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A monthly newsletter of CSIR-CECRI  
—compilation of significant happenings—

## Launch of India's First Indigenous Fuel Cell Bus

On December 15, 2021, Pune-based Sentient Labs, an R&D innovation lab, building on technologies incubated by KPIT Technologies Ltd., Pune announced the launch of 'Made in India' hydrogen fuel cell bus. This India's first indigenously developed and manufactured bus would run on hydrogen fuel cell that has been designed and developed by Sentient Labs in collaboration with the Council of Scientific and Industrial Research (CSIR) [National Chemical Laboratory (NCL) and Central Electrochemical Research Institute (CECRI)]. The 32-seater bus, equipped with central air-conditioning facility, is designed to provide a range of 450 kilometres by utilising 30 kg of Hydrogen. The modular architecture of the bus allows for a change in its design to modify according to the requirements of range and operating conditions.



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“

**The developed technology  
and R&D collaboration  
with CSIR will go a  
long way in powering  
Hydrogen Mission,  
AatmaNirbhar Bharat  
and importantly  
sustainable mobility**

”

### INSIDE THIS ISSUE

- Launch of India's first First Indigenous Fuel Cell Bus
- India International Science Festival-2021
- New Members in CSIR-CECRI Family
- Honours and Awards



The bus uses hydrogen fuel cells and air to generate electricity for power and can run for 600 km without stopping. The only emission from the bus is water, thus, making it the most environment-friendly mode of transportation. For comparison, a single diesel bus plying on long distance routes typically emits 100 tons of CO<sub>2</sub> annually and there are over a million such buses in India.

Additionally, the 'Made in India' fuel technology would cost around \$400 per kilowatt compared to \$1000–\$1,200 worldwide. While hydrogen generation technology can provide an alternative source of revenue to farmers, replacing diesel buses with hydrogen fuel cell buses will improve air quality drastically and also reduce oil import costs.

*"We are proud to launch an indigenously developed hydrogen fuel cell power bus. A strong technical team along with CSIR worked on several technology components. This will go a long way in powering Hydrogen Mission, AatmaNirbhar Bharat and importantly sustainable mobility".*

*"We envision that the solution will see widespread adoption powered by several partnerships. Our efforts will also be pivotal in enabling vehicle makers and suppliers to build a net-zero carbon path in India,"* Chairman of Sentient Labs, Ravi Pandit said in a Statement.

Meanwhile, Sentient Labs is engaged in discussions with Indian Automotive OEMs and fleet operations to market large-scale adoption of hydrogen fuel cell buses. *"We have multiple enquiries from people who want 30 to 40 vehicles and want to run it for 12-15 months,"* Pandit said.

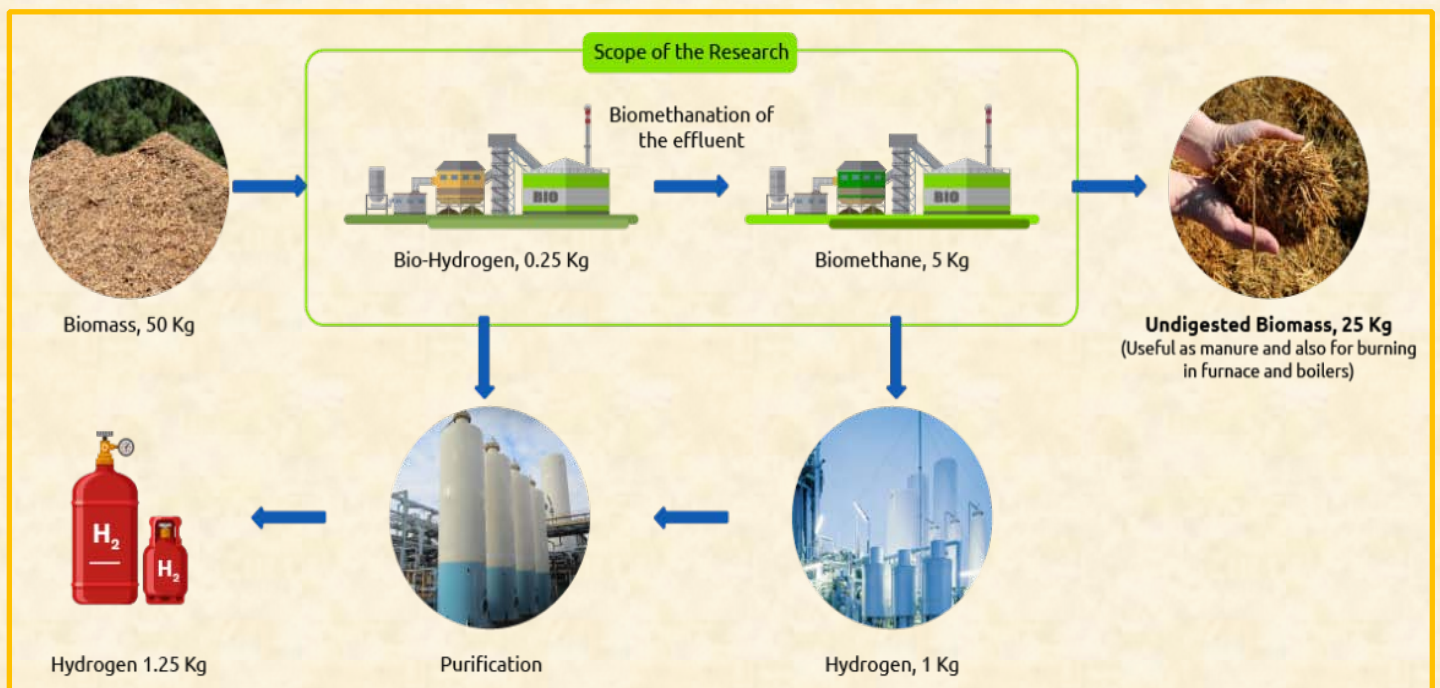
The chairman also informed that at least 5 lakh buses from the 20 lakh running on roads in India can be converted into fuel cell-powered vehicles. The bus will now run for 10 to 12 months at multiple places that have hydrogen restoration points.

Recently, Sentient had announced the **world's first technology** that generates hydrogen directly from agricultural residue for use in fuel cell-powered vehicles. This technology developed with the **Agharkar Research Institute, Pune** adds to the line-up of efforts around sustainable mobility.

Putting both the technologies by Sentient together can be an environment friendly and economically attractive proposal. *While Biomass-based hydrogen generation technology can provide an alternative source of revenue to farmers, replacing diesel buses with hydrogen fuel cell buses will improve air quality drastically and also reduce oil import costs*

In addition to the hydrogen fuel cell technology, Sentient Labs also indigenously designed and developed other key components such as balance of plant, powertrain and battery pack. All of these components have been deployed in the 9-metre, 32-seater, air-conditioned bus.

Raghunath Mashelkar, Member of Board of Directors, Sentient Labs, said: *"World over, efforts related to green hydrogen revolution are on, but Sentient Labs stands out. At Sentient, challenges that are core to India are understood, and solutions are developed. Digitisation, decentralisation and decarbonisation is what India needs for sustainable mobility and these innovations from Sentient will go a long way."*





## Business Development Leads

- ❖ Discussion with M/s. Hira Power & Steel Ltd., **Chattisgarh** on R&D Collaboration & Emerging Technologies for Commercialization [Dec 2]
- ❖ Workshop on *CSIR-COE-Carbon Capture Utilization and Storage*: Discussion and presentation on Hub-Spoke Model for industries participation and operation [Dec 3]
- ❖ Discussion with **NTPC-NETRA** on project proposals and R&D Collaboration by CSIR-TMD [Dec 8]
- ❖ Meeting with M/s. Titantech LLC, **Bangalore** on *Projects for Quantification of Gases* [Dec 9]
- ❖ Meeting with M/s. Tata Chemicals Ltd. on *Hard Coatings on Cutting Tools* [Dec 13]
- ❖ Discussion on joint collaborations between CSIR and **NTPC-NETRA** [Dec 9]
- ❖ Meeting with **CMTI, Bangalore** on R&D Collaboration [Dec 10]
- ❖ Internal Discussion on requirement of *Lithium Battery for NAL Aircraft Applications* [Dec 14]
- ❖ Meeting with M/s. Tata Chemicals Ltd. on *CO<sub>2</sub> Conversion* [Dec 15]
- ❖ Visit of Mr. S. Raveendran, Scientist/Engineer-SF, **IPRC/ISRO** on *Additive Manufacturing Facilities at CSIR-CECRI for fabricating Rocket Components for Launch Vehicles* [Dec 20]
- ❖ Discussion with **TWAD Board** on analysis of silt formation in pump set at Pudukkottai District, **Tamil Nadu** [Dec 10]
- ❖ Online Meeting with **Tata Steel Ltd.** on extraction of Gamma MnO<sub>2</sub> applicable to pilot plant establishment and further possible value additions [Dec 21]
- ❖ Discussion with M/s. **Asian Paints Ltd.** on Knowhow Transfer [Dec 21]
- ❖ Meeting with **Tata Chemicals Ltd.** on R&D Collaboration [Dec 22]
- ❖ Discussion with **Sri Meenatchi Industries, Sivakasi** on setting up of *Potassium Perchlorate Manufacturing Unit* [Dec 23]
- ❖ Meeting with **Blue Ashva Capital, Mumbai** on R&D Collaboration [Dec 23, 27]
- ❖ Meeting with **Gujarat Fluorochemicals Ltd.** on signing of NDA [Dec 23]
- ❖ Discussion on *Perovskite-Based Solar Cells: Materials, Methods and Future* organized by CSIR-TMD [Dec 27]
- ❖ Meeting with M/s. **Vedanta Ltd.** on exploring opportunities in Hydrogen Production and other R&D Developments [Dec 28]
- ❖ Meeting with M/s. **Bharat Forge Ltd., Pune** on R&D Collaboration [Dec 30]

## List of Newly Sanctioned Projects

Projects Sanctioned	Sponsor	Principal Investigator(s)	Budget (Rs. in Lakhs)	Start Date	End Date
Fabrication of pouch-type hybrid supercapacitor device with MXenes-based nanocomposite Electrodes in redox additive Electrolytes	Science & Engineering Research Board (SERB)	Dr. M. Sathish	27.83	13 Dec 2021	12 Dec 2024
High rate Discharge Test as per IEC 60623-2017 ED5 for three sets	M/s. SAFT India Pvt. Ltd., Bengaluru	Dr. Sundar Mayavan	1.5	15 Dec 2021	14 Feb 2022
Nanostructured MOFs as electrocatalysts for desulfurisation of organic sulphides in fossil fuels	Science & Engineering Research Board (SERB)	Dr. V. Suryanarayanan	22.22	20 Dec 2021	19 Dec 2024

➤ Funds realized under *CSIR-Fundamental & Innovative Research in Science of Tomorrow (CSIR-FIRST)* Scheme - 4 Nos. (Pls: Ms. R. Monika, Dr. M. Kathiresan, Dr. Rakesh Chandra Barik & Dr. K. Giribabu)

## Centre for Education and AcSIR Highlights

### AcSIR:

- ❖ Viva-voce examination for Mr. S. Arun, UGC SRF (Guide: Dr. Sundar Mayavan) [Dec 6]
- ❖ Viva-Voce Examination for Mr. R.N. Ramesha, UGC-SRF (Guide: Dr. K. Ramesha) [Dec 7]
- ❖ DAC Meeting for Mr. Prasanna Kumar (Guide: Dr. G. Sreedhar) [Dec 20]

- ❖ DAC Meeting for IDDP students Mr. Srikanth and Mr. Sai Charan [Dec 21]
- ❖ Viva-Voce Examination for Mr. Peddamasthanaiah Ette, CSIR-SRF (Guide: Dr. K. Ramesha) [Dec 21]
- ❖ Synopsis Submission of Mrs. G. Thamaraiselvi, DST INSPIRE SRF (Guide: Dr. S.K. Jha) [Dec 22]

### Centre for Education:

- ❖ Placement Interview for BTech Students [Dec 23]



## India International Science Festival 2021

India International Science Festival (IISF) is an initiative of Ministry of Science and Technology and Ministry of Earth Science of Government of India in association with Vijnana Bharati (VIBHA). The main objective of IISF is the celebration of science by all. Engagement of common people with science in a joyful and entertaining manner is essential for a healthy, prosperous and meaningful life. Through its creative programmes and activities, IISF provides opportunities to people and scientific fraternity in the country and abroad to come together, work together and experience the joy of doing science together for the wellbeing of India and humanity.

The 7<sup>th</sup> Edition of IISF - IISF 2021 - was held at Panaji, Goa from December 10 to 13, 2021. The theme of IISF 2021 is '*Celebrating Creativity in Science, Technology and Innovation for Prosperous India*'. IISF 2021 had twelve programme events including the mega science and technology expo and these events were designed on the basis of this year's Theme. As we are celebrating the 75<sup>th</sup> year of Swatantrata all the programs will reflect the spirit and idea of Aazadi ka Amrit Mahotsav. All programs have been categorized according to the five pillars suggested by our Hon'ble Prime Minister, Shri. Narendra Modi - 1. Economy, 2. Infrastructure, 3. System, 4. Democracy and 5. Demand

CSIR-CECRI played a key role in commemorating IISF 2021 like yesteryears. Various programmes were

organized, namely (i) On-line Science Quiz for school students (Dec 6); (ii) Young Scientists Conclave (Dec 6); (iii) Nobel Day 2021 Celebrations (Dec 10) and (iv) Online Skill Development Training Programme on "*Care & Maintenance of Lead Acid Battery*" (6-10 Dec 2021). Thousands of Students and Teachers from all over the Country actively participated in the above programs and got benefited.

Dr. K. Giribabu, Scientist from Electrodeics and Electrocatalysis Division, CSIR-CECRI was invited to deliver a Lecture among school Children in VIGYANIKA - Science Literature Festival on the theme, '*Inspiring Scientists - Road to Scientific Success*' on 12<sup>th</sup> December 2021. The idea of the event was to share the journey of personal experiences of the Scientist among student community and to encourage them to pursue a scientific career in India. Dr. Giribabu shared his inspiring journey from a backward rural background student to Scientist and CSIR Young Scientist Awardee. The session was chaired by eminent Professor Dr. Vijay P. Bhatkar, President, Vijnana Bharati and Chancellor, Nalanda University, Bihar. Dr. S. Sudhakar, Principal Scientist from Electrochemical Power Sources Division, CSIR-CECRI took active part in IISF-2021 and coordinated the Science Village Festival Event in which 950 students and 115 teachers from unprivileged and rural part of Goa participated enthusiastically.





## Skill Development Activities

### Skill Development:

- ❖ One Week Online Skill Development Training Program on "*Electrochemical Power Sources: Lead-acid Battery - Care and Maintenance*" conducted during 06-10 December, 2021.

### CSIR-JIGYASA:

#### Connect with Scientists Webinar Series:

The following lectures were arranged as a part of on-going Webinar Series:

1. "*How organic coating systems protect against corrosion*" by Dr. C. Arunchandran [Dec 3]
  2. "*Basics of electrochemical energy storage and conversion*" by Dr. P. Ragupathy [Dec 8]
  3. "*Recent advances in electrochemiluminescence based sensing protocols*" by Dr. S. Senthilkumar [Dec 16]
  4. "*Offshore engineering marvels for Oil, Gas and wind energy*" by Dr. S. M. Ganesan [Dec 23]
- ❖ Online Quiz Competition was conducted on 06.12.2021 in connection IISF-2021.
  - ❖ Webinar I2T - Idea to Innovative Thinking: Dr. J. Mathiyarasu delivered a talk on "*Conceptualization of Ideas & Reality in Research*"; Dr. S. Vasudevan delivered a talk on "*I2I on Water*" [Dec 7].
  - ❖ Meeting on Virtual Lab with IITB & NCL [Dec 28]

## Official Events

- ❖ Meeting with CECRI Chennai Unit on current R&D activities and futuristic developments [Dec 1]
- ❖ Meeting of Deputy Director of Horticulture, Sivaganga with CECRI Team regarding clogging in Drippers [Dec 2]
- ❖ International Virtual Conference on *Recent Advances in Lithium-ion Batteries & their Recycling Methods for Sustainable Development* by Open University, UK: Director, CSIR-CECRI made a presentation on "**Recent Developments in LIB Technology: Role of CSIR-CECRI**" [Dec 3]
- ❖ CSIR-ICeNGESS: Core Committee Meeting on Phase-I & Phase-II Activities [Dec 6]
- ❖ TNSCST - Vigyan Utsav (Science Festival): Virtual Meeting on "**Indigenous Technologies**" [Dec 8]
- ❖ International Virtual Conference on *Energy Sciences* organized by Mahatma Gandhi University, Kottayam: Inaugural Address by Director, CSIR-CECRI [Dec 10]
- ❖ Meeting of CSIR-Senior Research Fellowship Extension Committee [Dec 10]
- ❖ Expert Talk (Online) by Director, CSIR-CECRI on *Materials for Energy Storage Devices* to MTech (Energy Science & Technology) students of Mahatma Gandhi University, Kottayam [Dec 14].
- ❖ Meeting of CSIR-BPTEC Management Review Committee for the year 2021 [Dec 14]
- ❖ Firefighting Demonstration and Briefing on Safety Protocols to the Staff Members, Research Scholars and BTech Students in CSIR-CECRI Campus [Dec 15, 22, 30]
- ❖ Screening Committee Meeting for the post of Security Officer [Dec 15]
- ❖ Online Meeting on *India-UAE Collaboration on Green Hydrogen Mission* chaired by Prof. VijayRaghavan, PSA to GOI - Participation of Director, CSIR-CECRI [Dec 17]
- ❖ Monitoring Committee Meeting for EAC approved Projects [Dec 20]
- ❖ Meeting of the Dissertation-Project Works Committee [Dec 20]
- ❖ Online Meeting of Departmental Promotion Committee at CSIR Hqrs [Dec 22-24, 31]
- ❖ Committee Meeting on Proposal for Departmental Canteen Facility [Dec 22]
- ❖ Meeting on *development of Perovskite materials, process and solar cell fabrication* under the chairmanship of Dr. V K Saraswat, Hon'ble Member, NITI Aayog [Dec 23]
- ❖ Meeting of DG-CSIR with all CSIR Lab Directors [Dec 23]
- ❖ Walk-in-Interview for Engagement of Project Personnel [Dec 27]
- ❖ Quarterly Meeting of the Official Language Implementation Committee (OLIC) [Dec 28]
- ❖ 8<sup>th</sup> Meeting of Electroplating Chemicals and Photographic Materials Sectional Committee, BIS - Participation of Director, CSIR-CECRI [Dec 29]
- ❖ Meeting on Progress Review of "*Organic Radical Energy Devices*" [Dec 29]
- ❖ Discussion on Internal Audit [Dec 29]
- ❖ 12<sup>th</sup> Advisory Committee Meeting of CSIR-URDIP: Participation of Director, CSIR-CECRI [Dec 30]
- ❖ 24<sup>th</sup> Meeting of Secondary Cells and Batteries Sectional Committee, BIS on the Testing of Advanced Chemistry Cells & Batteries - Participation of Director, CSIR-CECRI [Dec 30]
- ❖ Farewell and Felicitation Function for the Retirees [Dec 31]



## Recent Research Publications

- ❖ *Current progressions in transition metal based hydroxides as bi-functional catalysts towards electrocatalytic total water splitting*

K. Sangeetha, K. Karthick, S. Sam Sankar, Arun Karmakar, M. Ragunath, Krishnendu Bera and Subrata Kundu  
Sustainable Energy & Fuels 5 (2021) 6215 [Cover Page]  
<https://doi.org/10.1002/cefc.202101501>

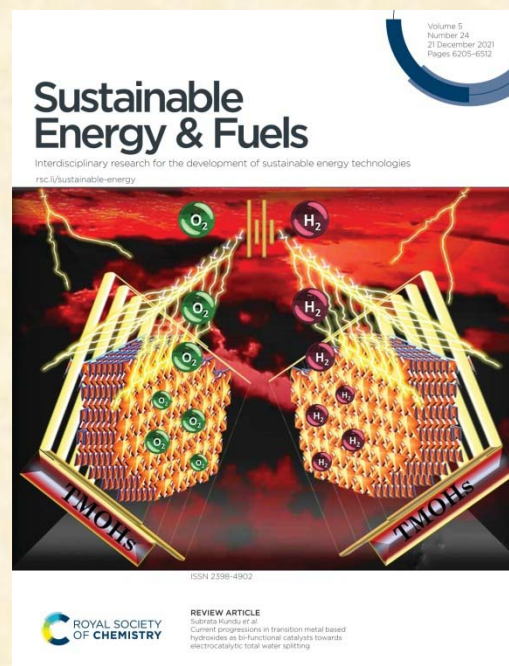
- ❖ *Graphene based materials as electrocatalyst for oxygen evolution reaction: A review*

H. Jung, Arun Karmakar, A. Adhikari, R. Patel and Subrata Kundu  
Sustainable Energy & Fuels [in press]  
<https://doi.org/10.1039/D1SE01716K>

- ❖ *Revealing the pH-universal electrocatalytic activity of Co doped RuO<sub>2</sub> towards the water oxidation reaction*

M. Ragunath, Arun Karmakar, K. Sangeetha, S. Sam Sankar, Krishnendu Bera, S. Nagappan, N.D. Hariharan and Subrata Kundu  
ACS Applied Materials & Interfaces [in Press]  
<https://doi.org/10.1021/acsami.1c20752>

based hydroxides (TMOHs) and their analogues as a better and cheaper alternative electrocatalyst materials in the total water splitting (TWS) application in terms of their activity, durability and stability. In addition, it also scrutinized the synergistic effect of incorporating chalcogenides and phosphides in the TMOHs system in terms of conductivity and stability as a bi-functional catalyst for alkaline water electrolysis.



This cover page showcased about the advantages of various designing strategies for transition metal

## Honours and Awards



Dr. S. Vasudevan, Senior Principal Scientist and Head, Electrochemical Process Engineering Division has been nominated as one of the Associate Editors of the International Journal "Water-Energy Nexus" published by Elsevier, Netherland.  
<https://www.sciencedirect.com/journal/water-energy-nexus/about/editorial-board>



Mrs. Nasrin Kabeer, DST-INSPIRE-SRF, ECPS Division (Guide: Dr. M. Sathish) has won the Best Oral Presentation Award for the research work "*MnCo<sub>2</sub>S<sub>4</sub> - MXene: A Novel Hybrid Electrode Material for High-Performance Long-life Asymmetric Supercapattery*" in the International Conference on Recent Advances and Innovations in Solar Energy, organized by DST-IITM Solar Energy Harnessing Centre, IIT Madras during December 02-04, 2021.

## Superannuation

❖



Dr. (Mrs) T. Vijayabarathi  
Senior Principal Scientist  
Electro-Organic and Materials  
Electrochemistry Division  
superannuated on December 30,  
2021 after a long illustrious service

❖



Dr. N. Meyyappan  
Principal Technical Officer  
Technology Transfer and  
Business Development Section  
superannuated on December 30,  
2021 after a long illustrious service

## New Members in CSIR-CECRI Family

❖



Mr. Tejavath Suresh  
has joined CSIR-CECRI Family on  
17.11.2021 as Technical Assistant in  
Civil Section

❖



Mr. R. Santoshkumar  
has joined CSIR-CECRI Family on  
06.12.2021 as Junior Secretariat  
Assistant (Gen) in Administration



# Snapshots



Skill Development Training Programme on  
"Lead- acid Battery - Care & Maintenance"



Celebration of Nobel Day 2021



Firefighting Demonstration and Briefing on other Safety Protocols to Staff Members and Scholars



Governing Council Meeting of SAEST [Dec 27]



Farewell and Felicitation to Retirees

## Obituary



Dr. M. Anbu Kulandainathan, Senior Principal Scientist, CSIR-CECRI left for heavenly abode on December 7, 2021. Born on 05.05.1964, he joined CSIR service on 29.12.1993 and has contributed immensely to Electrochemistry especially in the area of Electrosynthesis. His research interests mainly centred on the development of novel electrochemical technologies including electrochemical dyeing sans effluent, Metal-Organic Frameworks for application in Carbon dioxide sequestration and batteries, bio-electrochemical processes in textiles and nano electrochemistry, paired and self-supported organic syntheses and industrially relevant electrode reactions. His recent work on Carbon dioxide to Carbon nano-fibre gained much attention and fetched accolades for him and the Institute.

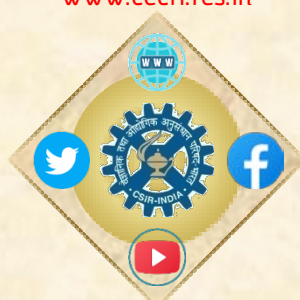


## TECHNOLOGY COMPENDIUM OF CSIR-CECRI

- ❖ Indigenous Li-ion battery
- ❖ Indigenous Sodium Ion Battery
- ❖ Performance Improved Lead Acid Battery
- ❖ Integrated Corrosion Monitoring Sensor Gadget accessible through a Mobile App
- ❖ Thermal Barrier Coatings for Strategic Applications
- ❖ Electrochemical Production of Sodium Hypochlorite as a Disinfectant (against COVID-19)
- ❖ Tri-layered reusable face mask with antibacterial coating
- ❖ Polymer Electrolyte Membrane (PEM) fuel cell
- ❖ Triboluminescent Coating and Smart Camera for Crack Detection in Structural Components
- ❖ Electrochemical Defluoridation of Drinking Water
- ❖ Solar Powered Proton Exchange Membrane (PEM) Based Water Electrolyser for Hydrogen Generation
- ❖ Cement-Polymer Composite Coating System for Corrosion Protection of Reinforcing and Prestressing Steels
- ❖ Solid Lubricant Coatings for Brahmos Missile Application
- ❖ Li Spheres for Torpedo Applications
- ❖ Electrowinning and Recovery of Tin from Primary Ore and Secondary Sources
- ❖ Electroplating of Gold, Copper and Nickel, Chromium, Zinc-Nickel Alloy; Anodizing of Aluminium; Electropolishing of Stainless Steel
- ❖ Electro-catalytic Conversion of CO<sub>2</sub> and butadiene to Adipic Acid; CO<sub>2</sub> to Formic Acid; CO<sub>2</sub> to Oxalic Acid.
- ❖ Farmer Friendly Soil Health (predictive) Analyzer
- ❖ Three Coat System for Steel Structures
- ❖ Inhibitor Cement Slurry Coating (ICSC) for Rebars
- ❖ Electrochemical Preparation of DL-Homocysteine Thiolactone Hydrochloride from DL-Homocysteine
- ❖ Electrochemical Perfluorination of Sulfolane to Perfluoro Butane Sulfonyl Fluoride
- ❖ Electrochemical Preparation of Calcium Lactobionate and Calcium Gluconate
- ❖ Electrochemical Production of KIO<sub>3</sub>
- ❖ Degradable Amorphous Alloy Coatings by Sputtering for Bioimplants
- ❖ Multicoat Protective Schemes for Concrete Structures and Bridges
- ❖ Moisture Compatible Coating for Cooling Towers
- ❖ Temporary Protective Coating for Maraging Steel & 15CDV6
- ❖ Corrosion Resistant Thermal Coating for Hydroclaves
- ❖ Al-Zn-In Galvanic Alloy Anode for Cathodic Protection
- ❖ Formulation of Neutral Paint Removing Jelly
- ❖ Corrosion Resistant Inhibitive Admixtures for Portland Pozzolana Cement
- ❖ Inhibitor Admixture for Concrete
- ❖ Cost Effective Metallic Coatings to Rebars Embedded in Concrete Structures
- ❖ Redox Active Polymer Encapsulated Lamellar (REL) Compound based Anticorrosive Coating for Reinforcement Bars
- ❖ Extraction of Calcium, Magnesium by Molten Salt Electrolysis
- ❖ Extraction of Zinc oxide and Metallic Zinc from Galvanizer Ash
- ❖ Extraction of Rare Earths and Alloys by Molten Salt Electrolysis

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