

December 2023

CSI Communication

Monthly Newsletter of Catalysis Society of India

Circulated to all CSI Members

Important Announcement:

CSI newsletter shall be pleased to publish half a page write-up under the title, Centre of Excellence in Catalysis Research in India from any Indian Academics, Research laboratories or Industrial organizations. You may send your brief write-up on your research activities to us which will be published in coming issues of CSI.

You can also share your recent happy moments like publications, granted patents, technology commercialization, fellowship, awards, etc. to highlight in the CSI communication.

Commercial & Policies

■ **Reliance Industries Pioneers Chemical Recycling of Plastic Waste in India**

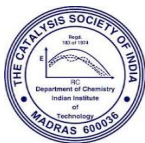
Reliance Industries Ltd (RIL) has pioneered a novel way to address persistent plastic waste issues by becoming the first Indian company to embrace chemical recycling. Leveraging its proprietary technology, the firm is converting all types of plastic waste especially those deemed non-recyclable into high-value materials for the creation of new plastics. The process involves transforming plastic waste into pyrolysis oil. This oil serves as a raw material for producing circular polymers, a significant step towards advocating for the circular economy in India. More impressively, these polymers are certified by the International Sustainability and Carbon Certification (ISCC) Plus, making them suitable for various applications, including food contact packaging.

Source: <https://bnnbreaking.com/world/india/reliance-industries-pioneers-chemical-recycling-of-plastic-waste-in-india/>

■ **Aether Industries, H.B. Fuller, and Saudi Aramco Technologies Company announce the first commercialization of the sustainable Converge® polyols technology**

Aether Industries Limited, one of India's leading specialty and fine chemical manufacturers has made a joint announcement with H.B. Fuller and Saudi Aramco Technologies Company for the first commercialization of the sustainable Converge® polyols technology. The manufacturing process was thoroughly validated at pre-commercial scale and was driven by sustainable and efficiency models. The Converge® platform represents a novel and cutting-edge technology for the manufacture of more sustainable polyols that could contain up to 40% of carbon dioxide by weight, thus reducing overall CO₂ emissions. These are a differentiated series of polyols with promising applications in the CASE (coatings, adhesives, sealants, elastomers) industry. The commercialization and revenue potential of these novel polyols is significant, with a targeted

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market of 850 KTA (850,000 MT per year) and a CAGR of 5%, out of the overall CASE industry polyol market size of more than 10,000 KTA.

Source: <https://www.equitybulls.com/category.php?id=341693>

▪ **GAIL, Trualt Bioenergy To Set Up 10 Compressed Biogas Plants**

GAIL, India and Trualt Bioenergy will set up 10 compressed biogas (CBG) plants with an investment of more than USD 72 million. The proposed plants under the joint venture are expected to process over 600 million kilogrammes of organic waste like agricultural residue, sugarcane press mud, and spent wash -- waste generated during ethanol production to produce over 33 million kg of CBG, nearly 20 million kg of solid fermented organic manure and over 30 million kg of liquid fermented organic manure per annum, the companies said. Each plant will have a capacity of 10,000 kg per day, resulting in a daily production of 100,000 kg of CBG.

Source: <https://business.outlookindia.com/news/gail-trualt-bioenergy-to-set-up-10-compressed-biogas-plants>

▪ **Hindalco to set up e-waste recycling plant at PIP, Dahej**

Aditya Birla Group company Hindalco Industries will be investing ₹ 2,000 crore in a copper and e-waste recycling facility, chairman Kumar Mangalam Birla said Tuesday. "The company is making an investment of Rs. 2,000 crore to establish the first-of-its-kind Copper and E-waste recycling facility in India," Birla said while speaking at the company's 64th annual general meeting.

Source: https://www.business-standard.com/companies/news/hindalco-to-invest-rs-2-000-crore-in-copper-e-waste-recycling-facility-123082200706_1.html

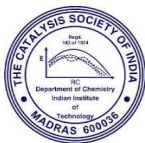
▪ **Neogen Ionics To Establish Battery Materials Facility In Gujarat**

Neogen Ionics Limited, a wholly owned subsidiary of Neogen Chemicals Limited, has completed the acquisition of approximately 65 acres of land in Pakhajan, Dahej PCPIR, Gujarat, as part of its forward-looking expansion strategy and in the pursuit of establishing a greenfield project. This dedicated site will serve as the foundation for a cutting-edge plant focused on battery materials and emerging business opportunities. In the initial phase of development, the plant will manufacture 30,000 metric tonnes of electrolytes and 4,000 metric tonnes of electrolyte salts and additives. The electrolyte plant will utilise Manufacturing Technology licensed from MUIS, a joint venture between Mitsubishi Chemical Corporation (MCC) and UBE Corporation, both integral parts of the Mitsubishi Chemical Group, a renowned Japanese conglomerate. Simultaneously, the electrolyte salts will be produced using Neogen's in-house technology, leveraging its 35 years of expertise in manufacturing lithium salts.

Source: <https://planet.outlookindia.com/news/neogen-ionics-to-establish-battery-materials-facility-in-gujarat-news-416631>

▪ **BTR New Material to Invest \$500 Million in Cutting-Edge Cathode Plant in Morocco**

Rabat - BTR New Material Group, a key player in the global electric vehicle battery components sector, announced this week a game-changing investment of \$500 million to establish an avant-garde cathode manufacturing plant in Morocco. This strategic venture, boasting an annual



production capacity of 50,000 tons of cathodes, signals a crucial leap forward in meeting the soaring global demand for lithium-ion batteries.

Source: <https://www.moroccoworldnews.com/2023/12/359851/btr-new-material-to-invest-500-million-in-cutting-edge-cathode-plant-in-morocco>

▪ **BPCL greenlights ₹5,044-crore polypropylene unit at Kochi refinery**

The decision, ratified during the board meeting on December 19, 2023, entails a gross project cost of ₹5,044 crore, marking a significant investment in expanding BPCL's production capabilities for setting up a Polypropylene (PP) Unit, for production of Polypropylene at Kochi Refinery. The proposed polypropylene unit is designed for a production capacity of 400 kilo-tonnes per annum (KTPA), with a targeted timeline of approximately 46 months from the date of investment approval.

Source: <https://www.cnbctv18.com/business/companies/bpcl-greenlights-rs-5044-crore-polypropylene-unit-at-kochi-refinery-18604761.htm>

▪ **MRPL firms up green aviation fuel plans**

Mangalore Refinery and Petrochemicals Ltd (MRPL) is gearing up to produce sustainable aviation fuel (SAF) in two years to support the government's one per cent blending target.

While Indian Oil Corporation (IOC) plans to start the country's first commercial-scale SAF plant at Panipat by 2026, MRPL is setting up 20-kilolitre-per-day plant to demonstrate indigenously-developed technology. The MRPL management is in the process of taking necessary board approvals for the construction of the SAF plant, said Sanjay Varma, who holds additional charge of managing director, MRPL. Subsequently, it will take about two-and-a-half years for setting up the plant at an estimated cost of around ₹450 crore, Varma added.

Source: <https://www.thehindubusinessline.com/companies/mrpl-firms-up-green-aviation-fuel-plans/article67654181.ece>

▪ **Hindalco to set up battery foil manufacturing facility in Odisha to tap EV-market**

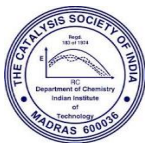
Hindalco Industries, the world's largest aluminum rolling and recycling company, plans to significantly expand its manufacturing capacity of fine quality aluminum foil that is used in rechargeable batteries to serve the rapidly growing market for electric vehicles (EVs) and energy storage systems. The company is investing Rs.800 crore to build a new plant near Sambalpur in Odisha that will initially produce 25,000 tonnes of the resilient product which forms the backbone of Lithium-ion and Sodium-ion cells. By 2030, demand for battery grade aluminium foil in India is expected to grow manifold to 40,000 tonnes, primarily driven by mushrooming growth in gigafactories for advanced cell manufacturing.

Source: <https://www.hindalco.com/media/press-releases/hindalco-set-up-battery-foil-manufacturing-facility-Odisha-tap-ev-market>

Scientific Updates

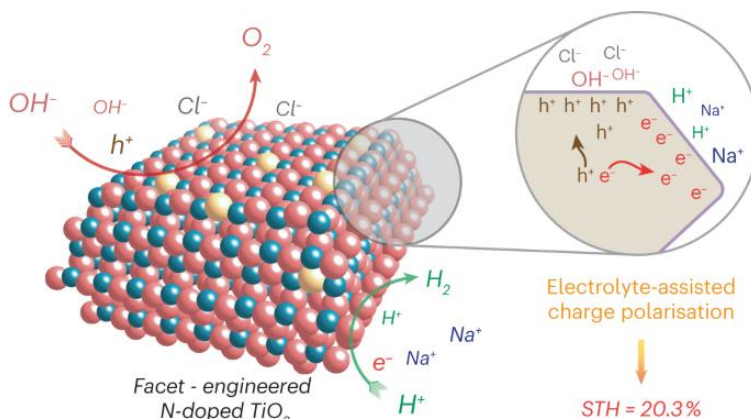
▪ **Electrolyte-assisted polarization leading to enhanced charge separation and solar-to-hydrogen conversion efficiency of seawater splitting**

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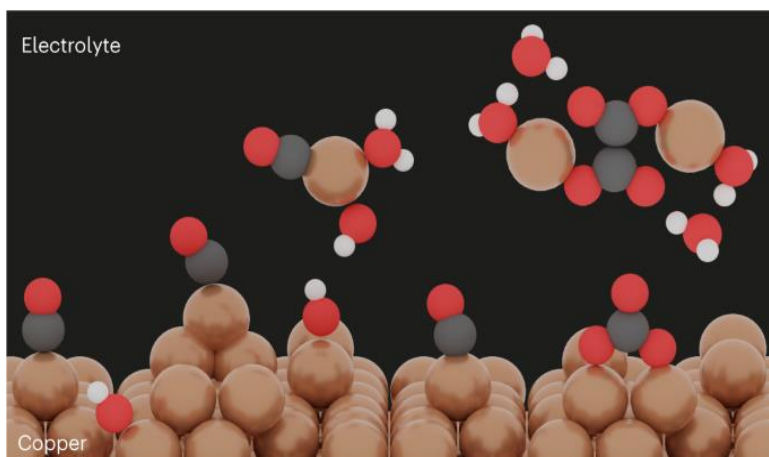
Photocatalytic splitting of seawater for hydrogen evolution has attracted a great deal of attention in recent years. However, the poor energy conversion efficiency and stability of photocatalysts in a salty environment have greatly hindered further applications of this technology. Moreover, the effects of electrolytes in seawater remain controversial. The present paper reports electrolyte-assisted charge polarization over an N-doped TiO_2 photocatalyst, which demonstrates the stoichiometric evolution of H_2 and O_2 from the thermo-assisted photocatalytic splitting of seawater. Extensive characterizations and computational studies show that ionic species in seawater can selectively adsorb on photo-polarized facets of the opposite charge, which can prolong the charge-carrier lifetime by a factor of five, leading to an overall energy conversion efficiency of $15.9 \pm 0.4\%$ at 270°C . Using a light-concentrated furnace, a steady hydrogen evolution rate of $40 \text{ mmol g}^{-1} \text{ h}^{-1}$ is demonstrated, which is of the same order of magnitude as laboratory-scale electrolyzers.

Source: <https://www.nature.com/articles/s41929-023-01053-9>; doi:10.26599/CF.2023.9200003 [https](https://www.nature.com/articles/s41929-023-01053-9)

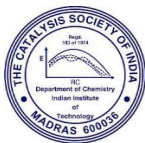


▪ Solution-based Cu^+ transient species mediate the reconstruction of copper electrocatalysts for CO_2 reduction

This paper reports on the intermediates that drive the rearrangement of copper catalysts for the electrochemical CO_2 reduction reaction (CO_2RR). Online MS and UV-vis absorption spectroscopy data are consistent with a dissolution-redeposition process, as previously demonstrated by in situ electron microscopy. The data indicate that the soluble transient species contain copper in the +1 oxidation state. Density functional theory identifies copper-adsorbate complexes that can exist in solution under operating conditions. Copper carbonyls and oxalates are suggested as the major reaction-specific species driving copper reconstruction during CO_2RR . This work motivates future methodological studies to enable the direct detection of these compounds and strategies that specifically target them to improve the catalyst operational stability.



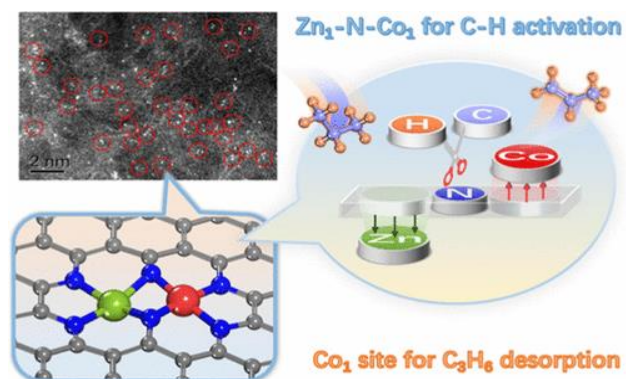
Source: <https://www.nature.com/articles/s41929-023-01070-8>



▪ Dual-Atom Catalyst with N-Colligated Zn₁Co₁ Species as Dominant Active Sites for Propane Dehydrogenation

Dual-atom catalysts (DACs) with paired active sites can provide unique intrinsic properties for heterogeneous catalysis, but the synergy of the active centers remains to be elucidated. Here, we develop a high-performance DAC with Zn₁Co₁ species anchored on nitrogen-doped carbon (Zn₁Co₁/NC) as the dominant active site for the propane dehydrogenation (PDH) reaction. Various experimental and theoretical studies suggest that the enhanced PDH performance stems from the promoted activation of the C–H bond of C₃H₈ triggered by the electronic interaction between Zn₁ and Co₁ colligated by N species. This work provides a promising strategy for designing robust hetero DACs to simultaneously increase activity and selectivity in the PDH reaction.

Source: *J. Am. Chem. Soc.* 2023, <https://pubs.acs.org/doi/10.1021/jacs.3c08616>

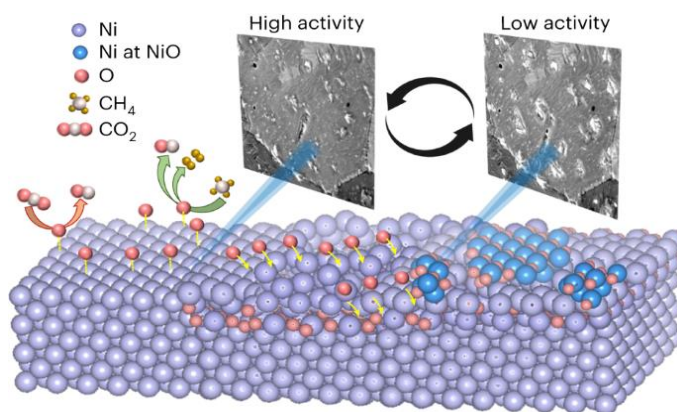


▪ Metastable nickel–oxygen species modulate rate oscillations during dry reforming of methane

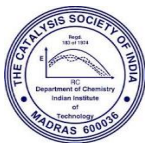
The role of different metastable oxygen species on a Ni catalyst during dry reforming of methane by combining environmental scanning electron microscopy, near ambient pressure X-ray photoelectron spectroscopy, on-line product detection and computer vision is reported. The critical role of dissociative CO₂ adsorption in regulating the oxygen content of the catalyst and in CH₄ activation is highlighted. Authors discover rate oscillations during dry reforming of methane resulting from the sequential transformation of metastable oxygen species that exhibit different catalytic properties: atomic surface oxygen, subsurface oxygen and bulk NiO_x.

The imaging approach allowed the localization of fluctuating surface regions that correlated directly with catalytic activity. The study highlights the importance of metastability and operando analytics in catalysis science and provides impetus towards the design of catalytic systems.

Source: <https://www.nature.com/articles/s41929-023-01090-4>



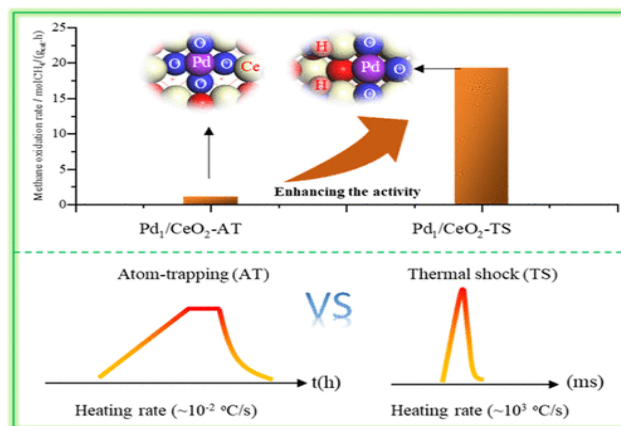
▪ Enhancing Methane Combustion Activity by Modulating the Local Environment of Pd Single Atoms in Pd₁/CeO₂ Catalysts



In this study, a method for creating a highly active and thermally stable Pd₁/CeO₂ catalyst by using thermal-shock synthesis (Pd₁/CeO₂-TS) is presented. By subjecting isolated Pd²⁺ ions to ultrafast shockwaves, we control their local environment, resulting in unique electronic structures and the geometry of the Pd single atoms. Compared with the single-atom Pd₁/CeO₂ catalyst formed through atom trapping (Pd₁/CeO₂-AT), Pd₁/CeO₂-TS showed improved activity for methane combustion with a nearly 20-fold increase in turnover frequency and reversible stability against water.

This increase in activity is attributed to the presence of coordination-unsaturated Pd–O species and surface hydroxyls on ceria. These factors enhance the oxygen activity and reduce the barrier for C–H bond activation, resulting in increased catalytic performance.

Source: ACS Catalysis, Jan 2023, <https://pubs.acs.org/doi/10.1021/acscatal.3c02167>

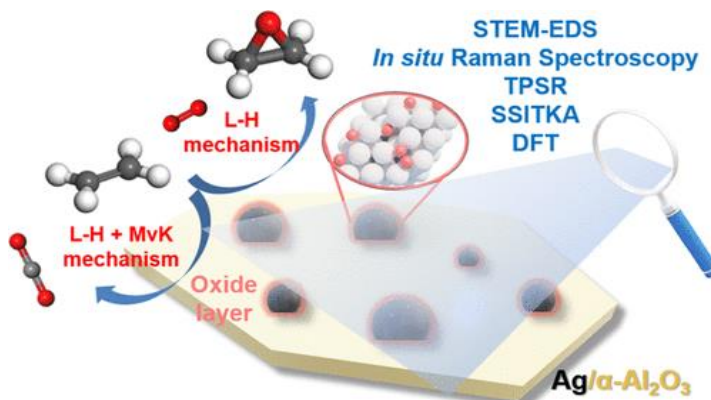


Revealing the Nature of Active Oxygen Species and Reaction Mechanism of Ethylene Epoxidation by Supported Ag/ α -Al₂O₃ Catalysts

The oxygen species on Ag catalysts and reaction mechanisms for ethylene epoxidation and ethylene combustion continue to be debated in the literature despite decades of investigation. Fundamental details of ethylene oxidation by supported Ag/ α -Al₂O₃ catalysts were revealed with the application of high-angle annular dark-field-scanning transmission electron microscopy-

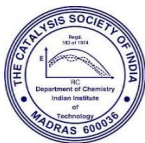
energy-dispersive X-ray spectroscopy (HAADF-STEM-EDS), *in situ* techniques (Raman, UV-vis, X-ray diffraction (XRD), HS-LEIS), chemical probes (C₂H₄-TPSR and C₂H₄ + O₂-TPSR), and steady-state ethylene oxidation and SSITKA (¹⁶O₂ → ¹⁸O₂ switch) studies. The Ag nanoparticles are found to carry a considerable amount of oxygen after the reaction. Ethylene epoxidation proceeds via a Langmuir–Hinshelwood mechanism, and ethylene combustion proceeds via combined Langmuir–Hinshelwood (predominant) and Mars–van Krevelen (minor) mechanisms.

Source: ACS Catal. 2024 <https://pubs.acs.org/doi/10.1021/acscatal.3c04361>



Catalysis Research out of India

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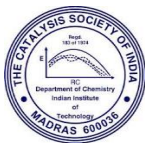


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Upcoming Symposium/Conferences/Seminars/Workshop

1. January 31-February 01, 2024-Future of Chemical Recycling 2024, Rotterdam, Netherlands
2. 18th International Congress on Catalysis from July 14-19, 2024, LYON, France.
3. 10th UK CATALYSIS Conference from 3rd-5th January, 2024 at HOLYWELL PARK, LOUGHBOROUGH, UK
4. XXIII International Symposium on Homogeneous Catalysis at Trieste, July 21-26, 2024
5. February 01-03, 2024-CGEC2024- The 1st International Congress on Green Environmental Catalysis, Osaka, Japan
6. March 06-08, 2024-EHEC 2024 -European Hydrogen Energy Conference, Bilbao, Spain
7. March 12-13, 2024-Chemical Recycling North America, Houston, TX, United States

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- International Conference on 'Emerging Trends in Catalysis & Synthesis 2024' from 07th to 09th March, 2024 at IIT, Kharagpur
- "19th Edition of Global Conference on Catalysis, Chemical Engineering & Technology" at Rome, Italy, from September 19-21, 2024

Announcements

- CSI Congratulates the following CSI members on the recognition they received recently.

Name	Achievements
Prof. Vivek Polshettiwar Professor at Tata Institute of Fundamental Research (TIFR) Mumbai	Elected as Fellow of Indian Academy of Sciences, Bangalore 2024



Quote of the Month

"Talent wins games, but teamwork and intelligence win championships."

—Michael Jordan

Editorial Team

Dr. Sharad Lande

Dr. Raksh Vir Jasra

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