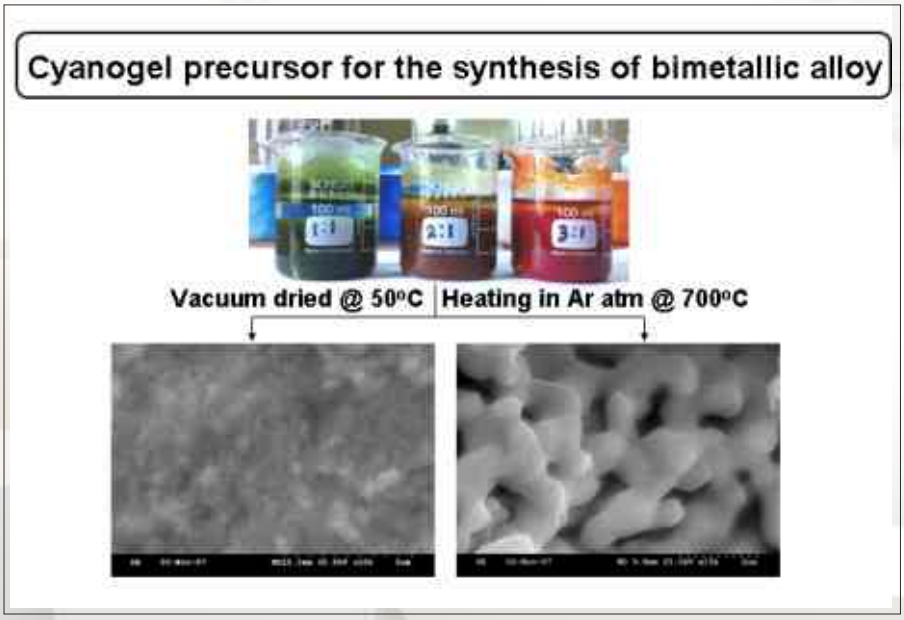
GAP-06/08

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 and Technology
Budget: ₹17.00 lakh
Duration: 2008–2011

New cyanogel route has been proposed for the synthesis of carbon supported bimetallic alloys catalysts, viz., Pd-Fe, Pt-Ru & Pd-Ni. Pd-Fe/C was synthesized in different compositions. Their electrocatalytic behavior towards oxygen reduction was in the order of Pd3-Fe/C>Pd2-Fe/C>Pd-Fe/C. Pt-Ru/C shows remarkable methanol oxidation due to structural variations and phase separation of Ru. Pd-Ni/C also shows good methanol oxidation activity and optimization of composition is underway.

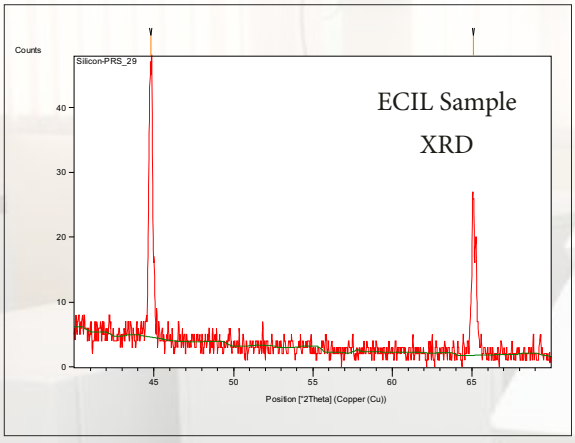


Identification of metallic coatings and alloys for underwater applications

Nodal officers: Dr. P. Veeramani and Mr. S. John

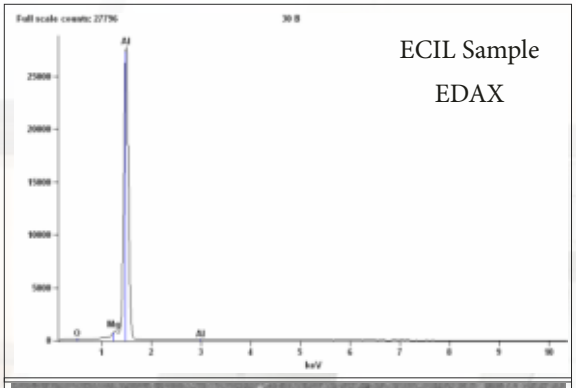
Sponsor: Electronics Corporation of India Limited
Budget: ₹2.19 lakh
Duration: 9 months

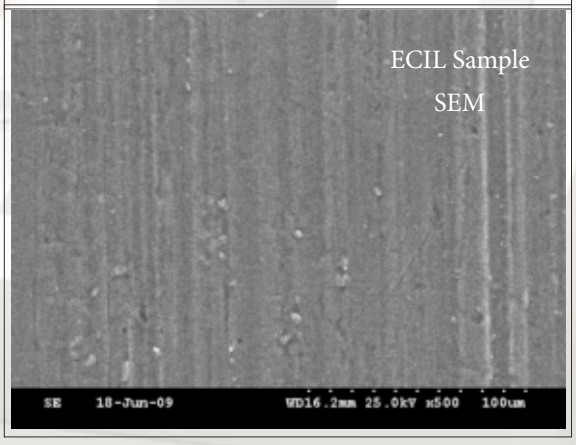
This project resulted from ECIL's interest in identifying metallic coatings and alloys for underwater applications. Aluminum alloys of various grades are employed for underwater applications. To suit their need certain specific grades were taken and surface modification was carried out by electrolytic processes. By this, oxide layer was formed and their features were studied and compared with existing specimens. Studies were performed on the thickness of coating, compositional analysis, adhesion, hardness and electrical conductivity. Trouble shooting measures were also identified for these coatings.



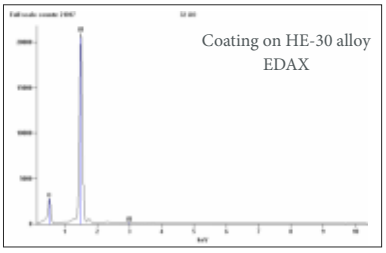
XRD on the sample revealed the presence of a theta-alumina coating. EDAX suggested that maximum weight percentage in the specimen was aluminum (77.93%). SEM figures showed uniformity of the surface.

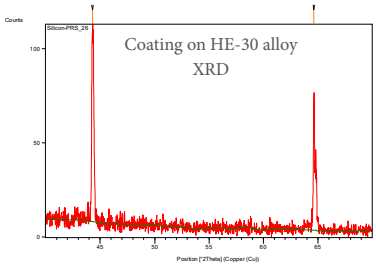
HE-30 grade aluminum alloy was chosen for this study. The XRD pattern revealed the presence alpha-alumina and theta-alumina in the surface modified material. The composition of the coating was determined by EDAX (aluminum: 52 wt.%; oxygen: 45

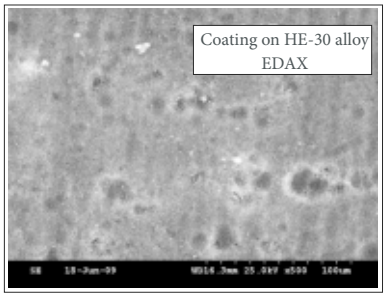




wt.%). The topography confirmed the uniformity of the coating on HE30 alloy. The oxide coating was found to be suitable for ECIL applications.







GAP-11/08

Development of cobalt based alloys for giant magneto resistance applications

Principal Investigator: Dr. S. Mohan

Sponsor: Defence Research and Development Organization
Budget: ₹14.92 lakh
Duration: 2008–2010

The giant magneto resistance (GMR) effect, which was first discovered in magnetic multilayers, also exists in heterogeneous alloys with ferromagnetic granules (Fe, Co) embedded in a non-magnetic metal (Cu, Ag). Magnetic multilayers that exhibit GMR effect have been the subject of numerous studies. They have great potential for technological applications, such as magneto resistive sensors and magnetic recording devices. This effect is a large change in electrical resistance that occurs when thin stocked layers of ferromagnetic and non-ferromagnetic layers are exposed to a magnetic field. The first magnetic layer allows electrons in only one spin state to pass through it easily. If the second magnetic layer is aligned than that spin channel can easily pass through the structure, and the resistance is low. If the second magnetic layer is misaligned then the neither spin channel can get through the structure easily and the resistance is high.

A new class of materials with alternating layers of different metals having thickness of a few nanometers with ultra fine microstructure are known as compositionally modulated alloys (CMA) or compositionally modulated mltilayers (CMM). As a result of layering at the atomic level, they exhibit unusual and outstanding properties such as enhanced mechanical and magnetic properties which are not obtainable in normal metallurgical alloys. CMM are also ideal as model systems in the study of fundamental aspects of materials in the field of magnetism, electrical transport phenomena, thermodynamic properties, etc. Vacuum based methods such as evaporation, sputtering and molecular beam epitaxy are widely used for the fabrication of GMR materials. An alternative possessing technique is electrodeposition. Electrodeposition process does not require any vacuum technology and consequently is less expensive.

Electrodeposition, by both direct current and pulse current, can be used to produce CMA. There are two major ways: (1) the single bath technique, where a pure metal and an alloy of the first metal are plated successively by changing the current density, pulse parameters and/or agitation, thereby controlling diffusion near the cathode surface; and (2) the dual bath technique, which involves the deposition in an alternating fashion of two constituents from separate baths. In this project both these techniques will be used to (a) deposit Cu-Ni, Co-Ni, Co-Cu alloys; and (b) investigate the giant magneto resistive (GMR) properties of stacked layers. GMR effect is a large change in electrical resistance that occurs when thin stacked layers of ferromagnetic and non-ferromagnetic layers are exposed to a magnetic field.

Cu-Ni alloy system

Adherent, smooth and bright deposits of Cu-Ni alloy were brush-plated successfully on copper substrates

from sulphate/citrate baths. The brush plated Cu-Ni alloy films were heterogeneous systems. Corrosion measurement showed an appreciable increase in corrosion resistance for the brush-plated Cu-Ni alloy on the copper substrate. Uniform coverage with the spherical nodular morphology of these coatings was observed from microstructure analysis.

Effect of electrolyte pH

The effect of solution pH on Cu-Ni alloy electrodeposition from sulphate/citrate electrolyte and the material properties of the deposits were investigated. The following conclusions can be drawn from the above results.

(1) Composition analysis showed that the higher bath pH increases the nickel content in alloy deposits.

(2) Polarization studies and electrochemical impedance spectroscopy on all deposits indicated that the Cu-Ni alloy deposited at pH 6 exhibited better corrosion behavior compared to other deposits. This has been deduced from increase in R_p value and reduction in I_{corr} value from polarization studies. Further, the high R_{ct} value obtained from Nyquist plots also confirm the above fact. We can also conclude that the nickel rich Cu-Ni alloy deposits exhibit better corrosion behavior than the others.

(3) Surface morphology of the alloy deposited at pH 6 was very smooth and uniform. This is because of reduction in grain sizes and average roughness.

Effect of temperature

The effect of bath temperature on Cu-Ni alloy electrodeposition from sulphate/citrate electrolyte and material properties of the deposits were investigated. The following conclusions can be drawn from the above results:

(1) Structure analysis shows that the crystalline size and grain size are reduced by increasing the bath temperature of Cu-Ni alloy deposits. Composition analysis showed that the higher bath temperature increases the nickel content in alloy deposits. There is an inverse relation between the nickel content and crystalline size.

(2) Polarization studies and electrochemical impedance spectroscopy on all deposits indicated that the Cu-Ni alloy deposited at 60°C exhibited better corrosion behavior compared to other deposits. This has been deduced from increase in R_p value and reduction in I_{corr} value from polarization studies. Further, the high R_{ct} value obtained from Nyquist plots also confirm the above fact. We can also conclude that the nickel rich Cu-Ni alloy deposits exhibit better corrosion behavior than the others.

(3) Microhardness of the Cu-Ni alloy increased gradually by increasing the bath temperature to 60°C. This is due to the change in grain and crystalline sizes

4. Surface morphology of the alloy deposited at 60°C was very smooth and uniform. This is because reduction of grain size, agglomeration size and average roughness.

Cu-Ni multilayer system

Smooth and bright deposits of Cu-Ni multilayers were deposited using two wave pulse on copper substrates from sodium citrate based baths. Uniform coverage with spherical nodular morphology and smooth coatings is seen from microstructure analysis. The XRD analysis confirms the formation of multilayer structures. There are eight peaks in this spectrum, four peaks correspond to Cu and another four peaks to Ni and these peaks are arranged alternatively, Cu and Ni indexed as face centered cubic lattice. These results confirm that there is no alloy formation, i.e each separate metal is only present.

Co-Cu alloy and multilayer system

Electrodeposition of Co-Cu alloys and multilayer were studied thoroughly using DC and pulse current technique. The current densities, duration of depositions were optimized to produce good quality

deposits. The effects of electrolyte pH, pulse parameters were also studied. From these studies we can conclude the following.

(1) Electrodeposition of Co-Cu alloy at current density 0.04 A/cm^2, 20 min and electrolyte pH 4.5 are the optimum conditions for giving good quality deposits.

(2) In pulse electrodeposition, 10 % Duty Cycle and 100Hz frequency is the optimum condition to produce good quality deposits of Co-Cu alloy.

(3) X-ray diffraction studies confirm the formation of alloy phase with the crystalline structure. The average crystalline size is 83.78 nm.

(4) The pulse electrodeposited Co-Cu alloy has better corrosion resistance than the DC Co-Cu alloy deposits and this was confirmed from the Tafel and electrochemical impedance studies. The pulse electrodeposited Co-Cu alloy has higher corrosion resistance than the DC coatings as well as the substrate.

(5) Even though the PED Co-Cu alloy has better corrosion resistance than the DC Co-Cu alloy, if it is compared to Co-Cu multilayer, the multilayer has superior corrosion resistance than the PED Co-Cu alloys. The Co-Cu multilayers were deposited with different bilayer thickness from the same electrolyte using two wave pulse technique.

GAP-12/08

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

Principal Investigator: Dr. S. Gopukumar

Sponsor: Department of Science and Technology and JST (Japan)
Budget: ₹33.89 lakh
Duration: 2008–2011

Layered high voltage (up to 5V) cathode materials like $LiMg_{0.1}Co_{0.9}O_2$, $LiNi_XCo_YMn_{1-X-Y}O_2$ and $LiM_{0.25}Ni_{0.25}Co_YMn_{1.5}O_4$ spinel delivering capacities of ~135, 175 and 120 mAh/g respectively were synthesized and characterized for their use in lithium rechargeable batteries.

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 and Forests
Budget: ₹13.17 lakh
Duration: 2008–2011

The objective of this project is the synthesis of hydrofluoroethers from perfluorocarboxylic acids by chemical and electrochemical methods. Anodic decarboxylation of butyric acid, octanoic acid, perfluorobutyric acid and perfluorooctanoic acid was carried out under various conditions. Decarboxylation studies were carried out using platinum and graphite anodes. The influence of the quantity of electricity passed, current density, nature of solvents and supporting electrolytes, etc. was studied. The products obtained were analyzed by GC-MS, ^{19}F- and ^{1}H-NMR. Results indicate the formation of a dimer as the major product. Ether, alcohol, ester, etc. were obtained as minor products.

GAP-18/08

Development of micro sensor for biomedical, food and environment applications

Principal Investigators: Dr. K.L.N. Phani and Dr. V.K. Khanna (CEERI)

Sponsor: Aeronautical Development Agency
(An NP-MASS program under a network project with CEERI and Bigtec)
Budget: ₹84.88 lakh
Duration: 2009–2012

Potentiometric estimation of calcium using ETH-129 ionophore in PVC modified ISFET configuration has been carried out in collaboration with CEERI, Pilani. Creatinine biosensor has been constructed both by enzymatic / non-enzymatic routes and the performance was optimized. Further development using ISFET-based biosensors for hydrogen peroxide, ammonia and nitric oxide are underway.

GAP-19/08

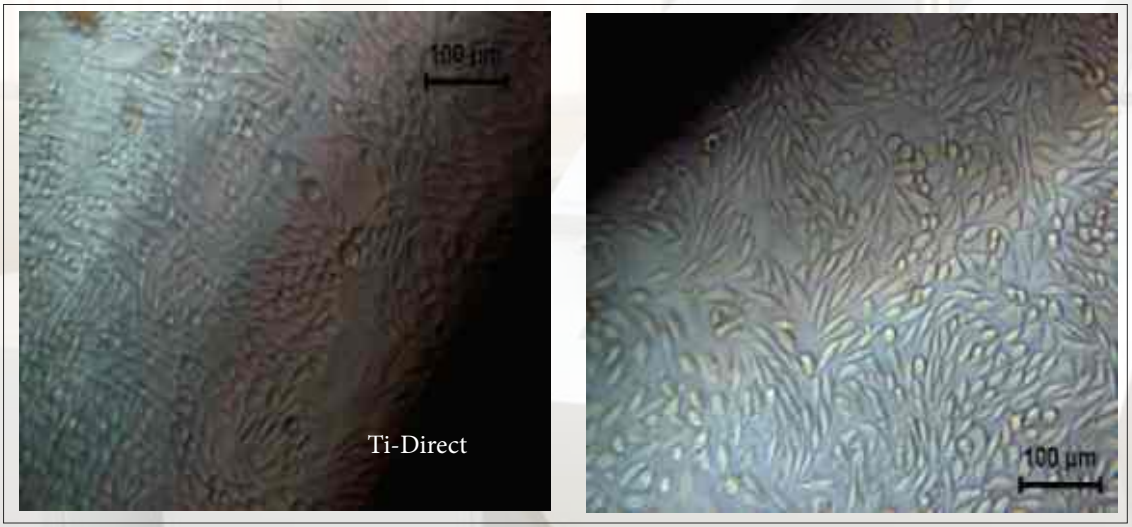
Development of nanoscale multilayered and nanocomposite super-hard coatings by reactive magnetron sputtering for biomedical applications

Principal Investigator: Dr. B. Subramanian

Sponsor: Department of Science and Technology
Budget: ₹22.35 lakh
Duration: 2009–2012

Developed Ti/TiN multilayer films of different thickness on substrates of low carbon steel, CP Ti and Si(100), and optimized the conditions. The structural analysis using XRD revealed that the films were polycrystalline, possessing a cubic structure and having a lattice parameter a = 4.2314 nm.

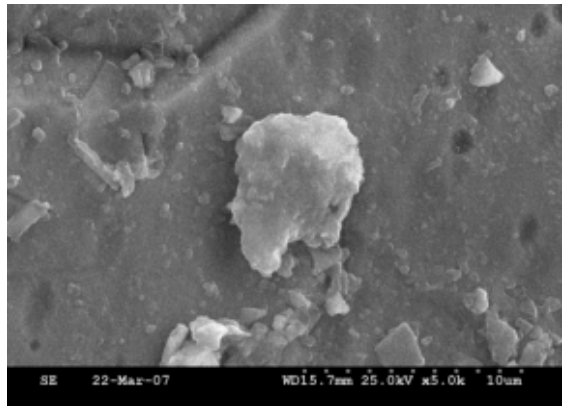
A dense columnar structure was observed from SEM analysis. The surface topography of these TiN thin films was studied using AFM. From the horizontal cross section analysis, the minimum and maximum globule size was estimated to be about 100 nm. Laser Raman spectroscopic studies showed characteristic peaks at 235, 320, 440, and 570 cm^{-1}, related, respectively, to transverse acoustic, longitudinal acoustic, second-order acoustic and transverse optical modes of TiN prepared by reactive sputtering. Also, it was found that bio films of calcium hydroxy apatite could be formed on the surface of TiN. Studies on the biocompatibility by cell adhesion as well as on intramuscular implantation and histopathology are being carried out at the Sree Chitra Tirunal Institute for Medical Science and Technology, Trivandrum. Coated surfaces were studied for their cytotoxicity effects using the direct contact, test on extract and



Fibroblasts with (a) CP Ti (b) TiN.

agar over lay techniques as per ISO 10993: Part 5. L-929 mouse fibroblast cells were used. Elongated tear drop shape of the cells shows the morphology of good healthy cells and round ones are cells which got affected. All the tested samples were non-cytotoxic.

Platelet adhesion tests on the 316L SS surface at 60 min incubation showed larger number of the adherent platelets, with a high degree of spreading and mutual interaction. There were only very few platelets adherent on the surface of TiN single layer coating and with Ti/TiN nanoscale multilayer specimen which may be due to the few pin holes present in the TiN layers. The disadvantage of physical vapor deposited coatings is that they inherently possess columnar microstructures leading to a large number of pores in the coatings. Platelets might have been trapped into the defective area rather than adhesion with spreading. Several reports have pointed out those surface associated properties, like structure, surface energy, surface charge and surface roughness, show great influence on the hemocompatibility of biomaterials. It is known that the isoelectric point (IEP) is approximately pH 7.4 for the blood. Because the mixed oxynitride phases exist at the surface of the Ti/TiN-multilayered film, the reported IEP value of its hydrated surface in air is approximately pH 4.0. When the multilayered film is exposed to the blood, the film will be negatively charged; thus, the blood elements with negative charge such as blood platelets will not adhere to the negatively charged surface easily, and therefore, thrombus on the surface will not be formed easily. The lower IEP value is attributed to the good hemocompatible nature of the deposited Ti/TiN-multilayered coating in the present work.



Platelet adhesion on the surface of 316L stainless steel substrates.

GAP-20/08

Electrochemical process for the synthesis of C_3 and C_4 perfluoroalkanoyl fluoride

Principal Investigator: Dr. M. Noel

Sponsor: Defence Research and Development Organization
Budget: ₹22.5 lakh
Duration: 2009–2011

The objective of this project is the synthesis of perfluorobutyrylfluoride and perfluorobutyryl-fluoride. These perfluoro acid fluorides are starting materials for the synthesis of perfluoroketones, which are substitutes for halon fire extinguisher. Feasibility and optimization studies were carried out for the synthesis of perfluoropropionyl fluoride from propionyl chloride by electrochemical fluorination. Due to low boiling point (–26°C) of perfluoropropionyl fluoride, various low temperature traps such as ultra low temperature immersion cooler (-70°C), liquid nitrogen, liquid nitrogen-methanol, dry ice-methanol, etc. were used to condense the vapor product. The trapping methods resulted in a low yield of the perfluorinated products.

Finally, hydrolyzing the perfluoropropionyl fluoride in a water trap was found to be suitable to capture the volatile product. Current density for the electrolysis was varied between 1.1 A/dm^2 to 1.8 A/dm^2. Under optimized conditions (1.8 A/dm^2, three water traps) the current efficiency was about 50%. 100 g of sodium perfluoropropionate was prepared and sent to the Fluoro-organic Division of IICT, Hyderabad for further studies. About 1000 g of sodium perfluoropropionate was prepared by operating a 1000 ml capacity ECF cell.

GAP-22/08

Signal amplification by gold nanoparticles in bioelectrocatalysis and sensing

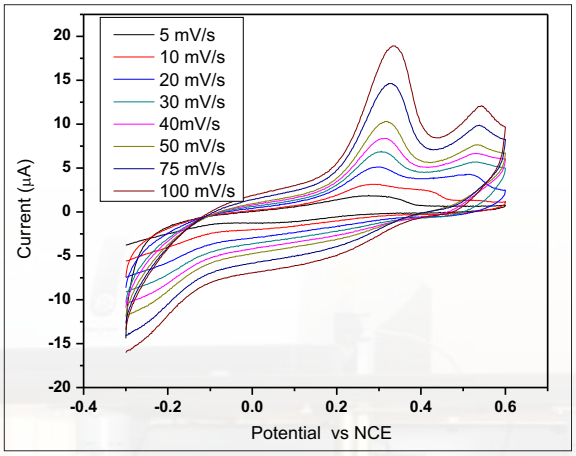
Principal Investigator: Dr. Sheela Berchmans

Sponsor: Department of Biotechnology
Budget: ₹28.43 lakh
Duration: 2009–2011

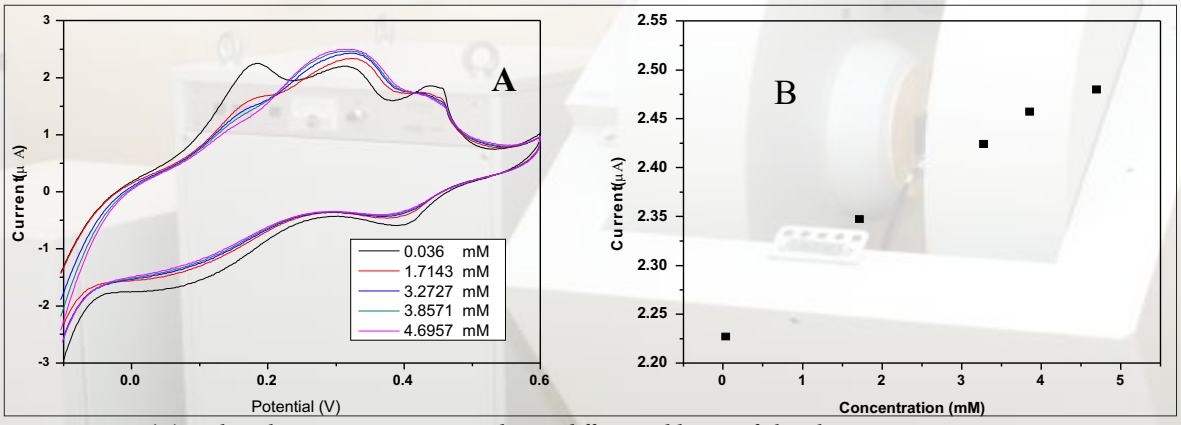
The objectives of the project are: (a) synthesis of nano building blocks such as monolayer protected metal nanoclusters, gold nano shells, dendimer encapsulated nanoclusters, polymer-gold nanocomposites; (b) evolving strategies for designing novel platforms for the fabrication of electrochemical transduction of H_2O_2 and NADH; and (c) evaluation of nanostructured assemblies for biosensor applications (e.g., phosphate ion sensor).

Fabrication of enzyme based sensing platform for phosphate

The enzyme pyruvate oxidase was immobilized on a gold electrode modified with gold nanocomposites with the help of chitosan films. The enzyme-immobilized electrode exhibited linear response to phosphate in the concentration range 0.03–4.5 mM.



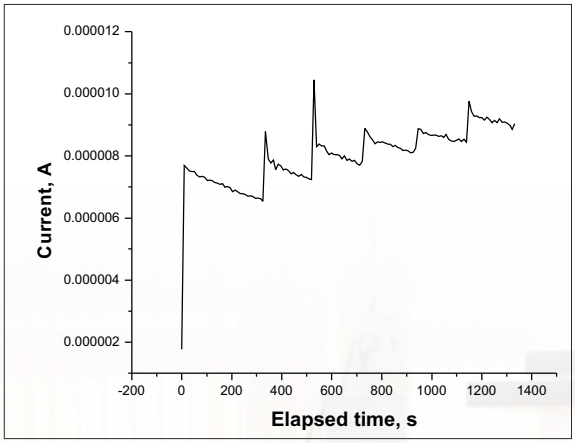
Cyclic votammograms of a pyruvate oxidase immobilized electrode in HEPES buffer (pH 5.5) at different scan rates. Reference electrode: Normal calomel electrode; counter electrode: Pt.



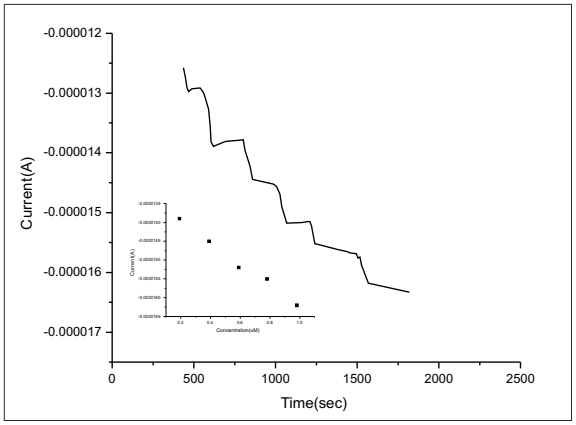
(A) Cyclic voltammograms corresponding to different additions of phosphate; scan rate: 5 mV/s.
(B) Plot showing the linearity between different concentrations of phosphate and current.

Au nanocomposites on MTMS {(3-mercaptopropyl)-trimethoxysilane}-modified silica nanoparticles self-assembled on Au for sensing NADH

This method is advantageous compared to performing NADH estimation on a bare electrode. On a bare electrode a potential of 0.640 V (the potential corresponding to oxidation of NADH) is required for the detection. Our modification strategy has reduced the potential bias by nearly 200 mV.



Amperometric response to addition of NADH with the Au surface modified by MTMS further functionalized with gold nanocomposites. Each addition corresponds to 49 M. Applied DC potential: 0.450 V.



Amperometric curve for different additions of H_2O_2. Eappld: –0.282 V. Each addition corresponds to 20 µl of H_2O_2 of stock 0.05mM.

Preparation of Ag nanocomposite modified Au electrode modified with a self-assembled monolayer of mercapto benzoic acid for H_2O_2 detection

The formation of silver nanocomposite on the gold electrode modified with mercaptobenzoic acid was characterized by cyclic voltammetry. The cyclic voltammogram showed the characteristic redox features of silver. The silver nanocomposite modified electrode was found to be catalytic for the reduction of H_2O_2. Amperometric analysis of H_2O_2 was conducted at –0.282 V vs. NCE using the Ag nanocomposite-modified electrode. Linearity is observed in the concentration range 180–1000 nM of H_2O_2.

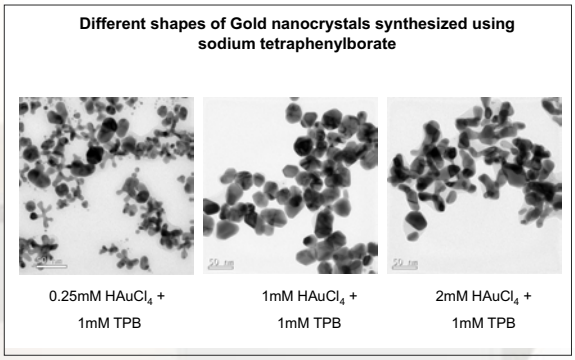
GAP-04/09

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

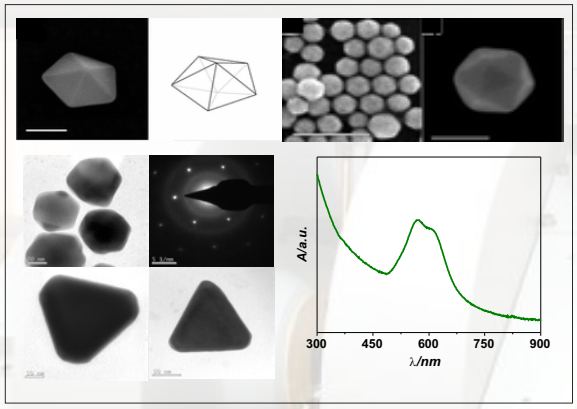
Principal Investigator: Dr. S. Senthilkumar

Sponsor: Department of Science and Technology
Budget: ₹10.90 lakh
Duration: 2009–2012

The objectives of this study are: 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 sonochemical 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 structure-sensitive under potential deposition reactions—cyclic voltammetry and impedance analysis); and to study structure-sensitive electrochemical reactions like oxygen reduction reaction and methanol oxidation.



Au-Pt/C bimetallic nanoparticles were synthesized by a polyol method using polyvinylpyrrolidone. The products were core-shell structures of Au-Pt/C bimetal nanoparticles of 5 nm size. Au@Pt/C structure favored the oxygen reduction reaction whereas Pt@Au/C exhibited high methanol tolerance in addition to promoting oxygen reduction. Other methods of preparation of gold nanoparticles yielded interesting nanostructures.



Gold nanoparticles generated using seedless method.

GAP-16/09

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

Principal Investigator: Dr. J. Mathiyarasu

Sponsor: Department of Biotechnology

Budget: ₹26.35 lakh

Duration: 2010–2013

The project aims at the development of a miniaturized sensor device using screen printed carbon composite electrodes for the estimation of toxic heavy metals such as Hg, Cr, Pb and Cd, and organophosphate pesticides such as paraxon, fenitrothion and methyl parathion.

GAP-05/09

Development of nano particles dispersed nickel composite materials by electro-codeposition technique using DC and pulse current

Principal Investigator: Dr. G.N.K. Ramesh Bapu

Sponsor: Department of Science and Technology
Budget: ₹14.98 lakh
Duration: 2009–2012

Electro co-deposition is a low-temperature process for the fabrication of nanostructured materials, usually in a single step without secondary treatment. Nanocomposite materials are of interest for both thin and thick film applications. They exhibit novel properties like superior wear resistance, hardness and corrosion resistance, with potential for application in next generation microdevices.

The objectives of the research programme are to: (a) develop nickel nanocomposites electrochemically using DC and pulse current techniques; (b) correlate the amount of co-deposited particles with concentration of particles suspended in solution, metal concentration, added surfactants, bath pH, electroplating parameters like temperature, current density, type of imposed current, degree of agitation etc.; (c) study the kinetics of codeposition of nanoparticles into the nickel matrix using electrochemical techniques; (d) characterise the nanocompopsites for hardness, wear and corrosion resistance; and (e) investigate the effect of nanoparticle incorporation on surface morphology, microstructure and crystallographic orientation of the composite coating.

For incorporation of Si particles in nickel matrix by electrodeposition, bath composition and electroplating parameters were standardized. The deposited Ni-Si composite showed higher hardness compared to nickel. The conditions for incorporation of nanoTiCN using direct and pulse plating method is being standardized now.

Experimental set up used for composite deposition.

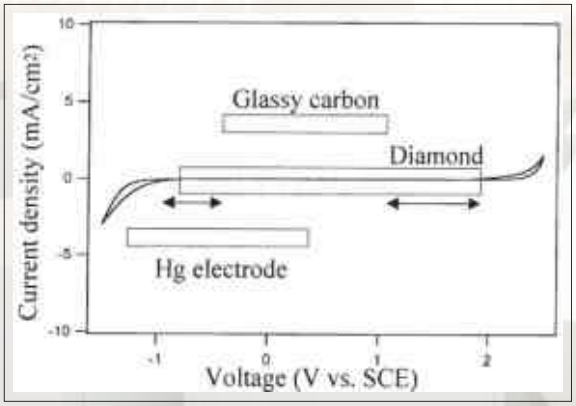
GAP-13/09

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

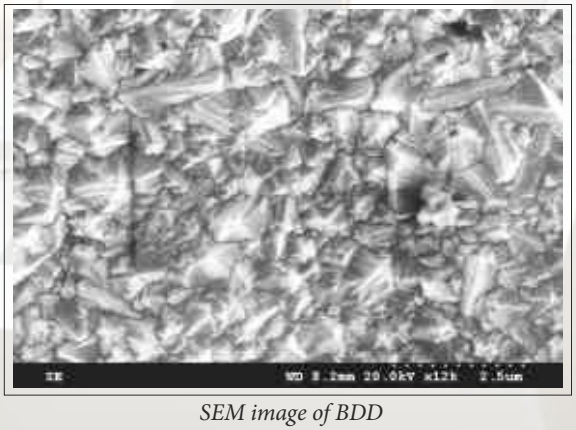
Principal investigator: Dr. V. Suryanarayanan
Client: Department of Science and Technology
Fee: ₹14.62 lakh
Duration: 2009–2012

Electrochemical studies with conductive boron doped diamond (BDD), a new sp^3 carbon based thin film material, have received much attention recently. The electrode provides superior chemical and dimensional stability, low background current, highly inert surface and a wide potential window in both aqueous and non-aqueous electrolyte system. These properties make the BDD an attractive candidate for electro incineration of organic pollutants for wastewater treatment and electro-analysis. One of the most useful properties of the BDD electrode is the facile generation of hydroxy, methoxy and acetoxy radicals at high anodic potentials from the aqueous solvent systems and these radicals can be utilized for the synthesis of corresponding organic oxy-derivatives.

The anodic oxidation of phenol derivatives in aqueous medium has served to generate key intermediates in the synthesis of natural products such as neolignans, isodityrosines and triquinanes. Similarly, electrochemical hydroxylation of methyl substituted aromatic derivatives leads to important precursors for the preparation of vitamin E. However, the yield of these intermediates on graphite electrodes is very low. The poor yield of the product is due to either high oxidation potential of the raw material or electrode fouling due to adsorption of starting materials or products on the anode during electrolysis. As an alternative material for improving the yield during electrolysis, BDD was employed. Glassy carbon (GC) electrode was used for comparative purposes.



Cyclic voltammogram for BDD in 0.1 M H_2SO_4 along with GC and Hg showing the range of potential windows



SEM image of BDD

Voltammetric studies showed that acidic methanol medium is suitable for the anodic oxidation of 2,6-dimethoxy phenol on both BDD and GC electrodes for the facile generation of free radicals. Furthermore, in acidic methanol medium, no severe surface fouling of the starting material or the product was observed on both the electrodes even though the organic compound gets oxidized at slightly higher potential than the aqueous or aqueous-methanolic media. The difference in the E_{pa} values obtained on the BDD and GC increased with increasing *p*H and alcohol content. In alkaline methanolic medium, this difference was as high as 1.10 V. Such difference may mean that BDD is not suitable for electrolysis in the alkaline medium.

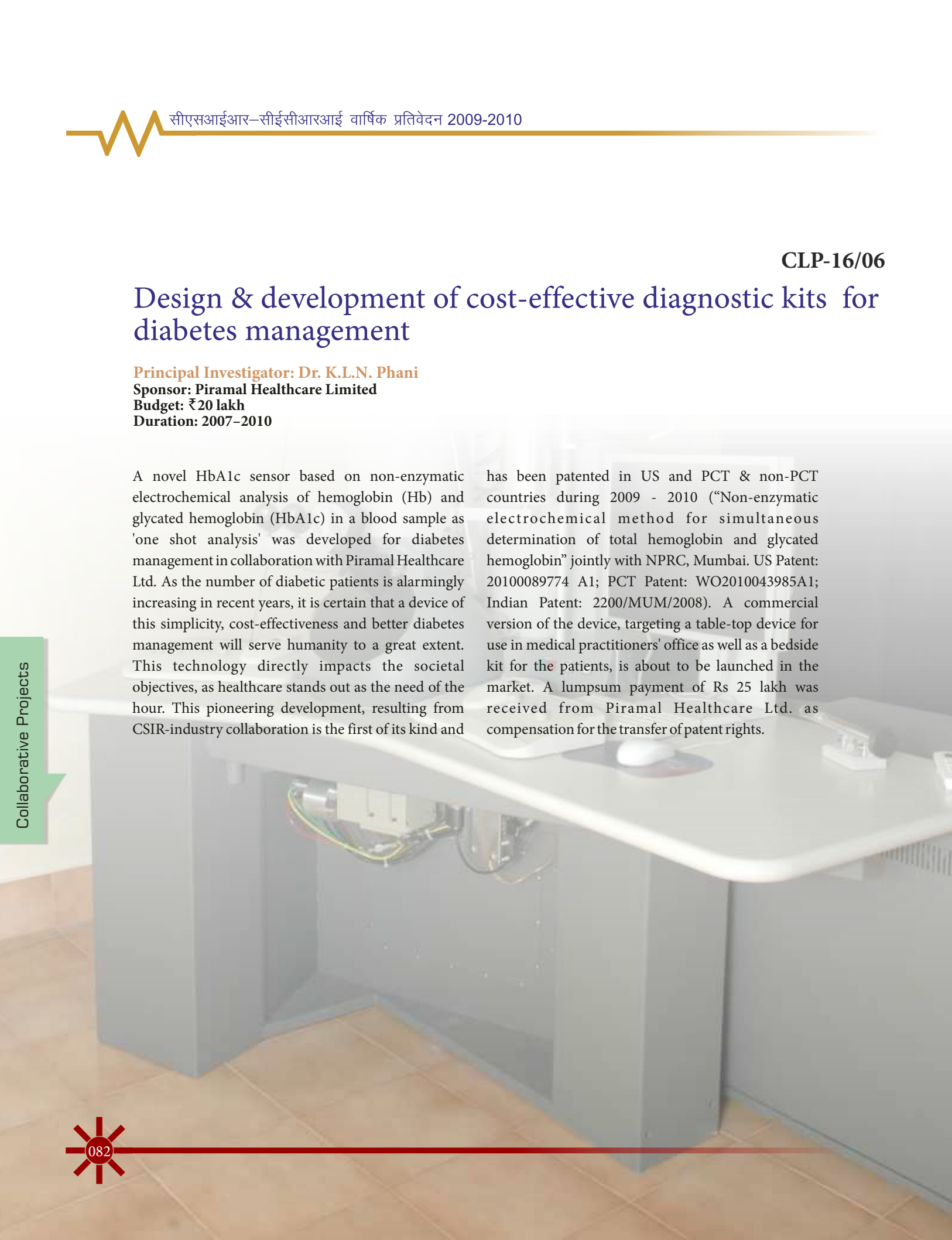
The above investigations showed that acidic methanol medium is the best medium of choice for the facile generation methoxy radicals during the preparative electrolysis of 2,6-dimethoxy phenol on both BDD and GC electrodes. The anodic oxidation of mesitylene takes place near the oxygen evolution on the BDD electrode in the acidic medium and GC is not suitable electrode in any other media.

CLP-16/06

Design & development of cost-effective diagnostic kits for diabetes management

Principal Investigator: Dr. K.L.N. Phani
Sponsor: Piramal Healthcare Limited
Budget: ₹20 lakh
Duration: 2007–2010

A novel HbA1c sensor based on non-enzymatic electrochemical analysis of hemoglobin (Hb) and glycated hemoglobin (HbA1c) in a blood sample as 'one shot analysis' was developed for diabetes management in collaboration with Piramal Healthcare Ltd. As the number of diabetic patients is alarmingly increasing in recent years, it is certain that a device of this simplicity, cost-effectiveness and better diabetes management will serve humanity to a great extent. This technology directly impacts the societal objectives, as healthcare stands out as the need of the hour. This pioneering development, resulting from CSIR-industry collaboration is the first of its kind and has been patented in US and PCT & non-PCT countries during 2009 - 2010 ("Non-enzymatic electrochemical method for simultaneous determination of total hemoglobin and glycated hemoglobin" jointly with NPRC, Mumbai. US Patent: 20100089774 A1; PCT Patent: WO2010043985A1; Indian Patent: 2200/MUM/2008). A commercial version of the device, targeting a table-top device for use in medical practitioners' office as well as a bedside kit for the patients, is about to be launched in the market. A lumpsum payment of Rs 25 lakh was received from Piramal Healthcare Ltd. as compensation for the transfer of patent rights.



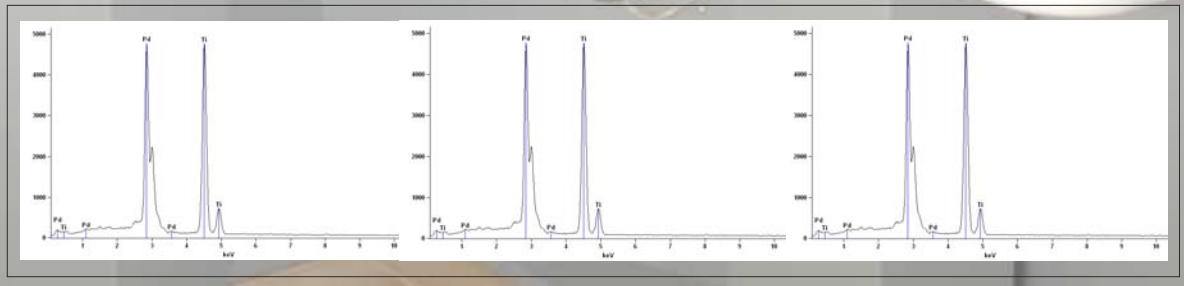
CLP-24/07

Enhanced processes for the removal of nitrate from water

Principal Investigator: Dr. S. Vasudevan
Sponsor: Indo-French Centre for Promotion of Advanced Research
Budget: ₹20.92 lakh
Duration: 2008–2010

Six electrocatalysts (Pd/Ti, Pt/Ti, PdSn/Ti, PdIn/Ti, PdAu/Ti and PdAg/Ti) were prepared by two methods: electrodeposition and thermal decomposition. The electrocatalysts were characterised by SEM, EDAX, XRF, etc. Their electrocatalytic performance was examined by cyclic voltammetry and chrono amperometry. A batch type (2.5 A / 7-litre) electrochemical cell was designed, fabricated and operated for the removal of nitrate. It was concluded that the Pd/Ti, PdSn/Ti and PdAg/Ti electrodes were suitable for electrochemical removal of nitrate and that the optimum current density was 0.25 A/dm^2 (pH: 6.5 - 7.0). It was also found that the amounts of nitrate, nitrite and ammonia present in the treated water were well within the drinking water standards in India and Europe.

2.5 A electrochemical dinitrification cell



EDAX profiles of the Pd/Ti electrode

Pd/Ag cathode

Metal oxide anode

CLP-01/08

Design and development of batteries for solar photovoltaic applications

Principal Investigators: Mr. S. Ambalavanan
Dr. P.C. Pant (MNRE)

Sponsor: Ministry of New and Renewable Energy
Budget: ₹160.96 lakh (CECRI)
Duration: 2008–2011

Pulse width modulation charge controllers with following specifications were fabricated in association with Crisp Automation, Coimbatore and field trial is going on.

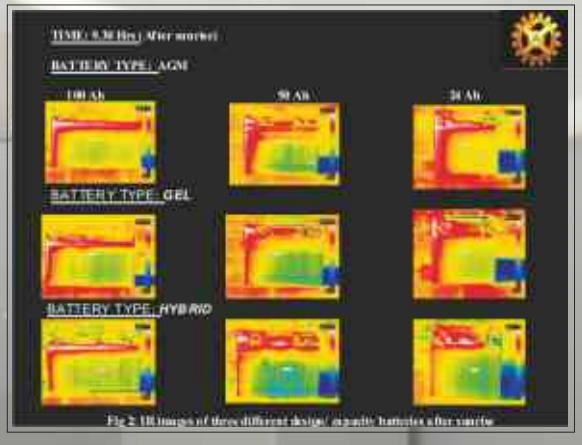
Temperature

One of the decisive factors that determine the service life of batteries is temperature. The rate of most electrochemical processes is approximately doubled when the temperature is raised by 10°C. A study was undertaken to examine temperature distribution with an infrared thermal camera. The resulting thermographs depicted thermal images of VRLA batteries of different design and capacities used for solar photovoltaic application.

In this study we have used 12V/24Ah, 12V/50Ah, 12V/100Ah each of AGM VRLA, gelled-electrolyte VRLA and hybrid VRLA batteries. The dimensions of these batteries are:

Capacity	Length*Breadth*Height (mm)
12 V / 24 Ah	195*165*155
12 V / 50 Ah	265*165*180
12 V / 100 Ah	315*165*210

Testing of PIC control PWM charge controller



Collaborative Projects

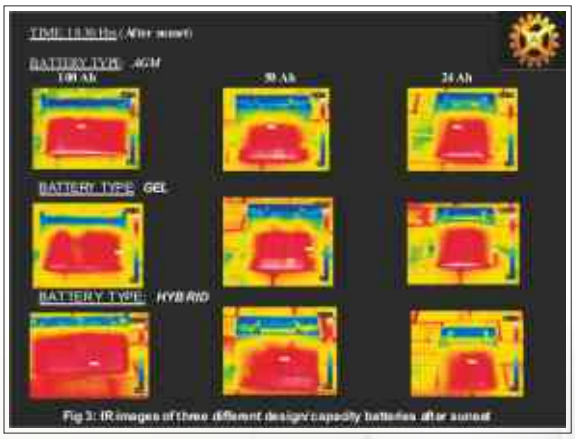


Fig 3: IR images of three different design/capacity batteries after sunset

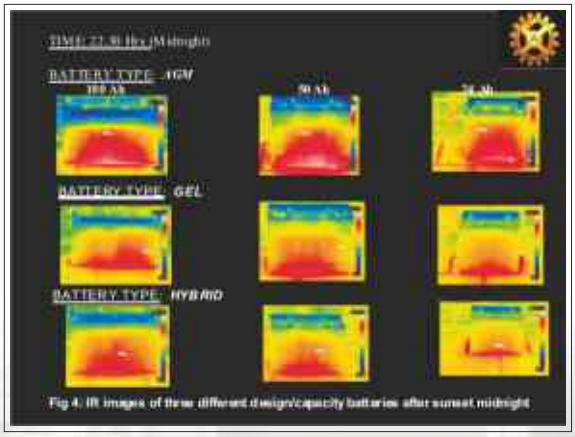


Fig 4: IR images of three different design/capacity batteries after sunset midnight

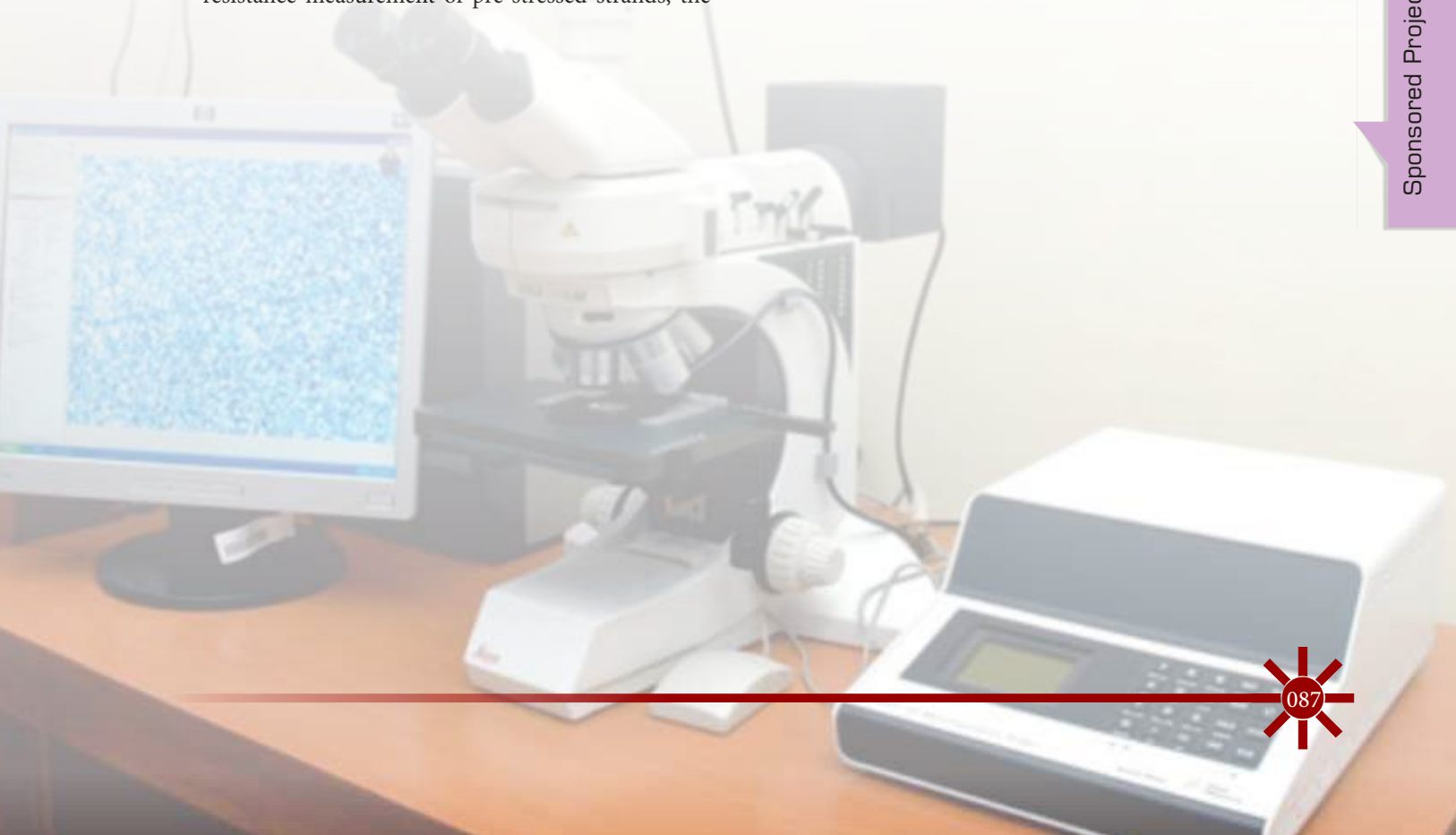
SSP-07/05

Corrosion monitoring of pre-stressed strands in Kudankulam nuclear reactor

Principal Investigator: Dr. SP. Manoharan
Sponsor: Nuclear Power Corporation of India Limited
Budget: ₹63.70 lakh
Duration: 2005–2010

A corrosion monitoring system was developed using (a) an embedded corrosion integrated sensor (CIS) and (b) measurement of strand resistance. The embedded corrosion sensor measures corrosion-related parameters such as chloride ion ingress in the concrete cover, corrosion potential, polarization resistance, concrete resistance and temperature.

In each reactor building, four CISs were embedded at different elevations. Using Cr200 Campbell scientific data logger sensor data were logged in a PC. In the resistance measurement of pre-stressed strands, the ends of the strands were nickel-plated and electrical contacts were established with 55 strands at both ends of each of the allotted cables (six H cables and six inverted U cables), and wires were terminated at four junction boxes. In each of the JBs, 3 x 55 channels were required four 4-wire resistance measurements. Accordingly, the PXI system was configured with two PXI2575 switches and NI PXI4065 DMM. A user-friendly software was developed in LabView platform for the automation of resistance measurements.



SSP-03/06

Maintenance of plating facility and gold plating on aluminium alloy component hardwares used in satellites

Principal Investigator: Dr. Sobha Jayakrishnan
Sponsor: Indian Space Research Organization
Budget: ₹57.00 lakh
Duration: 2006–2009

Momentum wheel assembly and reaction wheel assembly are important components in INSAT and IRS satellites. The cover plates of these components are made of AA6351 aluminium alloy, and need to be plated with gold as per ISRO specifications. This was carried out through a process sequence developed at CECRI consisting of special pre-treatment operations, plating of undercoats of Zn, Cu and Ni, followed by gold plating. Each component passes through a series of quality control tests before acceptance by ISRO Inertial Systems Unit (IISU). A plating facility for carrying out this work was established at CECRI to cater to the needs of IISU. This facility is ready for plating by incorporating necessary modifications and regular maintenance of all operating solutions and instruments and the plating of components carried out as per requirement. The plated components (momentum wheel assembly top case and bottom plates; reaction wheel assembly top case and bottom plates) are used in the satellites launched by ISRO and in Chandrayaan.

Microreaction wheel assembly parts of ISRO gold plated at CECRI

Sponsored Projects

SSP-14/06

Studies on the development of high durability and multi-functional concrete

Principal Investigator: Dr. V. Saraswathy
Sponsor: Yonsei University, South Korea
Budget: US$ 1.00 lakh
Duration: 2007–2011

Blended cements such as Portland Pozzolana cement (PP containing 25% fly ash, Portland slag cement (PSC) containing 50% slag and ordinary Portland cement (OPC) were taken with different mix proportions, namely, M25 and M40 grade with cover thickness of 25 and 40 mm with varying chloride ion concentrations from 13% by weight of cement.

The objectives of the investigation are:

1. study of the corrosion behavior of steel in OPC, PPC and PSC concretes under various environmental conditions (indoor and outdoor) atmospheric zone, splash zone and underwater zone
2. evaluation of the corrosion of blended cements under short-term and long-term laboratory conditions and field conditions using various electrochemical techniques
3. study of the long-term corrosion behavior of blended cements such as ordinary Portland cement and blended cements (Pozzolona cement (PPC) and slag cement (PSC)) with and without chloride
4. identification of suitable high-performance inhibitor systems for enhancing the durability of rebar in concrete (OPC, PPC and PSC) with chloride, and
5. determination of the tolerance limit of chloride in different grades of concretes using blended cements.

SSP-04/07

Preparation of painting manual and study of other corrosion problems at Numaligarh Refinery Ltd.

Principal Investigator: Dr. S. Muralidharan
Sponsor: Numaligarh Refinery Limited
Budget: ₹7.79 lakh
Duration: 2007–2009

This project has two objectives: (1) preparation of a painting manual; (2) studies of the corrosion problems faced in fire hydrant and cooling water pipelines, and heat exchangers.

Mild steel panels with different coating systems were exposed at six locations in NRL for atmospheric corrosion studies. Periodical observations were made on these samples. Based on the studies, a painting manual suggesting suitable protective coating systems for different locations in the refinery was submitted.

Water samples were collected from six locations. Weight loss studies, potentiodynamic polarization and the impedance measurements were made on carbon steel in the water samples. Bacterial enumeration was also carried out on these water samples. The results showed that the corrosion rate was maximum in reused firewater. Various types and combination of inhibitors were evaluated. Bacterial evaluation of the water samples indicate the presence of bacteria such as SRB in the water, which were deemed responsible for the corrosion of the fire hydrant and cooling water pipelines. The fire water contained higher amounts of SRB as compared to cooling water. Addition of corrosion inhibitors along with the biocide system was found to be effective in reducing the corrosion rate. Glutaraldehyde as a biocide along with corrosion inhibitors (ATMP, zinc sulphate, sodium benzoate and sodium gluconate) was found to be effective in reducing the corrosion rate in these water samples.

Sponsored Projects

SSP-07/07

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

Principal Investigator: Dr. N. Palaniswamy and Dr. K. Saravanan
Sponsor: Thane Creek Bridge, Navi Mumbai
Budget: ₹30.00 lakh
Duration: 2007–2010

Under the CSIR Bridge Engineering Consultancy Services Scheme B-15, CECRI has already done instrumentation work in one span of South Carriageway of second Thane Creek Bridge. To monitor corrosion of mild steel reinforcements, 30 corrosion monitoring sensors were installed at six different sections of the box girder in the instrumentation span P12P13. In each section, five probe sensors were installed at different locations like web, soffit, deck and cantilever portion of the box girder. In addition, potential probes were also installed at different locations in this span in order to assess the probability of corrosion. Since August 1993 field data on corrosion monitoring of mild steel reinforcements were collected over a period of 22 months. In addition to the above sensors, corrosion of pre-stressing cables were monitored using cable resistance technique in the South carriageway. Installation of wire connections for corrosion monitoring was done on 12 pre-stressing cables in span Nos. P11P15. Since October 1993 corrosion of pre-stressing cables was monitored for a period of 21 months. Later, a detailed report was submitted to Maharashtra PWD on the corrosion condition of Second Thane Creek Bridge.

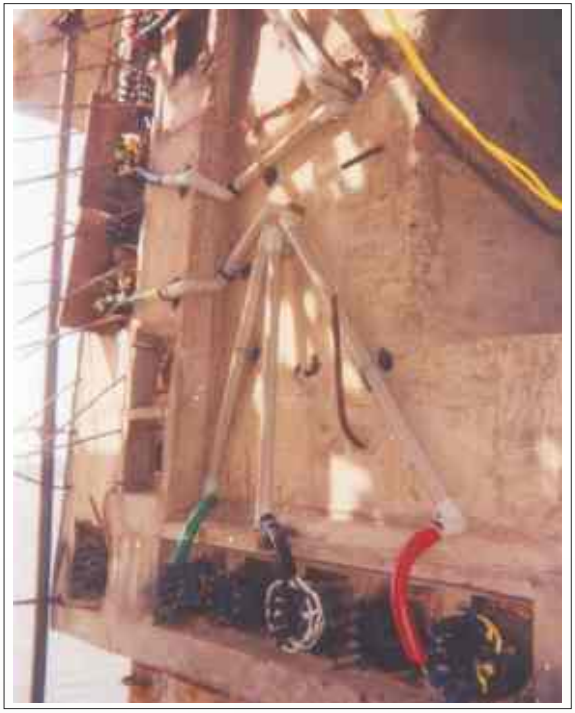
In the present work, a joint proposal was submitted by CECRI along with CRRI to Maharashtra PWD. CECRI is focused on corrosion monitoring of both mild steel and pre-stressing cables and CRRI concentrated on structural aspects. The main scope of the CECRI in this project are as follows:

All the previously installed corrosion monitoring probes, potential probes and electrical connections taken for monitoring of corrosion of pre-stressing cables will be checked initially for their present condition. Based on the above, corrosion monitoring probes and potential probes, suitable for future monitoring will be identified. Corrosion monitoring will be carried out with probe sensors. Cable resistance measurements will be carried out on previously monitored pre-stressing cables between the span Nos. P11P15. Corrosion monitoring on probes and prestressing cables found suitable for long term monitoring will be done by CECRI for a period of three years at three-monthly intervals.

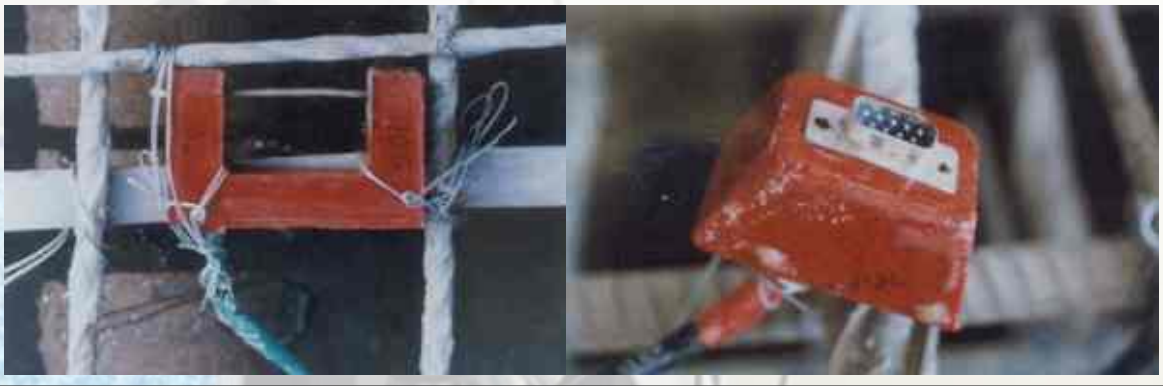
According to the above objectives, a scientific team visited the Second Thane Creek Bridge site and all the corrosion monitoring probe sensors were examined for their present conditions. Out of 30 corrosion monitoring probe sensors installed earlier, 14 probes were identified as damaged. Retrieval work was done on the damaged probes. Except one probe, remaining 13 probes have been retrieved and rendered suitable.

In addition, all the wire connections of pre-stressing cables were examined for their present condition. It was found that all the wire connections in the 12 pre-stressing cables were intact. Later, initial corrosion measurements were made on 29 probe sensors for predicting the percentage reduction in diameter of mild steel reinforcement. Potential measurement was also carried out on potential probes, which were identified in four locations of the instrumentation span P12P13.

Data on corrosion measurement was done on 12 pre-stressing cables located in the spans P11P15 at different lengths using cable resistance measurements. 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 on pre-stressing cables indicate lower values than the theoretically assessed values, indicating the corrosion-free condition of steel in the Second Thane creek bridge. Further monitoring is in progress.



Various arrangements made for the cable resistance technique



A close view of corrosion monitoring probe and monitoring socket installed at various places in the Second Thane Creek Bridge, Mumbai.

SSP 26/07

Studies on coatings for heat exchangers and condensers

Principal investigator: Dr. S. Syed Azim

Sponsor: Multi Coat, Pvt. Ltd.
Budget: ₹8.46 lakh
Duration: 2008–2010

The performance of coated panels were studied according to ASTM standards for their corrosion resistance, heat resistance, steam resistance, humidity resistance, antifouling resistance (exposure to natural sea at CECRI Tuticorin unit, 12 months), electrochemical impedance measurements (12 months) and surface free energy calculations from contact angle measurements.

Acid resistance test setup.

Samples after stem resistance test.

SSP-07/08

Development of electrochemical process for the production of tetraethyl ammonium hydroxide, tetrapropyl ammonium hydroxide and tetrabutyl ammonium hydroxide from the respective bromides

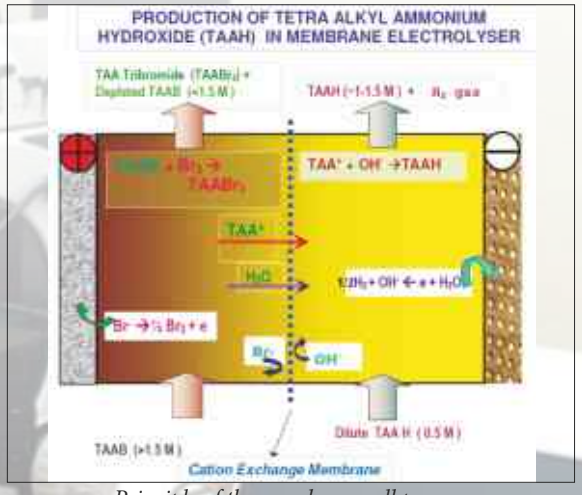
Principal Investigator: Dr. K. Asokan
Sponsor: Tatva Chintan Pharma Chern Pvt. Ltd.
Budget: ₹12.00 lakh
Duration: 2009–2010

Tetraalkyl (quaternary) ammonium hydroxides (TAAHs) are currently used industrially as stabilisers or solubilisers for organic compounds in aqueous solutions, as microbiocides or template agents in the synthesis of numerous zeolites, washing and etching of the surface of the semiconductor substrate, lubricant oil-fuel mixture in combustion engine and as organic base for making pharmaceuticals. Hitherto, they were prepared by chemical methods by which high concnetrations and purity could not be achieved. The electrochemical membrane process promises high product purity and reduced cost.

Tetraalkyl ammonium bromide (TAAB) solution was electrolyzed to produce the hydroxide, hydrogen and bromine. The anode and cathode chambers were separated by composite bilayer perfluorosulphonic / carboxylate membrane. An aqueous solution of TAAB (200–300 g/l) is fed to anode compartment. A weak solution of TAAH (50 g/l) was fed to the cathode compartment. On application of an electric current, tetra alkyl ammonium (TAA+) cations with associated water molecules got transported through the membrane to the cathode compartment. Bromide ions were discharged at the anode to form liquid bromine, which further reacted with the excess TAAB in anolyte to form tetra alkyl ammonium tribromide as an orange-yellow floating solid in the anolyte. Water was discharged at the cathode to form hydroxide ions and hydrogen. The hydroxide ions then combined with TAA+ to form TAAH. During the electrolytic process, the concentration of TAAH in the cathode compartment built up to 30–40%.

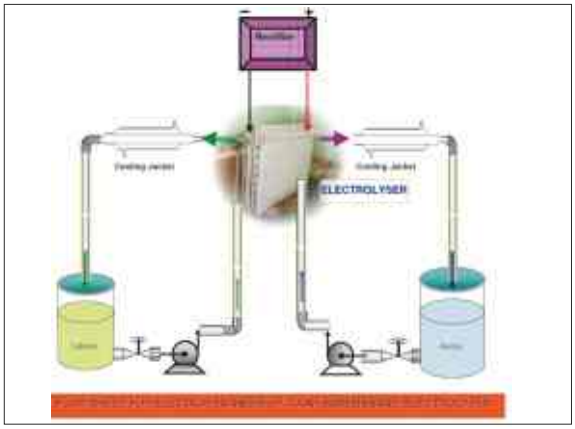
Development of the technological process

Electrochemical processes for the production of TEAH, TPAH and TBAH from the respective bromides were developed. Electrolysers with different cation exchange membranes and operating 10, 50 and 250 A ratings were designed. Process parameters for the above were also optimized.



Principle of the membrane cell process

Sponsored Projects



General process flow sheet

Electrolyser for the production of TPAH

Electrolyser for the production of TEAH

Membrane electrolyser of 250 A rating for the production of TBAH

SSP-09/08

To study atmospheric conditions and suggest suitable protective coating systems for steel structures and concrete structures on sea

Principal Investigator: Dr. S. Muthukrishnan
Sponsor: National Thermal Power Corporation Limited
Budget: ₹5.00 lakh
Duration: 2008–2010

Ten stands were erected at different locations inside and outside the plant of NTPC, Simhadri, Vishakapattinam. One stand was erected on the seaside. Monthly, quarterly and annual atmospheric corrosion rates were determined by exposing mirror polished mild steel panels. Annual atmospheric corrosion rates were also determined by exposing polished non-ferrous metals. Different paint schemes were formulated and evaluated at the above locations.

Results of atmospheric corrosion rates were submitted to NTPC at regular intervals. Suitable protective coating schemes for the chosen atmosphere were incorporated in the final report after studying the performance of the coatings. Technical specifications were also incorporated in the report.

SSP-14/08

Gold plating of minor components of RWA and MWA used in satellites

Principal Investigator: Dr. Sobha Jayakrishnan
Sponsor: Indian Space Research Organization
Budget: ₹4.01 lakh
Duration: 2008–2009

This is a project taken up based on an MOU between IISU and CECRI to cater to the gold plating requirements of ISRO. Minor components are a set of components made of aluminium alloy which require an adherent coating of gold ~1µm, which should withstand quality control tests stipulated for spacecraft applications. The plating was carried out as per the procedure and jigging schemes standardized earlier. A total of 460 components of varying geometries and sizes were plated.

The objective is to carry out gold plating as per the process identified between CECRI & IISU on the minor components made of aluminum alloy supplied by IISU. This project was taken up based on an MOU between IISU and CECRI to cater to the gold plating requirements of ISRO. Minor components are the components made of aluminum alloy which require an adherent coating of gold ~1µm which should withstand quality control tests stipulated for spacecraft applications. The plating was carried out as per the procedure and jigging schemes standardized earlier.

RWA and MWA minor parts of ISRO gold plated at CECRI

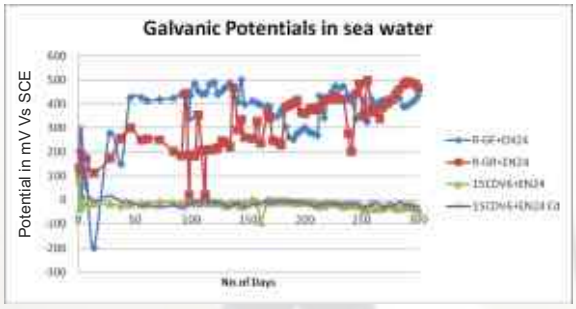
SSP 15/08

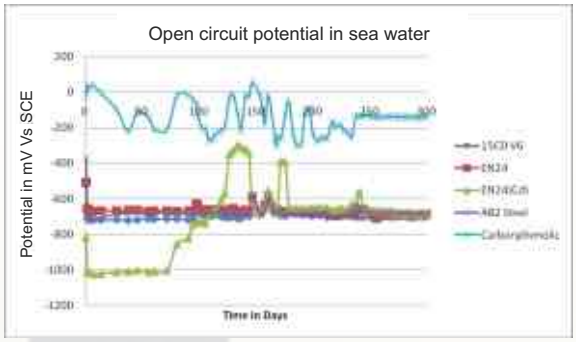
Corrosion studies of canister materials

Principal investigator: Dr. S. Syed Azim

Sponsor: Advance System Laboratory, Defence Research and Development Laboratory
Budget: ₹3.09 lakh
Duration: 2008–2010

Open-circuit potentials, coupled potentials, galvanic potentials, galvanic current measurements, EIS measurements and corrosion rates by weight loss measurements were carried out in seawater for 9 months for the following materials: AB2 steel, 15CDV6 steel, EN 24 steel with cadmium plating, EN 24 steel epoxy R-glass roving, epoxy R-glass fabric and carbon phenolic.





Sponsored Projects

SSP-17/08

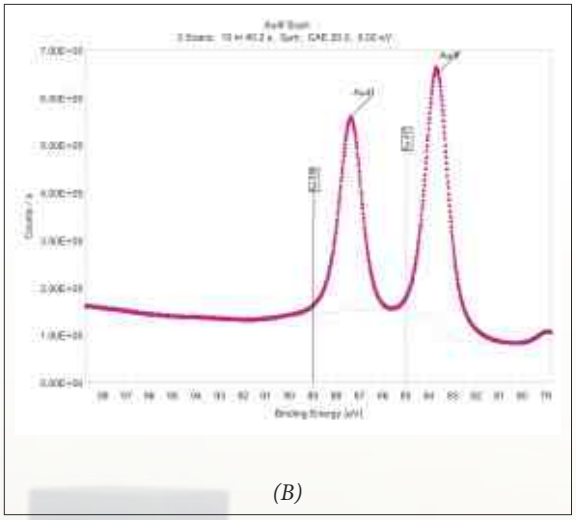
Feasibility study on gold plating on Cu-Be alloy fixtures for satellite applications

Principal Investigator: Dr. Sobha Jayakrishnan

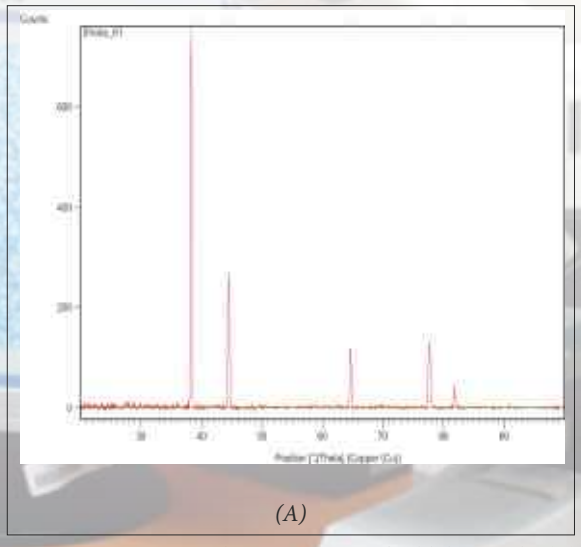
Sponsor: Indian Space Research Organization
Budget: ₹1.99 lakh
Duration: 2009-2010

ISRO Inertial Systems Unit is carrying out trials on the use of a special type of fixtures for use in satellite applications. There is a requirement for gold plating on these fixtures for which this project was taken up. The fixtures of IISU to be plated with gold are made of a Cu-Be alloy. The gold plating should withstand the qualification tests normal to any plated finish plus thermal cycling test by heat cycling from 65 to 150°C followed by adhesion test.

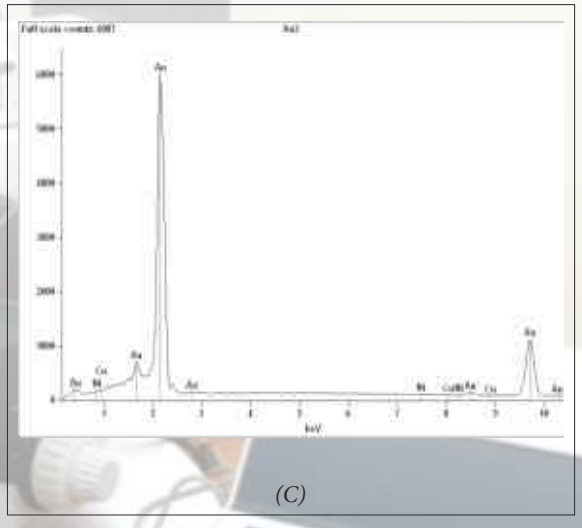
In this project, a suitable process sequence was identified for producing an acceptable gold plating finish that passes specified quality control tests.



(B)



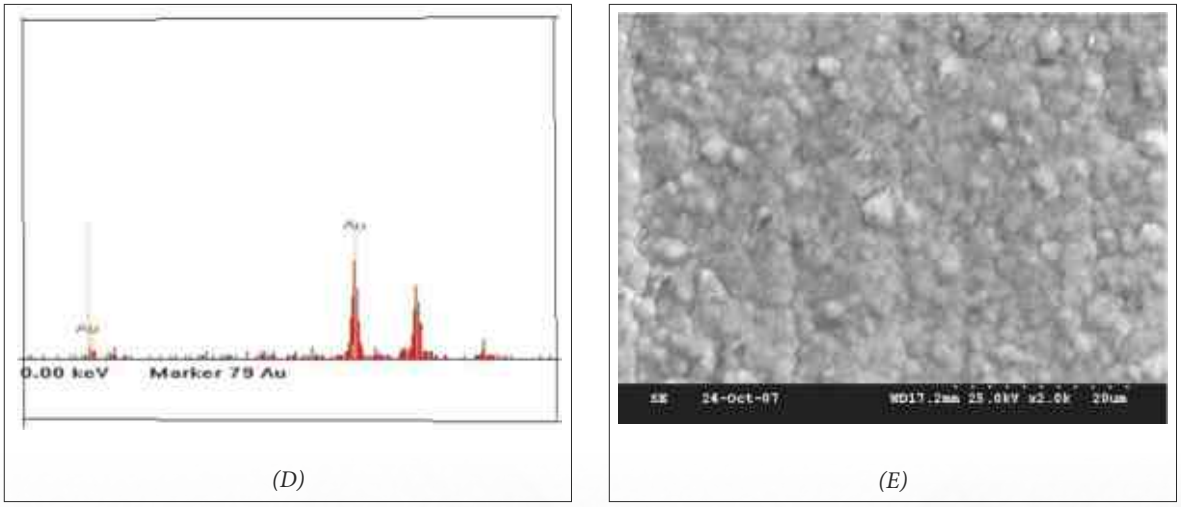
(A)



(C)

Characterization of gold deposits by (A) XRD, (B) XPS and (C) XRF, techniques

Sponsored Projects



(D) *(E)*

Characterization of gold deposits by (D) EDAX and (E) SEM techniques

SSP-21/08

To develop a suitable coating system for corrosion protection of steel structures of special mining equipments

Principal Investigator: Dr. S. Muthukrishnan

Sponsor: Neyveli Lignite Corporation
Budget: ₹2.92 lakh
Duration: 2009–2010

Special mining equipments working in acidic atmospheres have to withstand abrasion due to mining operations. Conducting polymers were incorporated along with inert pigment in the primer coat. Nanoparticles of TiO_2 and SiO_2 were prepared and used along with other pigments for the formulation of the undercoat. The primer and the undercoat were based on solid epoxy resin. Aliphatic polyurethane was used as the topcoat. The coating system was applied on sand blasted surface of SME. The area taken for the study was nearly 50 m^2. The performance of the coating was evaluated periodically for a year. Photographs were taken during the application of every coat and evaluation. The performance of the coating was adjudged to be good.

SSP-06/09

Feasibility on the preparation of L-cysteine from cystine

Principal Investigator: Dr. M. Noel
Sponsor: Vijayam Biocytes Private Limited
Budget: ₹2.34 lakh
Duration: 2009–2010

Redox catalytic processes involved in the paired electrosynthesis of L-cysteine and L-cysteic acid from L-cystine was investigated by cyclic voltammetry and confirmed by preparative electrolysis. The cyclic voltammetric behavior showed that in the catholyte, Sn^{2+}/Sn acts as a heterogenous catalyst for the electro-reduction of L-cystine whereas in the anolyte, the electro-generated bromine acts as a homogeneous redox mediator to enhance the electro-oxidation of L-cystine. L-Cysteine hydrochloride monohydrate (L-cysteine) and L-cysteic acid were also prepared from L-cystine by preparative electrolysis with high purity and high yields. Parameters like current density, catholyte-to-anolyte concentration ratio and mediator concentration were optimized for graphite cathode and DSA anode. At the optimum concentration of L-cystine with 1:1 concentration ratio (catholyte: anolyte), the material yield obtained for L-cysteine was above 80% and that for L-cysteic acid was close to 60%.

SSP-07/09

Long term corrosion protection scheme for aerospace articles immersed in sea

Principal Investigator: Dr. G.T. Parthiban
Sponsor: Defence Research and Development Organization
Budget: ₹9.95 lakh
Duration: 2009–2010

The objectives of this project are to (1) evaluate the corrosion behavior of missile assembly containing different metals; (2) analyze the galvanic corrosion behavior of the different metallic constituents used in interfacial ring assembly in sea water with 1:1 surface area ratio for one year; (3) analyze the galvanic corrosion behavior of the different metallic constituents used in interfacial ring assembly in seawater with actual surface area ratio; (4) analyze the galvanic coupling of multi-component cluster assembly for a year; (5) analyze the crevice corrosion behavior of different metallic constituents used in the interfacial ring assembly in seawater for a year; (6) assess the erosion corrosion behavior of the composite canister in seawater; (7) determine the susceptibility of the metals/alloys used in the article to vapor condensation corrosion; (8) analyze various corrosion protection schemes identified for the long-term performance of the article; (9) determine the long-term applicability of the various corrosion protection schemes; and (10) identify and recommend the most durable corrosion protection scheme for long-term corrosion control.

Specimens being immersed in sea for galvanic corrosion test

Before immersion in sea

After six months immersion in sea

SSP-08/09

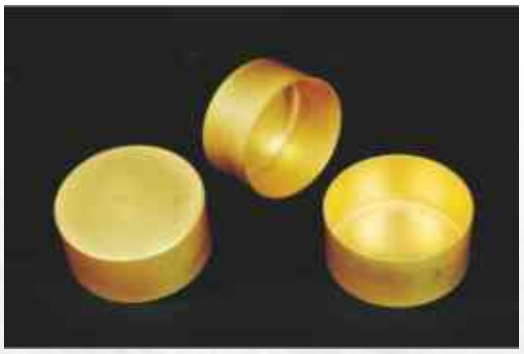
Gold plating on satellite components made of Al alloy / Cu alloy for ISRO

Principal Investigator: Dr. Sobha Jayakrishnan
Sponsor: Indian Space Research Organization
Budget: ₹71.37 lakh
Duration: 2009–2010

The objective was to carry out gold plating on satellite components of ISRO to space quality standard specifications by the process developed at CECRI. CECRI successfully developed a process for gold plating of spacecraft components made of aluminum alloy/ copper beryllium alloy for use in satellites. ISRO Inertial Systems Unit (IISU) was in need of space quality gold plating for satellite components and an MOU was signed between CECRI and IISU in 2002. The requirements of IISU are being satisfied since then by CECRI at the R&D plating facility set up exclusively for this purpose at CECRI. The components plated at CECRI are used in INSAT and IRS series of satellites and in Chandrayaan. CECRI has offered to transfer the developed technology to IISU and render necessary consultancy to set up a plating plant at IISU. The MOU has been extended for a one-year period to cater to the gold plating requirements of IISU until they are ready with their own plating facility.

Gold plating facility at CECRI created for ISRO

MWA cover plates for INSAT



Microreaction wheel assembly parts of ISRO

SSP-09/09

Feasibility study on the preparation of D-ribose from D-arabinose by electrochemical route

Principal Investigators: Dr. M. Noel and Dr. V. Suryanarayanan
Sponsor: Chemapol Industries
Budget: ₹1.60 lakh
Duration: 2008-2009

The project deals with an electrochemical method for the production of D-arabinose by decarboxylation of the sodium salt of D-gluconic acid. D-Arabinose is an important monosaccharide used for the production of D-ribose involved in the synthetic route of vitamin B2. Traditionally, it is prepared by degradative oxidation of aldonic acid using hydrogen peroxide. Industrial preparation of D-arabinose involves chemical oxidation of alkali salts of D-gluconic acid by sodium hypochlorite in acid solution. The disadvantage of the above method is the high cost in the subsequent separation of sodium chloride. In contrast, in the electrochemical oxidation process, D-arabinose can be produced in a single step directly from its sodium salt on graphite electrodes in a divided cell, which does not require any oxidizing agent or its regeneration. In this process, the extent of undesirable anodic reaction can be minimized. The conversion and selectivity is also good. The formation of low amount of side products and subsequent separation as well as purification processes to get pure D-arabinose is also very easy and simple.

SSP-10/09

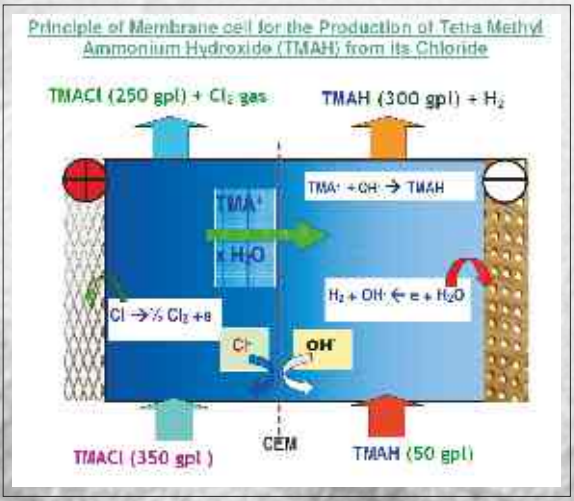
Development of a process for the production of tetra methyl ammonium hydroxide from its chloride

Principal Investigator: Dr. K. Asokan

Sponsor: National Organic Chemical Industries Limited
Budget: ₹5.74 lakh
Duration: 2009–2010

Tetra methyl ammonium hydroxide (TMAH) solution is a strong base. It is a phase transfer catalyst and is highly effective in stripping photoresists. It is used as an anisotropic etchant of silicon. It is also used as a basic solvent in the development of acidic photoresist in the photolithography process. It is also used as a surfactant in the synthesis of ferrofluid to prevent agglomeration. Electrosynthesis of TMAH can be done in an electrolyser in which the anode and cathode compartments are separated by a cation exchange membrane. TMAH and hydrogen are generated in the cathode compartment while chlorine is produced at the anode.

Once preliminary studies for the preparation of TMAH from TMAC (tetra methyl ammonium chloride) were completed, membrane cells of 10, 50 and 250A current ratings were designed and operated with various cation exchange membranes. The chlorine absorption system at the 250A current rating as well as process parameters were optimized. The technology for TMAH production will be released to NOCIL.



Membrane Cell Principle

250A electrolyser for the production of TMAH

SSP-11/09

Studying the causes of corrosion and suggesting the remedial measures to control internal corrosion in Chennai-Trichy-Madurai petroleum product pipeline of IOCL

Principal Investigator: Dr. S. Maruthamuthu
Sponsor: Indian Oil Corporation Limited
Budget: ₹6.30 lakh
Duration: 2009–2010

Microbiologically influenced corrosion is responsible for the internal corrosion in petroleum transporting pipeline. In this project, the influence of microbes in petroleum transporting pipeline was studied. Chemical and biological analyses were carried out on the corrosion product collected from different stations. The analyses revealed that the bacterial isolates had the ability to degrade the corrosion inhibitor used in the pipeline. An examination of the pipeline revealed a number of water stagnant points. The inhibitor used in the pipeline dissolved at water stagnant points and enhanced the growth of bacteria. The nature of biodegradation of the corrosion inhibitor was also analyzed by using FTIR, NMR and GC-MS. Corrosion inhibition efficiency of various inhibitors was determined by weight loss technique. A suitable inhibitor was selected and suggested to the users.

Chennai–Trichy–Madurai pipeline

Sample collection at Asanur station

SSP 12/09

Development of coatings for canister materials

Principal Investigator: Dr. S. Syed Azim
Sponsor: Defence Research and Development Laboratory
Budget: ₹9.87 lakh
Duration: 2009–2010

Corrosion resistance coatings based on epoxy glass flakes, zinc phosphate were formulated and applied over 15CDV6 steel, EN 24 steel, epoxy R-glass roving and epoxy wire wound glass fabric. Hydrophobic coatings based on PTFE-silicone/epoxy resins were formulated and applied over carbon phenolic composites. The adhesion and contact angle of the hydrophobic coatings were studied as per ASTM standards. A setup to apply the developed coating by spray was also designed and developed.

Contact angle of PTFE-silicone coating over steel.

Application of coating on actual canister tube by semi-automatic paint applicator.

SSP-14/09

Charge-discharge mechanics of Li-ion batteries

Principal Investigator: Dr. A.S. Prakash
Sponsor: General Motors Technical Center (I) Pvt. Ltd.
Budget: ₹16.08 lakh
Duration: 2009–2011

These studies focus on $LiMn_2O_4$ and $LiFePO_4$ cathode materials. So far compositional analysis (AAS) and physical and chemical characterizations have been completed as per the requirements of the sponsor.

SSP-15/ 09

To evaluate and advise on corrosion control measures for rails in the liner region

Principal Investigator: Dr. G.T. Parthiban
Sponsor: Southern Railway
Budget: ₹5.79 lakh
Duration: 6 months

The objectives of the project include (1) determination of the general corrosion, crevice corrosion and fretting corrosion behavior of the rail foot / liner region; (2) enumeration and identification of bacteria present on the rail foot; (3) study of the influence of urease bacteria, iron bacteria and manganese oxide bacteria on corrosion behavior of liner material, rail and ERC clips; (4) study of the influence of the above bacteria on crevice corrosion of rail, liner and ERC clips; (5) to advise on the different corrosion behavior of the rail foot / liner region; and (6) to suggest suitable remedial measures.

Corrosion of rails in the liner region

SSP-18/09

Studying the causes of corrosion and suggesting remedial measures to control internal corrosion in ATF (aviation turbine fuel) transporting pipeline of IOCL

Principal Investigator: Dr. S. Maruthamuthu
Sponsor: Indian Oil Corporation Limited
Budget: ₹7.38 lakh
Duration: 2009–2010

Aviation turbine fuel is a mixture of various hydrocarbons and additives. Some fuel-soluble chemicals are added in small amounts to enhance or maintain the properties related to fuel performance. The influence of microbes on corrosion in aviation turbine fuel transporting pipeline was reported. Chemical and biological analyses were carried out on the corrosion product collected from aviation turbine fuel pipeline. While examining the topography of the pipeline, the possibilities of some water stagnant points were noticed. The reason for the corrosion in the aviation fuel was investigated. Corrosion inhibition efficiency for various types of inhibitors was evaluated by the weight loss technique and the suitable inhibitor was selected.

Filter damage in ATF pipeline

Corrosion product in the pipeline

SSP-01/10

Electrolysis of cuprous chloridehydrochloric acid system for the preparation of cupric chloride and hydrogen

Principal Investigator: Mr. N. Sathaiyan
Sponsor: ONGC Energy Centre
Budget: ₹25.91 lakh
Duration: 2009–2010

In these days of energy crunch with simultaneous fast depletion of fossil fuel resulting in the release of alarming amounts of green house gases, efforts are on to find out alternative energy carrier (fuel), which will reduce the emanation of green house gases. In addition it could also be generated from renewable sources. In this context, hydrogen is considered as the best alternative and the same could be produced by i. Electrolysis, ii. Steam Methane Reforming (SMR) or iii. Splitting water by thermochemical cycle.

Production of hydrogen through electrolysis is the most energy intensive method and consumes 62.3 kWh/kg with an energy efficiency of 56%.

Thermochemical cycles are systems where all the reactant chemicals are cycled except water which is consumed in the process to generate oxygen and hydrogen. Among the 200 thermochemical cycles which have been proposed, only a few are promising based on theoretical considerations. Out of these the hybrid Cu-Cl thermochemical cycle has the advantage of taking place at a lower temperature than other prospective systems.

Electrolytic cell employed in the study

The hybrid Cu-Cl cycle consists of the following 4 steps:

$2\ Cu + 2\ HCl\ (g) \rightarrow 2\ CuCl + H_2\ (g)$ 425–450°C (1)

$4\ CuCl \rightarrow 2\ CuCl_2 + 2\ Cu$ Electrolysis at ambient (2)

$2\ CuCl_2\ (s) + H_2O\ (g) \rightarrow Cu_2OCl_2\ (s) + 2\ HCl\ (g)$ 310–375°C (3)

$Cu_2OCl_2\ (s) \rightarrow 2\ CuCl\ (l) + ½\ O_2\ (g)$ 450–530°C (4)

The electrochemical step is carried out at room temperature. Based on Central Electrochemical Research Institute's expertise on the electrolytic preparation of metals and in particular electrolytic regeneration of acidic cupric chloride with simultaneous recovery of copper in the form of powder, CECRI took up the task of collecting data on the electrolytic step.

With an objective of achieving a cell voltage of approx. 1 V, the experiments were conducted to find out the optimum operating conditions. Different cell designs were employed. More than 7 imported as well as indigenous membranes which were cationic, anionic or non specific were tested in the electrolytic cell. Influence of employing electrocatalytic anodes for the oxidation of cuprous to cupric was also tested. The conclusions arrived at are:

I. Anodic current density:
Preferably below 25mA/sq. cm

ii. Cathodic current density:
Preferably not less than 100 mA/sq. cm

iii. Diaphragm:
Preferably having a conductance of >50 m Siemens

iv. Cathode:
May be graphite or polished copper

v. Anode:
Graphite

vi. Electrolyte in anode compartment:
To be maintained 20 Cu(I) with 60 Cu(II) g/l

vii. Electrolyte in cathode compartment:
To be maintained 10-12 g/l Cu(I)

viii. Acid concentration:
Preferably 5.5 M in both compartments

Among the membranes tested Poly ethylene separator exhibited the lowest resistance. Nafion-300, cationic and anionic membranes supplied by M/s ONGC appeared to be the next best.

Scanning electron microscopic studies indicate the average size of copper powder is 15 microns

TSP-15/08

Supply of electrolyser for tetraethyl ammonium hydroxide synthesis

Principal Investigator: Dr. K. Asokan
Client: Tatva Chintan Pharma Chem Private Limited
Fee: ₹70,000
Duration: 3 months (2009)

Membrane electrolyzer (250 A rating) of working area 0.25 m^2 for the production of tetraethyl ammonium hydroxide from the corresponding bromide was designed and fabricated with anode, cathode and membrane.

TSP-04/09

Processing and supply of anodes and cathodes for the production of tetraalkyl ammonium hydroxide

Principal Iinvestigator: Dr. K. Asokan
Client: Tatva Chintan Pharma Chem Private Limited
Fee: ₹1,32,360
Duration: 3 months (2009)

Supply of four coated titanium anodes (plain configuration) of size 60 cm x 60 cm and two uncoated perforated titanium cathodes of size 60 cm x 60 cm suitable for the electrolytic production of tetraalkyl ammonium hydroxide from the respective bromides.

TSP-06/09

Processing of anodes for electrochemical treatment of effluent from yeast manufacturing

Principal Investigator: Dr. K. Asokan
Client: GET Water Solutions Private Limited
Fee:₹60,000
Duration: 1 month (2009)

Four numbers of tubular titanium mesh anodes of diameter 150 mm and length 750 mm for electrochemical treatment of effluent from yeast manufacturing unit (fabricated titanium substrates supplied by the firm) were processed with active catalytic coating.

TSP-19/09

Supply of membrane electrolyzer for production of tetramethyl ammonium hydroxide

Principal Investigator: Dr. K. Asokan
Client: National Organic Chemical Industries Limited
Fee: ₹1,10,300
Duration: 3 months (2010)

Membrane electrolyzer of 0.25 m^2 active area (250 A rating) with coated titanium expanded mesh anode and titanium perforated cathode was designed and fabricated for the electrolytic production of tetramethyl ammonium hydroxide from the corresponding chloride.

SSP-05/08

Feasibility study on the preparation of ribityl 3,4-xylidine from D-ribose

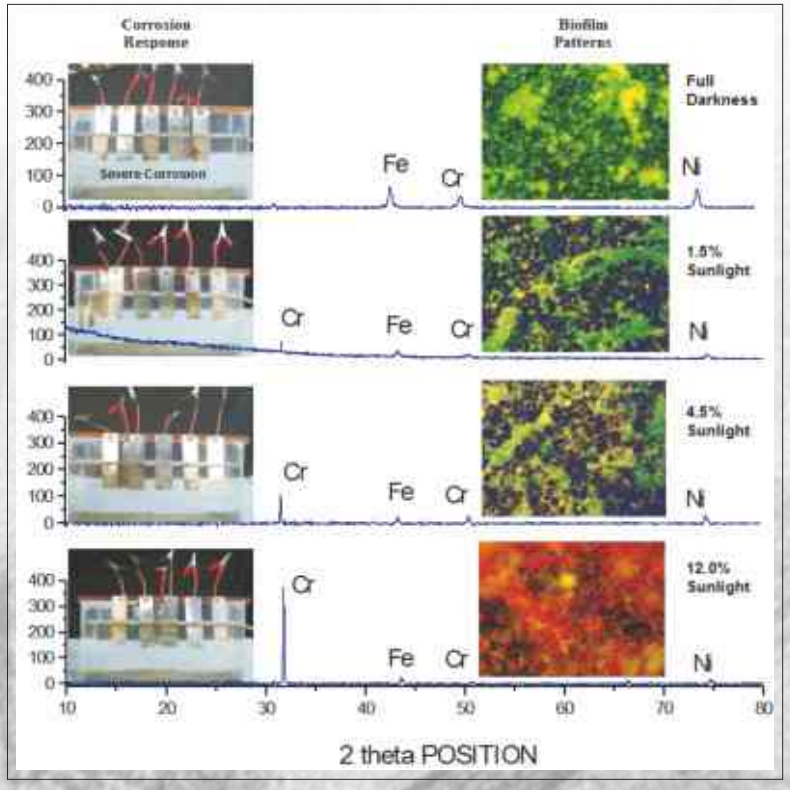
Principal Investigator: M. Noel
Sponsor: Chemapol Industries
Budget: ₹2.3 lakh
Duration: 2008–2009

The project investigates a catalytic method for the production of ribityl-3,4-xylidine from D-ribose. Ribityl-3,4-xylidine is an important intermediate in the production of vitamin B2. The conventional catalytic reduction of Schiff base using Raney nickel catalyst was used for the synthesis of ribityl-3,4-xylidine. D-ribose dissolved in water and 3,4-xylidine dissolved in methanol with a maximum pressure of 5 bar at 63°C in an autoclave led to a good yield of 50-60% of ribityl-3,4-xylidine. The product is highly temperature-sensitive especially during recrystallization. Furthermore, improvements of yields as well as product purity can be achieved by carrying out the catalytic reduction at elevated pressure for shorter duration and careful optimization of product isolation and recrystallization.

R & D Activities at Corrosion Testing Centre, Mandapam

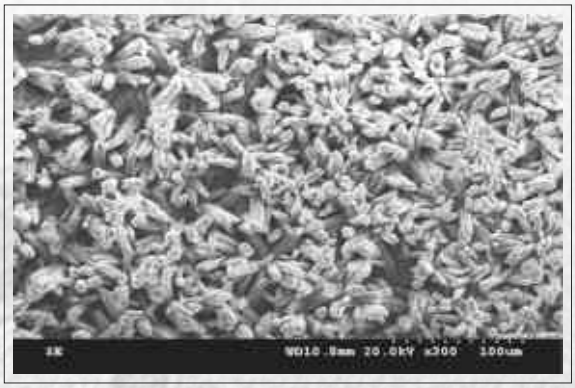
Photo-inhibition of localized corrosion

As a sequel to our previous work, UNS S30400 stainless steel (SS) was tested under conditions of full darkness and three levels of lighting in quiescent flowing seawater taken from the coastal waters of Mandapam in the Gulf of Mannar, Bay of Bengal for over 3 months. The amount of sunlight imparted on the samples were 1.5% (low), 4.5% (moderate) and 12.0% (high) of full solar irradiance under a specially designed experimental chamber located outdoors. Biofilm variations on the samples showed systematic increase in the number of diatoms with increasing light levels, but no correlation was seen for manganese



Influence of sunlight on biofilm development, corrosion response and XRD patterns for welded UNS S30400 alloy in quiescent flowing natural seawater under an experimental chamber specially constructed and located outdoors such as to impart diffuse sunlight at varying intensities on the alloy samples. Note that as little as ~5% of sunlight improves the corrosion resistance of the alloy in a remarkable manner with concomitant increase of chromium in the passive film.

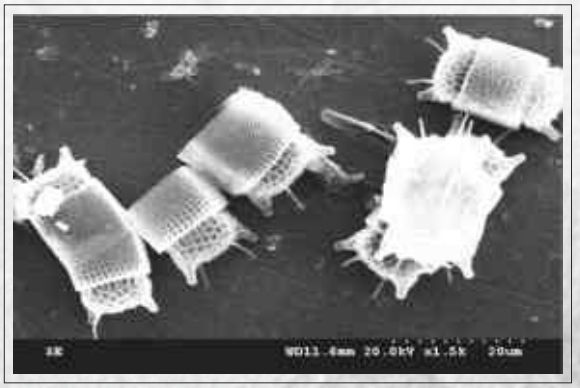
oxidizing bacteria (MOB), which are believed to control cathodic kinetics in a major way. Photo-inhibition of localized corrosion was noted at all light levels examined (with reference to dark condition) and the inhibition was statistically significant. As little as about 4.5% of full sunlight was found to provide substantial photo-inhibition over the entire duration of the tests. Mott-Schottky plots obtained using EIS showed systematic negative shift of the flat-band potential with illumination. The mechanism of photo-inhibition appeared to involve chromium enrichment, in the form of Cr_2O_3, and the resultant passive film thickening as exemplified by XRD and XPS data. The overall results from this study further reinforce our innovative idea that the application of illumination is a promising approach in the mitigation of SS corrosion under marine conditions, notwithstanding potent biological redox reactions.



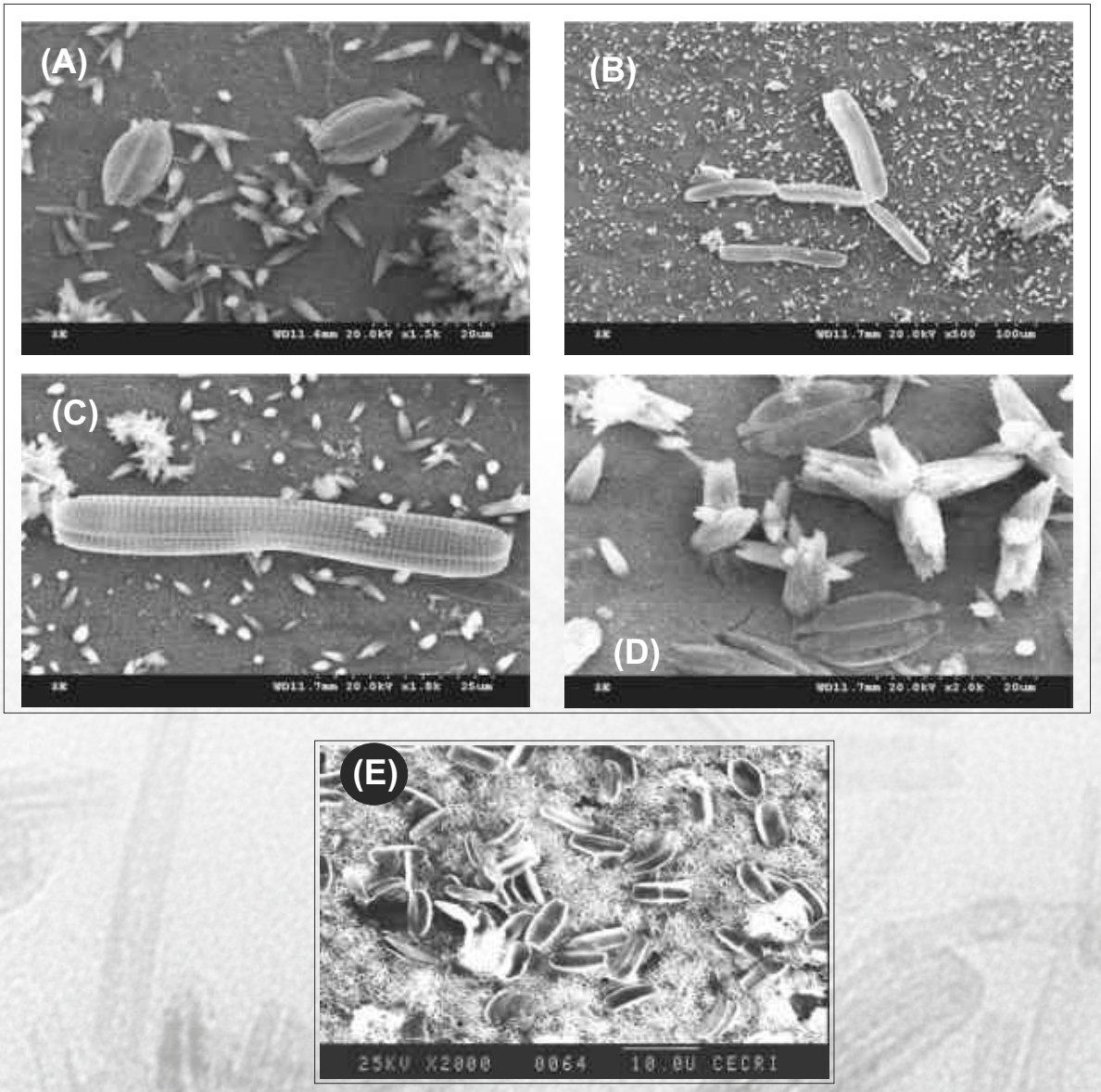
Fine structure of calcareous deposit formed on cathodic stainless steel in natural seawater

An improved SEM technique for observing biofilms and calcareous deposits

Calcareous deposits form on cathodically polarized metal surfaces in seawater and they bear very important implications for the economics of the overall cathodic protection system. Biofilms also form simultaneously under natural marine conditions. One of the challenges over the years has been the microscopic documentation of the two processes that occur concurrently. Conventional fixing and dehydration steps are known to introduce serious artifacts and to modify the structure of the mineral deposits. A simple method has been developed that yields unambiguous results for calcareous deposits and biofilms, either independently or together. Hundreds of pictures were obtained and those shown here exemplify the above mentioned improvement.



Picture of a biofilm showing various stages of cell division in Biddulphia mobilensis



A–E: Pictures exemplifying the competition for cathodic surfaces between calcareous deposits and biofilm microorganisms

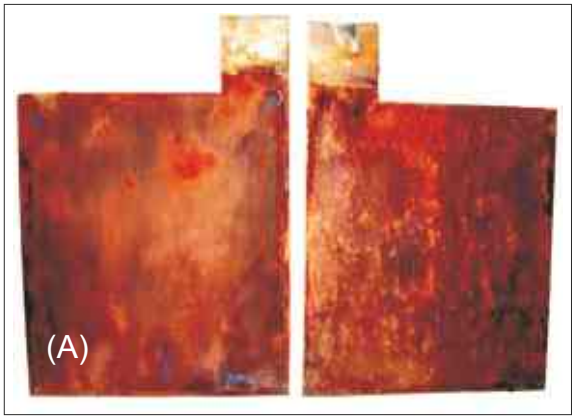
R & D Activities at Off-shore Platform & Marine Electrochemistry Center, Tuticorin

Microbially influenced corrosion of mild steel by marine bacteria isolated from sea surface slick

Total heterotrophic bacteria in sea surface slick were enumerated. Characterization and identification of bacterial isolates were done by biochemical tests. The genera identified under Gram-negative groups were Vibrio sp., and Pseudomonas sp,. The genera identified under Gram-positive groups were Bacillus sp., and Micrococcus sp. Among the Gram-positive Micrococcus sp. was found to be predominant. MIC was studied with pure cultures of Pseudomonas and Micrococcus sp. both by gravimetric and electrochemical methods. Corrosion rate of MS exposed to control broth was relatively lower than those exposed to bacterial cultures. However corrosion rate was relatively higher in the system treated with Pseudomonas culture than that of Micrococcus culture. A good agreement has been observed between gravimetric and electrochemical results. EDAX observations indicated higher iron content in the Pseudomonas system when compared to that of Micrococcus system which is in agreement with the MIC trend as noted in the present study. Presence of phenolic compounds in the Micrococcus biofilm and aromatic, aryl amines in Pseudomonas biofilm were identified by FTIR spectroscopic analysis.

Electrolytic recovery of dilute copper from a mixed industrial effluent of high strength COD

Recovery of copper is the first step in the sequence of operations of wastewater management of copper phthalocyanine dye process industry. The feasibility of the copper recovery was experimented using 2D stainless steel cathode reactor and subsequently in order to improve the metal recovery and CE, the flow electrolysis has been carried out using 3D stainless steel turning cathode reactor, which has a large electrode surface area around 10 times higher than the 2D electrode of the same weight of stainless steel and high mass transfer rate. The 3D stainless steel turning cathode reactor could rapidly recover copper of 99.5% from effluent with an acceptable current efficiency of 56.8% and minimum energy consumption of 2.37 kWh/kg removal of copper. Thus, the electrolytic treatment can be a promising and cost effective treatment for the acidic copper phthalocyanine dye effluent compared to the traditional treatment techniques. Further, an additional savings due to the marketing of the recovered copper, elimination of hazardous sludge handling and disposal costs is also accomplished in this electrochemical treatment. After the electrolytic recovery of copper, the effluent (<10 mg/l Cu and COD ~10,000 mg/l, pH < 1) becomes easy for further treatment. As a second phase, to mineralize



Copper deposit obtained with a current density of 1A/dm^2 on (A) 2D stainless steel; and (B) 3D stainless steel turning cathode in the flow condition from the acidic copper phthalocyanine process stream

the copper recovered effluent and also to extend the present experimentation for industrial trial run, bench scale studies are under progress by adopting suitable treatment techniques such as advanced oxidation processes followed by electro-coagulation and ultra-filtration.

Artemisia pallens as corrosion inhibitor for mild steel in HCl medium

Methanolic extract of Artemisia pallens was tested as corrosion inhibitor for mild steel in 4N HCl and conc. HCl. Weight loss and polarization techniques were used for evaluating corrosion inhibition in 4N HCl, while weight loss, SEM and FTIR studies were carried out in conc. Hcl.

The inhibition efficiency was found to increase with increase of the inhibitor concentrations due to the adsorption of the inhibitor molecules on the metal surface and the adsorption follows Langmuir's adsorption isotherm. The inhibition efficiency was found to be 93% at 1.5 g/l in 4N HCl and 96.5% at 40 g/l in conc. HCl. Hence, A. pallens extract can be used as an alternate to toxic chemical inhibitors for acidization and acid pickling of mild steel.

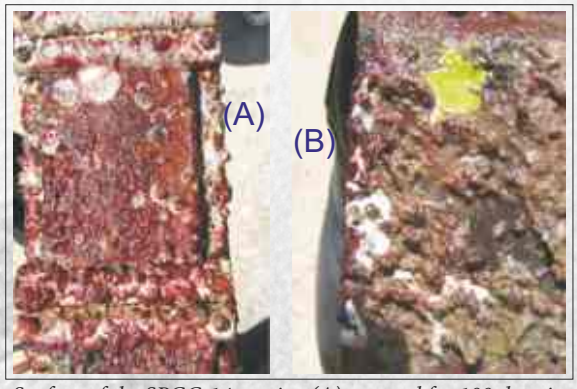
Artemisia pallens extract act as a good corrosion inhibitor for mild steel in HCl medium. The weight-loss measurements, electrochemical polarization study and surface and solution analysis, confirm the inhibitive nature of the inhibitor in HCl medium.

The adsorption of the inhibitor on the mild steel surface in HCl medium obeys Langmuir's adsorption isotherm. The inhibition efficiency of the inhibitor in HCl medium excels than that of the other natural products and hence it is a breakthrough in the era of natural inhibitors. A. pallens, being a natural and environmentally benign product, can be safely used as an alternative for toxic chemical inhibitors in acidization and acid pickling of mild steel.

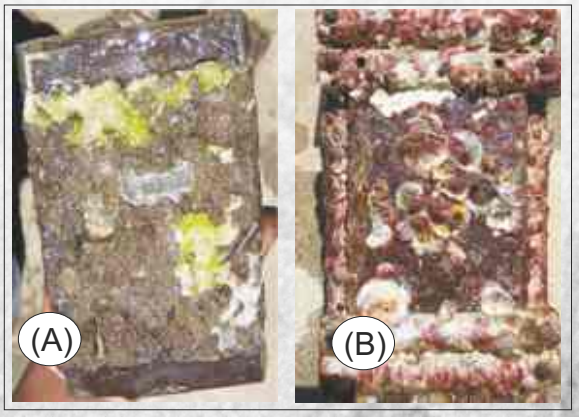
Evaluation of foul release coatings

The two different foul release coatings (SPGC-14 and SPGC-18) supplied by Multicoat Surfaces Pvt. Limited, Kolkata were evaluated in Tuticorin coastal seawater over a period of 4 months. Coupons (6"x4") were mounted on exposure rack and immersed in sea below the CECRI's offshore platform. The effectiveness of the foul release coatings were periodically observed (after 12, 28, 58 and 97 days of exposure) by seawater jetting for 3 minutes on the fouled specimens.

The foul release coatings were found effective on the 12th day of observation. However, their efficiency was found to decrease over the study period of 100 days. On the 12th day of observation only scum and slime were noticed, which were completely removed by water jetting. The settlement of barnacles besides algal growth was evident on the 28th day of observation. The water jetting could remove only portion of fouling. On the 58th day of observation, surface coverage of fouling was found enhanced with new recruitment of organisms such as oysters. The water jetting could remove only algal fouling. Dense coverage of fouling comprised of barnacles, oysters, algae and ascidians, were observed on the 100th day of the observation. The water jetting has removed most of the slime, scum and other soft fouling organisms are removed, leaving behind hard foulers, such as oysters and barnacles. The present result suggests that the foul release coatings are not suitable for sea going vessels and marine installations.



Surface of the SPGC-14 coating (A) exposed for 100 days in seawater; (B) exposed for 100 days in seawater and after seawater jetting for 3 minutes – only a portion of algae are removed



Surface of the SPGC-18 coating (A) exposed for 100 days in seawater; (B) exposed for 100 days in seawater & after seawater jetting for 3 minutes – only a portion of algae are removed

Preparation and characterization of nickel cermets from ceramic oxides with perovskite / fluorite / pyrochlore type crystal structures for use in intermediate temperature solid oxide fuel cells operating below 800°C

Reducing the operating temperature of the SOFC system from 1000°C to below 800°C was taken up for study in order to avoid the coarsening of the micro-structure with time of operation across the nickel cermet anode–electrolyte interface. Nickel cermet anodes from partially substituted lanthanum gallates and partially substituted ceria were prepared and measurements were made in order to quantify the sintering and percentage densification as a function of sintering temperature. Densification data as a function of sintering temperature are obtained. Attempts to use transition metals in very low levels as sintering aids in order to realize high densification factor close to theoretical density are being pursued. Porosity values of the sintered plates are also measured in order to quantify the role of the sintering aids on the sintering behavior of these ceramics. In co-operation with the Research Centre Juelich, Germany, investigations on the quasi-ternary system $LaMnO_3$–$LaCoO_3$ –"$LaCuO_3$" with control in the substitution stoichiometric levels is being pursued.

Development of molten carbonate fuel cell (MCFC) components

Performance and life time of unit MCFC were being investigated with respect to cell operating conditions and preparation variables of the cell components. The preparation variables of the integral matrix tape by introducing a bubble pressure barrier having fine porosity up to about 30% by volume was investigated. Particle size of the $LiAlO_2$ used for the bubble pressure barrier layer was found to be in the range 1 to 25 um. The aim of this study was to increase the specific power from 12 W/100 cm^2 area to 20 W/100 cm^2 area electrodes.

In order to improve the life time of MCFC, following studies are being carried out: (1) Electrolyte retaining capacity of the matrix tape with respect to porosity, pore structure and mesoporous nature; (2) Experimental investigations on self propagating combustion synthesis of mesoporous alumina and $LiAlO_2$ for desired powder characteristics. Furthermore, the electrical resistivity measurements as a controlling parameter to quantify and to optimize the pore structure of the sintered nickel electrodes are being studied using additive strontium/barium titanate as a sintering inhibitor and to improve wetting nature of the sintered electrodes.

Modeling and simulation

Observation of self-regulating response in $Li_xM_yMn_{2-y}O_4$ (M=Mn, Ni): A study using density functional theory

Density functional theory is used to understand the response of the transition metaloxygen octahedra in $Li_xMn_2O_4$ and $Li_xNi_{0.5}Mn_{1.5}O_4$ to lithium intercalation and de-intercalation. Electronic structure computations on these compounds for x = 0.0, 0.5 and 1.0 indicate that the 3d DOS of Mn is almost unaffected to variations in x. On the other hand, the oxygen 2p-DOS and to a lesser extent Ni 3d DOS are found to be sensitive to perturbation. The observations are explained on the grounds of self-regulating response, characteristic of systems having localized d states that communicate with a covalent manifold.

Simulated XRD profiles of carbon nanotubes (CNTs): An efficient algorithm and a recurrence relation for characterising CNTs

We developed an efficient algorithm and a novel recurrence relation for computing the Debye function of carbon nanotubes. This allows the computation of the XRD profile of CNTs for arbitrary lengths in times which scales linearly with the tube length. Using the recurrence relation, we further show that the XRD peak intensities are proportional to the tube length. The slopes and intercepts of the peak intensity versus tube length plots are characteristic of the CNT type. This work will help to create a database for CNTs akin to the ICDD data for 3-D crystals. Methods are also sketched to deduce tube properties from the XRD data.

On the observation of a huge lattice contraction and crystal habit modifications in $LiMn_2O_4$ prepared by a fuel assisted solution combustion

Two batches of poly-crystalline lithium manganate were prepared by a fuel-assisted solution combustion method. $LiMn_2O_4$(s) was prepared using starch as the fuel and $LiMn_2O_4$(p) was prepared using polyvinyl alcohol as the fuel. XRD studies indicated a significant and consistent shift in the 2θ values of all the hkl peaks to higher values in $LiMn_2O_4$(p) compared to $LiMn_2O_4$(s) indicating a lattice contraction in the former. TG/DTA studies indicated a higher formation temperature (25°C higher) for $LiMn_2O_4$(p). The higher formation temperature most likely promotes the oxidation of some Mn^{3+} to Mn^{4+} with a lower ionic radius causing a lattice contraction. This hypothesis is confirmed through XPS studies which indicated the presence of a higher fraction of Mn^{4+} in $LiMn_2O_4$(p) than that present in $LiMn_2O_4$(s). A crystal shape algorithm was used to generate the crystal habits of lithium manganate from their XRD data leading to an understanding on the exposed hkl planes in these materials. From the atomic arrangement on the exposed hkl planes it is predicted that $LiMn_2O_4$(p) would be less prone to manganese dissolution and hence would possess a higher cycle life when

compared to $LiMn_2O_4$(s).

Crystal shape determination in thin films and studies on the substrate influence on the crystal shape in CBD-CDS thin films.

In the present work, the substrate-polishing effect on the structural characteristics, crystal shape, surface morphology, S:Cd ratio, room temperature photoluminescense emission and photoelectrical properties of chemical bath deposited nanocrystalline cadmium sulfide thin films have been demonstrated. The 3D crystal shape of the deposited film was constructed based on the algorithm. The CdS on in-house, chemically polished p-Si (100) substrate shows near hexagonal crystal shape when compared with the film on sonicated-unpolished p-Si (100) substrate. Also, it illustrates better crystallinity, closely packed surface morphology, S:Cd ratio of 52:48 and intense PL emission at room temperature.

Electric field induced enhancement in the interfacial charge transfer kinetics of a solid polymer electrolyte

A novel electrostatic method for preparing modified solid polymer electrolytes (SPEs) is reported. Application of an electric field on an evaporating mixture of Kynar, ethylene carbonate, propylene carbonate and $LiPF_6$ dissolved in tetrahydrofuran resulted in a solid polymer electrolyte whose charge transfer resistance was at least an order of magnitude lower than that formed without the application of an electric field. We believe that the observed enhancement is probably due to an electric field induced orientation of dipoles in the polymer chain.

New materials for electrochemical energy storage

Synthetic methodologies for anode and cathode materials for use in lithium-ion batteries were developed and physical and electrochemical characterization of these materials completed. The following are the list of new electrode materials developed.

a. Synthesis of carbon-coated nano-$LiFePO_4$ bestowed with a high capacity of 160 mAh/g at 1C rate.

b. Synthesis of hierarchically porous network of nano-$Li_4Ti_5O_{12}$ as a high-performing anode material.

c. Developed nitrate melt decomposition method for the bulk production of cathode materials such as $LiCoO_2$, $LiCo_{1/3}Ni_{1/3}Mn_{1/3}O_2$, $LiCo_{0.2}Ni_{0.8}O_2$ and $LiNi_{0.5}Mn_{0.5}O_2$. The method is rapid, simple, cost effective and allows synthesis in scalable quantities.

d. Synthesis and characterization of nanoarchitectured oxide materials such as SnO_2, Co_3O_4, TiO_2, V_2O_5 and hollow nanospheres of SnO_2, TiO_2, Co_3O_4 which finds application as superior anode materials.

e. Rutile TiO_2 nanoneedles through sol gel route.

ICP-01/08

New electrode materials for high energy density lithium rechargeable batteries

Principal Investigator: Dr. S. Gopukumar

Sponsors: Council of Scientific and Industrial Research; Royal Society
Budget: ₹1.00 lakh
Duration: 2008–2010

New materials based on lithium nitride were synthesized and their performance as an anode evaluated for lithium rechargeable batteries. High performing cathode materials like $LiCu_xCo_{1-x}O_2$ and $LiZn_xCe_yMn_{2-x-y}O_2$ delivering capacities of ~150 and 124 mAh/g, respectively, were also synthesized and characterized for their use in lithium rechargeable batteries.

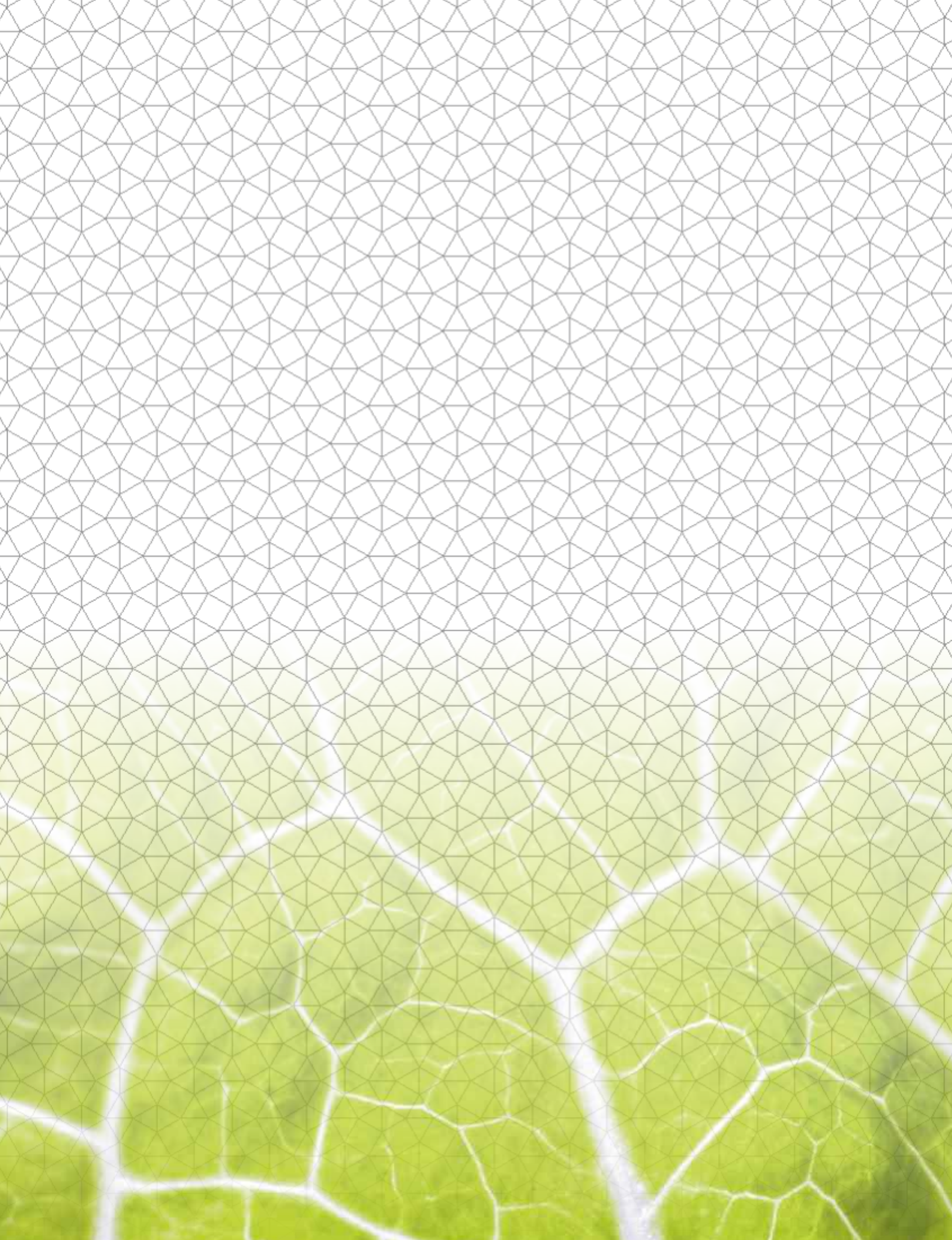
ICP-01/09

Design and Development of electrochemical sensors for human health care applications

Principal Investigator: Dr. V. Yegnaraman
Sponsor: Indo-German Programme CSIR-BMBF
Budget: ₹4.90 lakh
Duration: 2009–2011

This project is an international joint research program with Kurt-Schwabe-Institute for Sensor and Measuring Technology, Meinsberg- 04720 Ziegra-Knobelsdorf, Germany. Screen-printed modified carbon paste electrodes were fabricated, evaluated and optimized for the detection of hydrogen peroxide, dopamine and uric acid in clinical applications.

Tailpiece



UV-VIS-NIR Spectrophotometer

Make	VARIAN
Model	Cary 5000 Scan
Wavelength range	175–3300 nm
Spectral bandwidth	0.01 nm
Detector	Photo multiplier/ PbS NIR
Samples	Solid and liquid
Software	Cary WinUV
Accessories	Multi cell holder, Temperature, attachment (-10 to 100^{0}C) and Specular reflectance attachment
Modes	Transmittance, absorbance
Feature	Chemical kinetic analysis

UV-VIS-NIR Spectrophotometer

Make	VARIAN
Model	Cary 500 Scan
Wavelength range	190–3300 nm
Source	Deuterium Wl lamp
Detector	Photomultiplier/PbS photocell
Modes	Transmittance/absorbance/ diffuse reflectance/specular reflectance

Fluorescence Spectrophotometer

Make	VARIAN
Model	Cary Eclipse
Wavelength range	200–1100 nm
Source	Xenon pulse lamp
Detector	Photo multiplier tube
Modes	Excitation, emission
Feature	Double monochrometer

Gas Chromatograph/ Mass Selective Detector (GC/MS)

Make	Agilent Technologies
Model	7890 A Series GC with 5975C Mass Spectrometer
Gas chromatography	
Sample type	Organic & volatile liquids
Injector	Split/splitless (standard)
Oven temperature	Ambient +4^{0}C to 450^{0}C
Oven ramps/plateaus	Constant, 20/21 positive/negative ramps
Carrier gas	
Control modes	Constant pressure and flow modes, pressure flow programmable
Feature	Retention time locking
Mass selective detector	
Ion source type	Inert electronic ionization (EI)
Mass filter	Monolithic hyperbolic quardrapole
Maximum mass	1050 amu
Detector	Triple axis HED EM
Scan rate	upto 12,500 amu/sec

Laser Raman Microscope

Make	Renishaw
Model	Renishaw invia Raman microscope
Source	He-Ne laser 633 nm with adjustable power upto 18 mw
Wave number	100–3300 cm^{-1}
Detector	CCD
Applications	Raman and photoluminescence spectroscopy, corrosion studies and electrochemistry

FT-IR/FT Spectrometer-Microscope

Make	Thermo Electron Corporation
Model	Nexus 670 with Centaurms 10X microscope
Detectors	Temperature stabilized DTGS and liquid nitrogen cooled MCT-A detector
Spectral range	375–11,000 cm^{-1}
Spectral resolution	0.125 cm^{-1}
Beam splitter	XT-KBr
Software	OMNIC IR

Accessories

Attenuated total reflectance

FT-85^{0}C grazing angle for thin film/mono layer analysis

Specular reflectance for non-destructructive method of measuring surface coatings

Features

Spectral subtraction

Mathematical correction

Baseline correction and library of thousands of reference IR spectra

FT Module

Detector	InGaAs (indium gallium arsenide)
Excitation	Nd YAG (neodymium-doped yttrium aluminium garnet) laser source
Laser wavelength	1064 nm (9378 cm^{-1}) 1.5 watts
Spectral Range	3600–100 cm^{-1} stokes lines 2200–200 cm^{-1} anti-stokes lines
Software	OMNIC Raman software

Thermal Analyzer (TGA-DSC-DTA)

Make	TA Instruments
Model	SDT Q600
Maximum Temperature	1500^{0}C
Maximum heating rate	100^{0}C/minute upto 1000^{0}C & 25^{0}C/minute above 1000^{0}C
Atmosphere	Air, nitrogen
Features	Programmable heating rate, data can be collected while cooling also, simultaneous TG, DSC and DTA analysis
Sample	Solids
Software	Thermal advantage

Scanning Vibrating Electrode Technique (SVET)

Make	Princeton Applied Research
Model	SVP 100 SRET
Max. sample size	100 mm × 75 mm
Scan speed	2 mm/sec
Horizontal movement	100 mm (x and y axis)
Vertical movement	35 mm (z axis)
Vibration amplitude	1–60 mm
Spatial resolution	25–50 mm
Salient features	Non-contact technique to characterize localized corrosion, determination of work function and conducting, semi-conducting and coated materials, detect holidays in coatings

Nuclear Magnetic Resonance (NMR) Spectrometer

Make	Bruker
Model	Avance 400 MHz
Features	Multi nuclei facilities with 1D, 2D and pulse programming
Operation modes	Solid state, solution state with variable temperature facility (-100^{0}C to 100^{0}C)
Application	Structural elucidation of molecules

Electron Paramagnetic Resonance (EPR) Spectrometer

Make	Bruker Biospin
Model	EMX Plus
Source	Microwave X band klystron
Operation mode	Powder, liquid and crystal samples at RT and down to 100 K
Software	Bruker WIN EPR acquisition and processing
Applications	Free radicals, intermediates in electrochemical studies, spin labels, polymers, corrosion, fullerenes, transition metal complex studies

Micro-Hardness Tester

Model No.	MH-6
Make	Everone Enterprises Ltd.
Method	Vickers hardness test
Test load	10 gf to 1000 gf
Measuring Length	0.1 mm–200 mm
Microscope magnification	100X, 400X

Metallurgical Microscope with Image Analyzer

Make	Leica Microsystems
Model No.	Leica DM LM microscope incident light techniques, day light filter, dark field filter, Green filter reflected light technique
Magnification	50X, 100X, 500X, 1000X
	MHT10 Vickers micro hardness tester with load of 300 gf
Image analyzer software	Leica metallurgy suite: number of phases, grain size decarburization depth
Applications	To study the microstructure of alloys, plating sample and etched metals. Concrete mixtures and battery separators can also be analyzed

Scanning Probe Microscope (SPM)

Make	Molecular Imaging
Model	PicoSPM Picoscan 2100
Modes	AFM contact mode and non-contact mode CSAFM and STM
STM scanner range	Vertical:0.7–7 mm Horizontal:0.5–50 mm
AFM range	Vertical:0.7–7 mm Horizontal:0.5–30 mm Maximum sample size: 2.5 cm × 3.0 cm
Application	Used to measure surface topography, surface conductivity, static charge distribution, localized friction, routine surface roughness analysis and 3D imaging

Scanning Electron Microscope (SEM)

Make	Hitachi
Model	S-3000H
Magnification	30X–3,00,000X
Specimen size	Max. 150 mm diameter
Accelerating voltage	0.3–30 kV
Resolution	3.5 nm @ 25 kV high vaccum mode
Attachments	Energy-dispersive X-ray analysis (EDAX) and backscattered electron detector (BSED) energy dispersive analysis
Application	To study surface morphology of samples and elemental mapping

X-ray Photoelectron Spectrometer (XPS)

Make Thermo Scientific

Model MULTILAB 2000 base system for surface analysis using XPS, Auger and ISS techniques

Sources

Twin anode Mg/Al (300/400 W) X-ray source
Ex05 ion gun for etching and ISS studies
Electron gun with spot size < 50 mm dia

Detector

Alpha 110 analyzer with 7 channeltrons,
4 variable analyzer slits viz. 5 mm, 2 mm,
1 mm and 4mm

Modes

CAE (constant analyzer energy) and
CRR (constant retard ratio)

Selectable area of analysis

100 mm, 200 mm, 350 mm, 600 mm and 4 mm x 4 mm of specimen

Salient features

UHV of 10^{10} mbar base pressure in the analysis chamber using ion pump and titanium sublimation pump

CCD camera and zoom microscope for optical viewing of the sample. Sample heating and cooling stages in preparation and analysis chamber

Sample manipulator with high precision four axes movement

Data acquisition and processing using Advantage (ThermoFisher, UK) software

Sample requirements

Solid samples of 2–3 mm thick and 9 mm diameter pellets and plates. Thin films of area 10 mm^2

Application

Survey of elements from atomic numbers 2–92 . Oxidation state of individual elements and their percentage concentration

Powder X-ray Diffractometer (XRD)

Make	PANalytical
Model	PW3040/60 X'pert PRO
Source	X-ray tube 3 kW with copper and cobalt target
Detectors	RTMS solid state detectors fitted with graphite crystal and gas filled proportional counter
Goniometer	Single vertical circle
Resolution	0.001^{0}
Software	Hi-Score plus search-match software, X'Pert Plus crystallographic analysis software with Rietveld capability, Profit line profile analysis software

Attachments	Samples spinner Zero background sample holder Particle size distribution analyzer Thin film attachment Variable temperature accessory (up to 1600^{0}C)
Type of samples	Powders, plates and coatings
Software features	Indexing and reflection Rietveld analysis

X-ray Analytical Microscope (XRF)

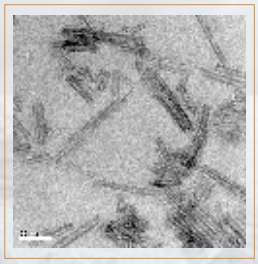
Make	Horiba
Model	XGT-2700 X-ray analytical microscope
Source	X-ray tube with Rh target
Detector	High purity sillicon detector (XEROPHY)
Detectable elements	Sodium to uranium (atomic numbers 11 to 92)
CCD camera	Magnification 30X and 100X approx.
Software	Elemental mapping and phase analysis

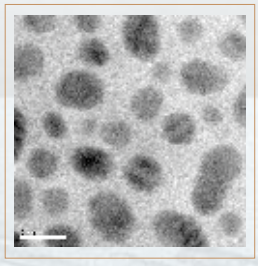
X-ray Fluorescence Coating Thickness Instrument

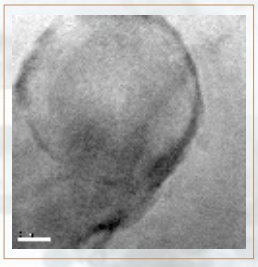
Make	CMI International Inc.
Model	XRX series
Source	X-ray tube with tungsten target
Detector	Proportional counter
Samples	Thickness of virtually any coating, single layer or multi layers on any base. It can determine solution concentration and alloy

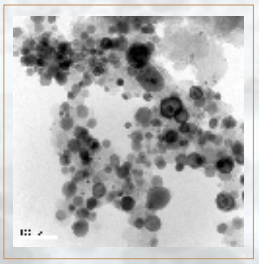
Transmission Electron Microscope (TEM)

Make	FEI
Model	Tecnai 20 G^2 (FEI make) Resolution: line-1.8 Å, point-2.40 Å incorporated with STEM bottom mount CCD camera (Gatan-make) TEM magnification range 25X - 700 KX
TEM holders	Single tilt and single tilt low background Double tilt and double tilt low background
STEM features	STEM HAADF resolution 0.24 nm STEM magnification range 150 × 230 MX
EDS	Detection: Boron to highers (EDAX-make) specimen stage: fully computer-controlled eucentric side-entry, high stability compustage





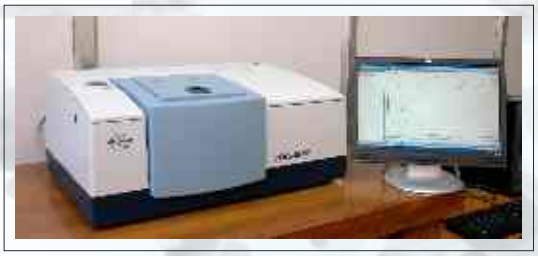




Ion Chromatograph

Make	Metrohm Ltd.
Model	Modular anion and cation system with chemical suppression
Modules	Conductivity detector, UV-visible detector, VA detector
Analyzable ions	**Cations:** lithium, sodium, potassium, magnesium, calcium, strontium, barium, manganese, iron, cobalt, nickel, copper, zinc, silver, cadmium, aluminium, ammonium, lead, cyanide, additives used in plating **Anions:** chromate, vanadate, tungstate, molybdate, phosphate, nitrate, fluoride, chloride, bromide, iodide, hydroxide, selenate, sulphate, antimonite
Applications	Analysis of anions and cations in drinking water, effluents, plating solution for the determinations of surfactants

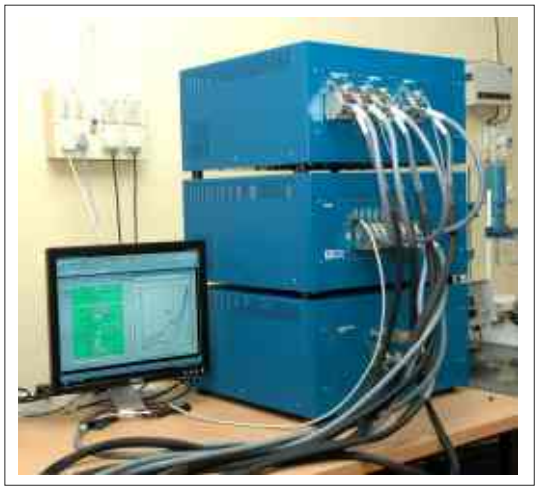
FT-IR Spectrometer



Make	Bruker Optik GmbH
Model	TENSOR 27
Source	Middle-infrared light (MIR)
Detector	DLaTGS
Spectral range	370 to 7,500 cm^{-1}
Spectral resolution	0.125 cm^{-1}
Beam splitter	Ge-based coating on KBr
Software	OPUS TM

Multi-channel Potentiostat/Galvanostat

Make	Advansys International
Mode No.	VMP3
No. of Channels	8
Compliance voltage	20 V
PC interface	USB2 and ethernet connector
Software	EC-Lab and EC-Lab Express
Techniques	Voltammetry, corrosion, waveform programming, EIS, fuel cell and battery testing



Inductively Coupled Plasma Mass Spectrometer (ICPMS)

Make	Thermo Electron Corporation
Model No.	X Series 2
Plasma source	Solid state 27.12 MHz RF generator
Detector	Simultaneous analog/pulse counting electron multiplier
Mass detector range	Mass range 2-255 amu
Sensitivity	ppb (> 8 orders of magnitude)
Software	Plasma Lab
Advanced features	Third generation CCT protective ion extraction
Accessories	Auto sampler Stand alone hydride generator kit Attachment for organic samples

Central Instrumentation Facility

The Central Instrumentation Facility caters primarily to the analytical and characterization requirements of sponsored, collaborative, grant-in-aid and in-house projects of the institute. It also extends such services to academia, industries and other R&D institutions for their advanced research. The facility has grown into a major centre for analysis of bulk materials and surfaces in this part of the country. The major focus of its services lies in the areas of spectroscopy, microscopy, surface analysis, thermal analysis, elemental analysis, X-ray diffraction, chromatography, electrochemical impedance, and electroanalysis. It houses state-of-the-art equipment worth about Rs 20 crore. During this financial year an amount of Rs.5.428 lakhs was collected as analysis charges from academic institutions.

Major R&D Facilities

- UV-VIS-NIR spectrophotometer – Varian Cary 500 Scan and Cary 5000 scan
- Fluorescence spectrophotometer – Varian Cary Eclipse
- FT-IR spectrometer – Bruker Optik GmbH, TENSOR 27
- FT-IR/FT-Raman spectrometer – Thermo Electron Nexus 670 with Centaurms 10X microscope
- Laser Raman microscope – Renishaw Invia Raman microscope
- Nuclear magnetic resonance spectrometer – Bruker Avance 400 MHz
- Electron paramagnetic resonance spectrometer – Bruker Biospin EMX Plus
- Micro hardness tester – Everone Enterprises MH-6
- Metallurgical microscope with image analyser – Leica DM LM
- Scanning electron microscope – Hitachi S-3000H
- X-ray photoelectron spectroscopy – Thermo Scientific MULTILAB 2000
- Scanning vibrating electrode technique – PAR SVP100 SRET
- Powder X-ray diffractometer – PANalytical PW3040/60 X'pert PRO
- Powder X-ray diffractometer – D8 Advance, Bruker AXS
- X-ray analytical microscope – Horiba XGT 2700
- X-ray fluorescence coating thickness instrument – CMI International XRX series
- Transmission electron microscope – FEI Tecnai 20 G2
- Ion chromatograph – Metrohm

Analog NO monitor.

❖ Gas chromatograph/mass selective detector – Agilent Technologies 7890A with 5975C

❖ Multi channel potentiostat/galvanostat – Advansys International VMP3

❖ Inductively coupled plasma mass spectrometer – Thermo Electron, X series 2

❖ Temperature modulated differential scanning calorimater – DSC1, Mettler Toledo

❖ Ultranano particle size analyzer – NPA253, Nanotrac

Instrument Development Activity

1) An embedded controller based concrete resistivity meter

This instrument, based on the four-probe technique, was developed to measure the resistivity of concrete in RCC structures. The measurable resistivity range is 0–2000 kΩ-cm. The instrument is useful for civil engineers and corrosion scientists.

2) An impedance monitor for lead-acid batteries

An embedded controller based impedance monitor was developed to monitor the state-of-charge of lead-acid batteries. A single frequency ac current is impressed, the ac voltage drop across the battery is amplified, rectified and fed to a PIC microchip. The system displays the value of the battery impedance on a 2-line 16-character alphanumeric liquid crystal display.

3) Development of a micro electrode array for electrochemical applications

Microelectrode array devices are not made in India as of now. These electrode arrays can be made by adopting microlithography technology used in semiconductor device fabrication. This facility, available at IIT-Madras, was used to fabricate the electrode arrays. Characterization of the arrays was carried out by electrochemical techniques. The micro electrode array was then used in electroanalysis, typically for trace level detection of heavy metals (As, Pb, Cd, etc.) in water. They can also be used as biosensors for trace level estimation of neuro-chemicals such as dopamine.

4) Analog NO monitor

Interfaced with a modified glassy carbon electrode, which acts as an NO sensor, this instrument measures nitric oxide in ppm units, by amperometric technique. It finds application in bio-medical instrumentation as well as in sensing nitric oxide in biological systems. This was developed for the CSIR network project (NWP 0035) titled "Development of nanomaterials and devices for health care and diseases."

5) Embedded controller-based semiconductor deposition control unit

This is a PIC micro-controller based stand-alone control system to deliver constant current/voltage pulse or dc supply to deposit semiconductor films. The instrument was developed for the CSIR network project (NWP 0010) titled "Development of speciality inorganic materials for diverse applications."

6) Pesticide monitor

This analog instrument, with digital read-out fitted with an amperometric interface, was developed under DST grant-in-aid project GAP 25/07 titled "Development of electroanalytical sensor for pesticides."

Other S&T services

72 electrical measurement instruments were calibrated during the period under review.

Pesticide monitor. *1-A galvanostat with 20V max output.*

Computer & 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, 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).
- 8 Mbps dedicated leased line for internet and intranet services (to be expanded to 1 Gbps connectivity).
- 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.
- High end servers to host DHCP Services, CECRI Intranet and Databases.
- LCD Projection Systems for Seminars/ Meetings presentations, Plasma Displays for displaying important events of CSIR-CECRI.
- Video Conferencing Facility.

HPC Cluster facility with 22 nodes (each node has 4 CPUs) + Master + NAS (2TB HDD).

Software developed

- Bank Credit Software to generate credit statement and to track payments credited to the account of the staff.
- Online Application System for recruitment to the post of Scientists at CECRI.
- Online Stationery Indent for Printer Cartridge/ Toner to facilitate indentors to place stationery indents for cartridge/toner online and to get it without much delay. This software provides electronic movement of indents from the indentor to stores and minimizes personnel movement.
- Online Purchase Indent Software was customized.

Scientific activity of the division

·Data analysis using Neural Networks & Database development for Electrochemical applications.

e-Library

e-Library, a one-stop virtual resource repository for information on electrochemical science and technology, was inaugurated by Prof. Samir K. Brahmachari, DG-CSIR on August 29, 2008.

Mission and Vision:

- Inter-operable institutional open-access repository of CECRI's research articles including proceedings of symposia and conferences and doctoral theses.
- Resource center for users to access information such as digital contents of journals, books, standards, patents, secondary databases, etc.
- Trend of research in electrochemistry and other fields through literature-based analysis (growth of literature, 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.
- Latest news and perspectives in the area of electrochemical science and technology.

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, schematic/concept diagrams etc.

Activities during 2009–2010

- Automation of the Knowledge Resource Centre using Libsys Software.
- Annual Report for the year 2008-2009 and a Brochure of Analytical Facilities at CECRI was designed and produced.
- Posters highlighting the research activities of CECRI was designed and produced for CSIR Technofest-2010, CSIR Foundation Day, various conferences and seminars.
- A new website for e-Library was developed and updated with the following features:
  - ⊙ Research Output containing the list and full text of publications from CECRI since its inception.
  - ⊙ Forms download section containing commonly used forms arranged in groups for convenience.
  - ⊙ CECRI News, a bi-monthly newsletter, providing snapshots of happenings in CECRI.
  - ⊙ New Arrivals section containing the list of newly arrived books and Displayed Journal section containing the list of Journals, with contents page, 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.

Engineering & technical services

The following facilities were added to workshop for a value of Rs 22 lakh during 2009–10.

Tool and cutter grinder: This is used to sharpen milling cutters and tool bits as well as other cutting tools. It is a versatile machine and can be used for a variety of grinding operations: surface, cylindrical, or complex shapes. The image shows a manually operated setup.

Plasma cutting: Plasma cutting is a process that is used to cut steel and other metals of different thicknesses using a plasma torch. In this process, an inert gas is blown at high speed out of a nozzle; at the same time an electric arc is formed through that gas from the nozzle to the surface being cut, turning some of that gas to

Gas tungsten arc welding / TIG welding: Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce a weld. The weld area is protected from atmospheric contamination by a shielding. GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium and copper alloys. The process grants the operator greater control over the weld.

Hydraulic stacker: Engineered for smooth operation and outstanding durability, the hydraulic stacker can handle the following applications: lift and transport

skids, bales and baskets; load/unload trucks; stock shelves; and handle dies, molds, or pallets. By combining a power lift with an easy to operate manual push, the hydraulic stacker is perfect for manoeuvring in tight or congested areas.

New fabrications done at CNC machining centre

Flow field fabrication in graphite, stainless steel and titanium plates for fuel cell and hydrogen generation applications; sensor assembly for NMR; hydrogen compressor assembly set up; coin cell assembly for lithium batteries; and sample holder for XPS and laser coating instrument.

Electrical works

Work to the tune of Rs 25 lakh was completed under CSIR-funded programs. These include providing lights in the peripheral road area for a 2-km circle in the campus for daily security round-up; installation of automatic power factor correction unit with load manager system for I and II point transformers; providing street lights in the campus, replacing overhead lines with UG cable. Other works include providing electrical connection for a value of Rs 17 lakh to Bitrode life cycle testers of various capacities at the Battery Building; erection of tapping switches and bus bar connection for 7000 A rectifier at the Battery Building for a value of Rs 17 lakh; renovation electrical works at the Electro-Inorganic Chemicals Division for a value of Rs 2.75 lakh; general maintenance to the institute and maintenance of internal street lights; maintenance and operation of two 166 kVA generators and two 500 kVA generators that provide power supply

to the institute during power shut-down period.

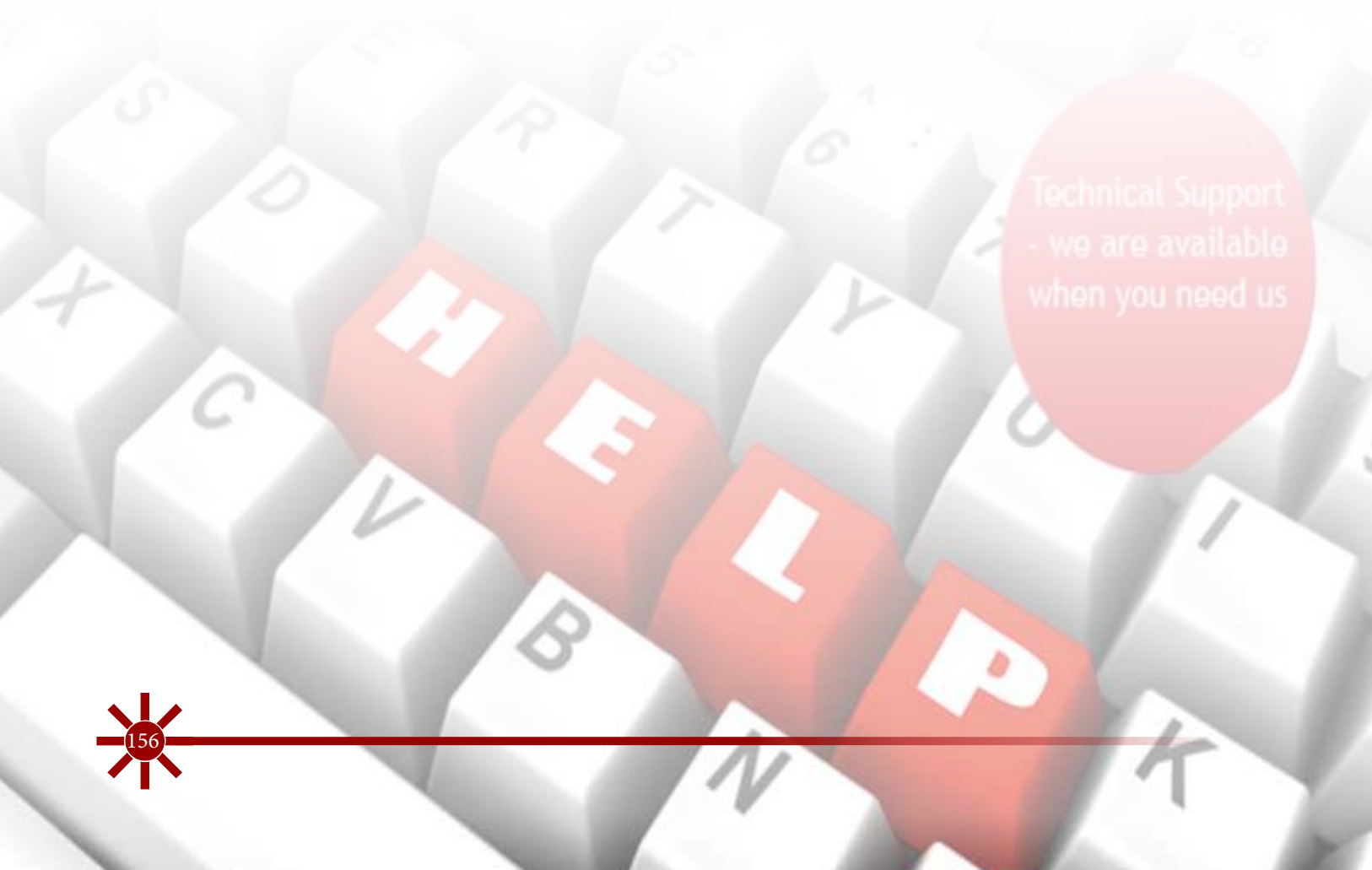
Other facilities

General facility: An automatic tyre inflator with air compressor was installed at main gate as general usage facility.

Air-conditioning: Around 15 new split air-conditioners were installed at various instrument facility areas. Precision air-conditioner for the cluster computing system and its maintenance. General maintenance of approximately 350 air-conditioners.

Glass blowing: More than 150 job works were carried out in scientific glass works section.

Engineering drawing: Around 500 drawing works were carried out for 80 job cards. In addition, certificate writing work for all courses were carried out.



Awards and Honours

Dr. N. Palaniswamy	Mascot National Award 2009
Dr. G.N.K. Ramesh Bapu	N.M. Sampat Award
Dr. M. Natesan	NACE International Gateway of India Section (NIGIS)
Dr. N. Muthukumar (formerly research scholar)	NIGIS Best PhD Award
Dr. P. Veeramani Dr. S. Mohan	Best Electroplater Award
Dr. M. Shahid Anwar	Madhya Pradesh Young Scientist Award for Physics - 2009

Foreign Deputation

Name	Country visited	Purpose of visit	Period of deputation	Sponsor
D. Velayutham Gr. IV (5)	Australia	To avail the Australian Endeavour Scholarship	Mar 2, 2009 to Jul 1, 2009	Australian Endeavour Fellowship
P. Sridhar Gr. IV (5)	Germany	To attend 2nd Indo-German Workshop on Fuel Cells and Hydrogen Energy	Mar 16, 2009 to Mar 20, 2009	CSIR & BMBF
A.K. Sahu Gr. IV (1)	Germany	To attend 2nd Indo-German Workshop on Fuel Cells and Hydrogen Energy	Mar 16, 2009 to Mar 20, 2009	CSIR & BMBF
S. Gopukumar Gr. IV (4)	UK	To carry out preliminary work and to discuss project planning and targets under the collaborative project of CSIR-Royal Society	May 21, 2009 to May 25, 2009	CSIR & Royal Society
A. Sivashanmugam Gr. IV (4)	UK	To carry out preliminary work and to discuss project planning and targets under the collaborative project of CSIR-Royal Society	May 21, 2009 to May 25, 2009	CSIR & Royal Society

Name	Country visited	Purpose of visit	Period of deputation	Sponsor
A.K. Sahu Gr. IV (1)	Canada	To present a paper at the International Conference on Hydrogen + Fuel cells 2009	May 31, 2009 to Jun 3, 2009	CSIR
N. Kalaiselvi Gr. IV (3)	USA	To avail Raman Research Fellowship	Jun 1, 2009 to Sep 30, 2009	CSIR
S. Vasudevan Gr. IV (2)	France	To carry out research work on IFCPAR Project No.3800-W1 at the Laboratory for Catalysis and Organic Chemistry	Jun 3, 2009 to Jul 2, 2009	IFCPAR
J. Lakshmi SRF	France	To carry out research work on IFCPAR Project No.3800-W1 at the Laboratory for Catalysis and Organic Chemistry	Jun 3, 2009 to Jul 2, 2009	IFCPAR
Sheela Berchmans Gr. IV (5)	Korea	To present a paper at the 2nd Microbial Fuel Conference, GIST	Jun 10, 2009 to Jun 12, 2009	CSIR
K. Firoz Babu Proj. Asst.	UK	Vist under the collaborative project between CSIR & Royal Society	Jul 9, 2009 to Sep 29, 2009	CSIR & Royal Society
Bosco Emmanuel Gr. IV (4)	Australia	To accept Distinguished Visiting Scientist Fellowship	Jul 27, 2009 to Jan 1, 2010	CSIRO, Australia
M. Paramasivam Gr. IV (4)	Germany	To pursue research with Prof. Ulrich Guth under INSA-DFG Bilateral Exchange Programme	Aug 1, 2009 to Oct 30, 2009	INSA & CECRI
Alok K.R. Paul Gr. IV (3)	USA	To present a paper at the US-India Workshop in Power and Energy	Sep 29, 2009 to Oct 1, 2009	Workshop organizers

Name	Country visited	Purpose of visit	Period of deputation	Sponsor
L. John Berchmans Gr. IV (3)	Germany	Exchange visit under DST-DAAD project	Oct 1, 2009 to Oct 30, 2009	DST
A. Manuel Stephan Gr. IV (2)	Italy	To deliver three lectures at the Symposium on Electrochemical Power Sources	Oct 12, 2009 to Oct 16, 2009	Symposium organizers
K. Asokan Gr. IV (5)	USA	To present two papers	Oct 20, 2009 to Oct 22, 2009	CSIR & CECRI
P. Murugan Gr. IV (2)	Japan	Visit under a collaborative project of DST-JST	Oct 30, 2009 to Jan 22, 2010	DST & JST, Japan
S. Gopukumar Gr. IV (4)	Taiwan	Indo-Taiwan Joint Research Project work and to deliver an invited talk at ACEPS-4	Oct 5, 2009 to Nov 15, 2009	DST-GITA
M. Raju Gr. IV (4)	USA	Training on battery testing systems at Bitrode Corp.	Nov 16, 2009 to Nov 21, 2009	Bitrode Corp, USA & CECRI
A. Manokaran Gr. IV (1)	Italy	To present a paper at the 3rd European Fuel Cell Technology and Application Conference	Dec 12, 2009 to Dec 18, 2009	CSIR
P. Sridhar Gr. IV (5)	Italy	To present a paper at the 3rd European Fuel Cell Technology and Application Conference	Dec 12, 2009 to Dec 18, 2009	CSIR
S. Gopukumar Gr. IV (4)	Japan	For discussions on DST-JST collaborative project	Dec 9, 2009 to Dec 16, 2009	- DST-JST
B. Subramanian Gr. IV (2)	Germany	To present a paper in the 7th International Symposium on Applied Plasma Science: ISAPS'09	Aug 31, 2009 to Sep 4, 2009	CSIR

Name	Country visited	Purpose of visit	Period of deputation	Sponsor
S. Senthilkumar Gr. IV (1)	Germany	To pursue work under a Indo-German project	Sep 14, 2009 to Nov 12, 2009	CSIR & BMBF
James Joseph Gr. IV (3)	Germany	To pursue work under a Indo-German project	Sep 14, 2009 to Nov 12, 2009	CSIR & BMBF
G. Selvarani SRF	Brazil	To present a paper at the International Conference on Advanced Materials	Sep 20, 2009 to Sep 25, 2009	CSIR
A. Sivashanmugam Gr. IV (4)	Taiwan	To work under the Indo - Taiwan project	Feb 25, 2010 to Mar 26, 2010	DST-GITA & NSC, Taiwan
B. Subramanian Gr. IV (2)	Korea	To present a paper at the 3rd International Workshop on Plasma Application & Hybrid Functionally Materials	Feb 26, 2010 to Feb 26, 2010	JSPS, Japan & NWP-10
S. Gopukumar Gr. IV (4)	Japan	For discussions on a DST - JST collaborative project	Mar 25, 2010 to Mar 30, 2010	DST & JST, Japan

Seminar & Training

Industry-oriented technology courses

CECRI offers a variety of technology courses to scientific and technical personnel employed in industries, government and academic institutions. These moderately-priced courses are designed to impart necessary knowledge and skills and are conducted by competent scientists with the help of skilled auxiliary/technical staff. Participants are provided ample opportunities for hands-on experience.

During 2009–10, CECRI conducted 14 industry-oriented technology courses in the following subjects.

- Corrosion Science and Engineering (6 modules)
- Batteries (2 modules)
- Electrochemical Materials Science (1 module)
- Industrial Metal Finishing (2 modules)
- Electroplating & Metal Finishing Technology (3 modules)

The courses are structured as modules each lasting 5–6 days. 165 participants from various organizations attended the courses during 2009–10, generating funds to the tune of Rs 12,44,184 as course fees.

Industry-oriented technology courses conducted during 2009–2010

Sl. No.	Name of the course	Duration	No. of partici-pants	Value (₹)
1	Corrosion control in boilers and heat exchangers	24.08.09 to 28.08.09	9	59,562
2	Corrosion control in thermal power plants	07.09.09 to 11.09.09	7	46,326
3	Cathodic protection systems and devices	14.09.09 to 18.09.09	4	26,472
4	Pipeline corrosion and its control	05.10.09 to 09.10.09	5	33,090
5	Corrosion diagnosis and durability enhancement of concrete infrastructures	19.10.09 to 23.10.09	9	59,562
6	Paints for corrosion protection	26.10.09 to 30.10.09	25	1,65,450
7	Lead-acid batteries: science & technology	09.11.09 to 13.11.09	17	2,18,394
8	Lead-acid battery: care and maintenance	16.11.09 to 18.11.09	6	33,090
9	Surface coatings by physical vapor deposition, chemical vapor deposition and surface analyses	30.11.09 to 04.12.09	13	69,489
10	Industrial practice of electroplating and metal finishing	07.12.09 to 11.12.09	30	2,31,630
11	Maintenance of electroplating baths	14.12.09 to 18.12.09	11	84,931
12	Electroplating of copper, nickel, chromium and precious metals	18.01.10 to 22.01.10	15	1,15,815
13	Troubleshooting in electroplating and metal finishing	08.02.10 to 12.02.10	08	54,047
14	Electroplating and anodizing- principles and practices	15.02.10 to 19.02.10	6	46,326
Total			165	12,44,184

Special training programs under Consultancy/Technical Services during 2009–2010

Sl. No.	Name of the Course	Duration	No. of participants	Value Rs.
1	*Corrosion and its control in petroleum production* held at CECRI for Cairn Energy India Pvt. Ltd., Gurgaon.	11.08.09 to 13.08.09	10	2,46,797
2	*Corrosion and its control* held at CECRI for Marketing Division, Indian Oil Corporation Limited, Mumbai.	31.08.09 to 04.09.09	15	3,06,634
3	*Advanced Electroplating Technology* held at CECRI for Fabrication Department-Naval Systems, Bharat Electronics Ltd., Bangalore.	09.11.09 to 13.11.09	16	2,20,600
4	*Advanced Painting Technology* held at CECRI for Fabrication Department-Naval Systems, Bharat Electronics Ltd., Bangalore.	09.11.09 to 13.11.09	11	2,20,600
5	*Advanced Electroplating Technology* held at CECRI for Fabrication Department-Naval Systems, Bharat Electronics Ltd., Bangalore.	16.11.09 to 20.11.09	12	2,20,600
6	*Advanced Painting Technology* held at CECRI for Fabrication Department-Naval Systems, Bharat Electronics Ltd., Bangalore.	16.11.09 to 20.11.09	10	2,20,600
	Total		**74**	**14,35,831**

Events

CECRI Foundation Day

Dr. Nagesh R. Iyer, Director, SERC, Chennai delivered the CECRI Foundation Day Lecture on July 27, 2009 on *Grand structural enginering challenges and their solutions: A few illustrative cases.*

Dr. Nagesh R. Iyer, graced the occasion as Chief Guest and delivered the CECRI Foundation Day lecture

CPYLS

The CSIR Programme on Youth for Leadership in Science was organized during December 3-5, 2009 for the benefit of X standard toppers of the previous year. Dr. A. Shenbagavalli, Registrar-in-Charge, Alagappa University, Karaikudi inaugurated the programme and gave a special address.

Vigilance Awareness Week

The Vigilance Awareness Week was observed during Novemebr 3-7, 2009. Mr. P.G. Madusoodanan, Section Officer (General) delivered a lecture on *Vigilance to be the way of life* on November 5, 2009.

CECRI Open Day

CECRI celebrated the CSIR Foundation Day by declaring September 26, 2009 as Open Day. More than 20,000 people consisting of general public, students, research scholars and faculty members of academic institutions from the nearby cities visited the Institute.

National Science Day

The National Science Day was celebrated on March 2, 2010 when Prof. M. Palaniandavar, Bharathidasan University, Tiruchirappalli delivered the National Science Day Lecture on *Electrochemical techniques in inorganic and bioinorganic chemistry.*

Professor M. Palaniandavar delivering the National Science Day Lecture

CSIR Foundation Day Lecture

The CSIR Foundation Day Lecture was delivered by Dr. H. Sivaramakrishnan, President (Research), Piramal Life Sciences Limited, Mumbai on September 24, 2009. The topic of the lecture was *Collaboration for Invention: A perspective of an industrial scientist.* Dr. V. Yegnaraman, Acting Director, presided and honored CECRI employees who had retired between September 2008 and August 2009 as well as those who had completed 25 years of service in CECRI/CSIR. Cash awards were presented to the wards of CECRI staff for excelling in science subjects in the higher secondary examinations of April 2008. He also gave away prizes to the winners of the essay and drawing competitions conducted for the wards of CECRI staff and BTech students.

Dr. H. Sivaramakrishnan, President (Research), M/s Piramal Life Sciences Limited (PLSL), Mumbai delivered the Foundation Day Lecture

हिंदी माह समारोह–2010

सीएसआईआर – केंद्रीय विद्युतरसायन अनुसंधान संस्थान, कारैकुडी में दि. 1 से 30 सितंबर, 2010 तक हिंदी माह मनाया गया । इस हिंदी माह के दौरान 11 प्रतियोगिताएँ आयोजित की गई जिसमें संस्थान के कर्मचारियों के साथ – साथ जेआरएफ एवं बी.टेक के विद्यार्थियों ने उत्साहपूर्वक भाग लिया ।

हिंदी माह का प्रारंभ ऑनलाइन दैनिक प्रश्नोत्तरी के साथ किया गया । प्रतिदिन इंट्रानेट 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 । दैनिक प्रश्नोत्तरी प्रतियोगिता को इस हिंदी माह, 2010 की सबसे अधिक सफल प्रतियोगिता कहा जा सकता है, चूंकि कर्मचारियों ने इसी में सबसे अधिक प्रतिभागिता दर्ज की । इस दौरान कुल 600 से भी अधिक उत्तर प्राप्त हुए।

इस दौरान साप्ताहिक ऑन्लाइन वर्ग – पहेली का आयोजन भी किया गया । इसमें हर सप्ताह इंट्रानेट 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 गई और समेकित रूप से सबसे अधिक अंक प्राप्त करने वालों को क्रमशः प्रथम, द्वितीय एवं तृतीय पुरस्कार दिए गए ।

दि. 06.09.10 को सामूहिक परिचर्चा प्रतियोगिता आयोजित की गई जिसमें अधिकारियों एवं कर्मचारियों ने भाग लिया और 'एक सीएसआईआर' विषय पर जोशपूर्ण चर्चा की ।

दि. 13.09.10 को हिंदी नारा लेखन एवं हस्ताक्षर 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 अर्थात वैज्ञानिक वर्ग , तकनीकी वर्ग , प्रशासनिक वर्ग आदि प्रत्येक वर्ग से सबसे सुंदर हस्ताक्षर एवं नारा लिखने वाले एक व्यक्ति को पुरस्कृत किया गया। समूह घ के कर्मचारियों में हिन्दी के प्रोत्साहन के मद्देनजर उनके वर्ग में भी एक पुरस्कार रखा गया था।

दि. 14.09.10 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 एक हिंदी प्रश्ननोत्तरी प्रतियोगिता आयोजित की गई ।

इस प्रतियोगिता में भाषा, साहित्य, इतिहास, राजनीति, खेल–कूद आदि से जुड़े सामान्य ज्ञान से सम्बंधित प्रश्न पूछे गए । इसके अंतर्गत दृश्य–श्रव्य सत्र भी रखे गए थे।

दि. 16.09.10 को भाषण प्रतियोगिता आयोजित की गई । भाषण के लिए हिंदी में काम करने के लिए प्रोत्साहन योजनाएँ, बच्चों के लिए हिंदी सीखना कितना आवश्यक, मेरे कार्यालय की उपलब्धियाँ, जल ही जीवन है– इसे बचाएँ आदि विषय दिए गए जिसका कर्मचारियों ने इच्छानुसार चयन कर उस पर भाषण दिया ।

दि. 20.09.10 को चित्र–वर्णन प्रतियोगिता में सभी प्रतिभागियों को ग्लोबल वार्मिंग तथा रुपए के एवं अशोक चिन्ह के चित्र की प्रतियाँ दी गई जिसमें से इच्छानुसार किसी एक का प्रतिभागियों ने अपनी–अपनी कल्पना के अनुसार वर्णन किया ।

दि. 23.09.10 को हिंदी गीत गायन प्रतियोगिता आयोजित की गई । इस प्रतियोगिता में प्रतिभागियों ने वाद्य यंत्रों का सहारा लिए बिना पूरे उत्साह एवं हाव–भाव के साथ हिंदी फिल्मों के तथा देशभक्ति गीत गाए । यह प्रतियोगिता कर्मचारियों के साथ–साथ बी. टेक के विद्यार्थियों के लिए भी आयोजित की गई ।

हिंदी माह समापन एवं पुरस्कार वितरण समारोह

हिंदी माह 2010 समापन एवं पुरस्कार वितरण समारोह दि. 30/09/10 को शाम 4.00 बजे संस्थान के विज्ञान प्रेक्षागृह में आयोजित किया गया ।

डॉ.वी. बालकृष्णन, उप निदेशक, क्षेत्रीय कार्यान्वयन कार्यालय(दक्षिण – पश्चिम) इस समारोह के मुख्य अतिथि थे । संस्थान के निदेशक डॉ. वी. यज्ञरामन जी के विदेशी दौरे पर होने के कारण संस्थान के कार्यकारी निदेशक डॉ. एन पलनिस्वामि जी ने इस समारोह की अध्यक्षता की । सर्वप्रथम हिंदी माह आयोजन समिति के अध्यक्ष डॉ. वी. अनंत ने मुख्य अतिथि तथा उपस्थित सभी व्यक्तियों का स्वागत किया ।

डॉ. एन पलनिस्वामी ने शॉल एवं पुष्प गुच्छ से मुख्य अतिथि का स्वागत किया ।

तदुपरांत उन्होंने अपने अध्यक्षीय भाषण में कहा कि यदि कोई व्यक्ति मातृभाषा के साथ–साथ हिंदी भी सीख लेता है तो वह भारत में कहीं भी व्यवहार कर सकता है । हिंदी माह के सफल संचालन व आयोजन के लिए हिंदी अनुभाग के अधिकारियों/कर्मचारियों तथा पुरस्कार विजेताओं को उन्होंने बधाई दी ।

श्री सोमेश्वर पाण्डेय, हिंदी अधिकारी ने इस पूरे हिंदी माह के दौरान आयोजित की गई प्रतियोगिताओं का प्रस्तुति के माधयम से संक्षिप्त ब्योरा दिया । उन्होने हिंदी माह के दौरान सबसे अधिक सफल ऑनलाइन दैनिक प्रश्नोत्तरी के बारे में बताते हुए कहा कि कागज के कम प्रयोग एवं पेड़ो के संरक्षण तथा अधिकाधिक कर्मचारियों की प्रीतभागिता के उद्देश्य से, यह ग्रीन दैनिक प्रश्नोत्तरी प्रतियोगिता ऑनलाइन आयोजित की गई। चूंकि सभी कर्मचारियों को अपने कार्यस्थान से अपनी सुविधा व समयानुसार इंटरनेट की सहायता से इसमें भाग लेने की सुविधा थी, इसलिए कुल 20 प्रश्नों के 600 से भी अधिक उत्तर प्राप्त हुए। जिनकी आगामी प्रतियोगिता की सूचना के साथ पावती भी भेजी गयी। इस प्रकार इस प्रक्रिया में लगभग 1200 ई–मेल का आदान–प्रदान हुआ है, जिसमें से लगभग 900 ईमेल द्विभाषी हैं। उन्होंने कहा कि अगले वर्ष ऑनलाइन के माध्यम से और प्रतियोगिताएँ आयोजित की जाएँगी। उन्होंने यह आशा व्यक्त की कि अगले वर्ष संस्थान में हिंदी में काम करने वालों तथा प्रतिभागियों की संख्या में निश्चित रूप से और अधिक वृद्धि होगी ।

तदुपरांत मुख्य अतिथि डॉ. वी. बालकृष्णन जी ने अपने भाषण में सबसे पहले संस्थान में ऑनलाइन प्रतियोगिताओं के आयोजन के लिए बधाई देते हुए कहा कि जब किसी साधारण कार्य को असाधारण तरीके से किया जाए तब उस कार्य की सफलता कई गुणा अधिक हो जाती है । उन्होंने संस्थान के उच्च अधिकारियों से हिंदी में काम करने का अनुरोध किया उन्होंने कहा कि जब उच्च अधिकारी हिंदी में काम करने लगेंगे तो अधीनस्थ कर्मचारी भी हिंदी में काम करने के लिए प्रोत्साहित होंगे । उन्होंने इस विषय पर ज़ोर दिया कि हमें हिंदी का काम नहीं बल्कि हिंदी में काम करना चाहिए। हिंदी माह मनाना, प्रतियोगिताएँ आयोजित करना ,पुरस्कार वितरित करना आदि हिंदी का काम है, जो कि हिंदी में काम करने के लिए लोगों को प्रोत्साहित करने के लिए मात्र है। प्रोत्साहन का काम तो हो रहा है परंतु अनुवर्ती कार्य पूरी तरह से अधिकारियों/कर्मचारियों पर ही निर्भर है । उन्होंने अधिकारियों/कर्मचारियों से नेमी टिप्पणियों को अंग्रेज़ी के साथ – साथ हिंदी में भी लिखने का अनुरोध किया । उन्होंने आशा व्यक्त की कि हिंदी के प्रति लोगों की यह रुचि सिर्फ हिंदी माह तक सीमित न रहकर आगे भी बरकरार रहेगी । तत्पश्चात विभिन्न प्रतियोगिताओं के पुरस्कार विजेताओं को पुरस्कार प्रदान किए गए तथा तथा इन प्रतियोगिताओं के निर्णायकों एवं संचालकों (बाह्य एवं स्थानीय) को उनके योगदान के लिए सम्मानित किया गया तथा इसके साथ ही वर्ष 2009 – 2010 में कार्यालयीन कार्य हिंदी में करने वाले अधिकारियों/कर्मचारियों को भी नकद प्रोत्साहन पुरस्कार भी प्रदान किए गए ।

अंत में श्री मेन्युल थॉमस, प्रशासन नियंत्रक द्वारा धन्यवाद प्रस्ताव के साथ समारोह सम्पन्न हुआ । इस समारोह का संचालन श्रीमती जी कलैवाणी, हिंदी अनुवादक ने किया।।

Visits by Foreign Scientists

Prof. Digby D. Macdonald, Pennsylvania State University, USA delivered a lecture on *Passivity and passivity breakdown* on December 10, 2009 amidst his visit to IISc, Bangalore.

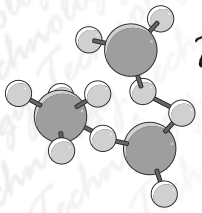
A team of Japanese scientists, **Prof. Jun-ichi-Yamaki, Mr. Mingjiong Zhou, Mr. Seung Hee Han, Mr. Sun II Park, Mr. Yoh Tanaka** and **Mr. Hideki Mizuta**, visited the institute between Decemebr 23 and 26, 2009 under the Indo-Japan Project GAP 12/08.

Dr. Pritam Singh, Emeritus Professor of Chemistry, Murdoch University, Australia visited the institute during January 17 - 19, 2010 to discuss an MoU between CECRI and Murdoch University.

Prof. Bing-Joe Hwang, National Taiwan University of Science and Technology, Taiwan and Principal Investigator of an Indo-Taiwan collaborative project with CECRI visited between January 30 and February 3, 2010 for discussions on the above project.

Prof. Florence Epron, University of Poitiers, France visited CECRI under the Indo-French Project, CLP 24/07, between February 9 and 19, 2010.

Mr. Manfred Decker, Kurt Schwabe Institute for Sensor and Measuring Technology, Germany visited CECRI between February 10 and March 13, 2010 under the CSIR-IB, BMBF Cooperative Programme.



Technologies & Patents

Technologies Developed

a. Electrochemical activation of electrodes for hydrogen generation

b. Electrolytic process for the production of tetraethyl ammonium hydroxide, tetrapropyl ammonium hydroxide and tetrabutyl ammonium hydroxide from the corresponding bromides by membrane electrolyzer.

Technologies Licensed

a. Electrochemical activation of electrodes for hydrogen generation, *Easten Electrolyser Ltd., New Delhi,*

b.Electroless nickel plating of maraging steel components for TEJAS aircraft, *Aeronautical Development Agency, Bangalore.*

c. Electrosynthesis of potassium permanganate by cation-exchange membrane process, *Libox Chem (India) Pvt. Ltd., Mumbai.*

d.Electrolytic process for the production of tetrapropyl ammonium hydroxide from the corresponding bromide by membrane electrolyser, *Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar.*

e.Electrochemical method for hydrogen compression, *Eastern Electrolyser Ltd., New Delhi.*

f. Electrolytic process for the production of tetrabutyl ammonium hydroxide from the corresponding bromide by membrane electrolyser, *Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar.*

Patent applied

An electrochemical coagulation process for the removal of nitrate from drinking water and electrolytic cell therefor.

S. Vasudevan, Florence Epron, S. Ravichandran, G. Sozhan, S. Mohan and J. Lakshmi.

Patents filed

Polyaniline based wash primer paint coating for galvanized iron.

S. Sathyanarayanan, S. Syed Azim and G. Venkatachari.

Non Enzymatic Electrochemical method for simultaneous determination of total hemoglobin and glycated hemoglobin (jointly with Peramal Healthcare Ltd.

V. Yegnaraman, K.L.N. Phani, J. Mathiyarasu, V. Manohar and G. Varghese

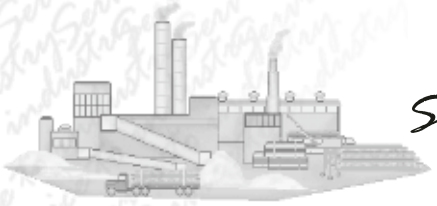
(Indian/US/PCT/Iran/Iraq/Bangaladesh/Nepal)

Technologies Transferred

A process for electrosynthesis of tetrapropyl ammonium hydroxide was released to Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar, Gujarat on June 18, 2009.

A process for electrosynthesis of tetrabutyl ammonium hydroxide was released to Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar, Gujarat on January 5, 2010. A process for the electrosynthesis of tetraethyl ammonium hydroxide was released earlier to the company in March 2009.

A know-how for electrosynthesis of potassium permanganate by a cation-exchange membrane process was transferred to Libox Chem (India) Pvt. Ltd., Goa on August 13, 2009.



Service to Industry

1. Supply of electrolyzer for tetraethyl ammonium hydroxide synthesis (TSP-15/2008)

A membrane electrolyzer (250 A rating) of working area 0.25 m^2 for the production of tetraethyl ammonium hydroxide (TEAH) from its bromide (TEAB) was designed and fabricated with anode, cathode and membrane, and supplied to Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar, Gujarat for a fee of ₹70,000.

2. Processing and supply of anodes and cathodes for the production of tetraalkyl ammonium hydroxide (TSP-04/2009)

Four coated titanium anodes (plain configuration) of size 60 cm x 60 cm and two uncoated perforated titanium cathodes of size 60 cm x 60 cm suitable for the electrolytic production of tetraalkyl ammonium hydroxide from the respective bromide were supplied to Tatva Chintan Pharma Chem Pvt. Ltd., Ankleswar, Gujarat for a fee of ₹1,32,360.

3. Processing of anodes for electrochemical treatment of effluent from yeast manufacturing (TSP- 6/2009)

Four tubular titanium mesh anodes of diameter 150 mm and length 750 mm for electrochemical treatment of effluent from a yeast manufacturing unit (fabricated titanium substrates supplied by the firm) were processed with active catalytic coating, and supplied to GET Water Solutions Pvt. Ltd., Chennai for a fee of ₹60,000.

4. Supply of membrane electrolyzer for the production of tetramethyl ammonium hydroxide (TSP- 19/2009)

A membrane electrolyzer of 0.25 m^2 active area (250 A rating) with a coated titanium expanded mesh anode and a titanium perforated cathode was designed and fabricated for the electrolytic production of tetramethyl ammonium hydroxide (TMAH) from its chloride (TMAC), and supplied to NOCIL Ltd., Mumbai for a fee of ₹1,10,300.

5. Coating of titanium expanded mesh and tantalum sheet with catalytic coating for the production of tetraalkyl ammonium hydroxide from its bromide

Four titanium expanded mesh anode of size 60 cm x 42 cm and one tantalum plain sheet of size 25 cm x 35 cm supplied by the firm were coated with a catalytic active coating to function as anode for the production of tetraalkyl ammonium hydroxide from its bromide in a membrane electrolyser, and supplied to Tatva Chintan Pharma Chem Pvt. Ltd., Ankleshwar, Gujarat for a fee of ₹1,03,616.

Recipients of PhD degree

Recipient	Subject Area	Title of the Thesis	University	Month/ Year
K. Raghavendran Research Scholar	Lithium batteries	Classical and quantum-mechanical computations on spinel type $Li_xM_yMn_{2-y}O_4$ for lithium batteries	Alagappa University	May 2009
S. Senthilkumar Research Scholar/ Scientist	Chemistry	Investigations on the generation of supported metal nanoparticles for catalytic and electroanalytical applications	Bharathidasan University	July 2009
R. Vedalakshmi Scientist	Civil engineering	Corrosion protection of steel reinforcements in blended cements of low and medium strength concrete under marine environ mental conditions – a real time study	Anna University	July 2009
R. Sripriya Research Scholar	Industrial chemistry	Electrochemical studies in micellar and microemulsion medium	Alagappa University	July 2009
M. Kanagasabapathy Research Scholar	Industrial chemistry	Studies on electrodeposition of zinc-iron alloy deposits from complex baths	Alagappa University	July 2009
G.T. Parthiban Scientist	Metallurgical engineering	Electrochemical behaviour of magnesium in alkaline medium	Bharathidasan University	November 2009
N. Jayaprakash Research Scholar	Chemistry	Synthesis and characterization of certain high capacity electrode materials for lithium batteries	Bharathidasan University	December 2009
B. Anandkumar Part-time Research Scholar	Industrial chemistry	Molecular characterization and corrosion behavior of sulphate reducing bacteria (SRB) isolates from Indian petroleum refinery	Alagappa University	December 2009
Akhila Kumar Sahu Scientist	Chemistry	Novel materials for polymer electrolyte fuel cell	Madras University	January 2010
S. Raghu	Environmental studies	Treatment of textiles effluents by advanced techniques	Bharathidasan University	February 2010

Publications 2009

No	Authors	Title	Journal	Vol	Page
1	Elango-A, Periasamy-M, Paramasivam-M	Study on polyaniline-ZnO used as corrosion inhibitors of 57S aluminium in 2M NaOH solution	Anti-Corros. Meth. Mater.	56	266
2	Parthiban-GT, Palaniswamy-N, Sivan-V	Effect of manganese addition on anode characteristics of electrolytic magnesium	Anti-Corros. Meth. Mater.	56	79
3	Sheela Berchmans, Arunkumar-P, Lalitha-S, Yegnaraman-V, Bera-S	Preparation of catalytic films of platinum on Au substrates modified by self-assembled PAMAM dendrimer monolayers	Appl. Catal. B	88	557
4	Gangulibabu, Bhuvaneswari-D, Kalaiselvi-N	Feasibility studies on newly identified $LiCrP_2O_7$ compound for lithium insertion behavior	Appl. Phys. A	96	489
5	Aravindan-V, Vickraman-P, Sivashanmugam-A, Thirunakaran-R, Gopukumar-S	LiFAP-based PVdF-HFP microporous membranes by phase-inversion technique with Li/$LiFePO_4$ cell	Appl. Phys. A	97	811
6	Sharmistha Bagchi, Shahid Anwar, Lalla-NP	Effect of swift heavy ion irradiation in Fe/W multilayer structures	Appl. Surf. Sci.	256	541
7	Premkumar-P, Kannan-K, Natesan-M	Evaluation of menthol as vapor phase corrosion inhibitor for mild steel in NaCl environment	Arab. J. Sci. Eng.	34	71
8	Thangavel-K, Muralidharan-S, Saraswathy-V, Quraishi-MA, Ann-KY	Migrating vs. admixed corrosion inhibitors for steel in portland, pozzolona and slag cement concretes under macro cell condition	Arab. J. Sci. Eng.	34	81
9	Eashwar-M, Subramanian-G, Palanichamy-S, Rajagopal-G, Madhu-S, Kamaraj-P	Cathodic behaviour of stainless steel in coastal Indian seawater: calcareous deposits overwhelm biofilm	Biofouling	25	191

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