March 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

- **India needs INR 33,750 Cr of Investment to Achieve Domestic Lithium-Ion Battery Manufacturing Target: CEEW**

India needs investments worth up to INR 33,750 crore (USD 4.5 billion*) to achieve the government PLI target of setting up 50 GWh of lithium-ion cell and battery manufacturing plants, according to a study released by the Council on Energy, Environment and Water (CEEW). The country requires up to 903 GWh of energy storage to decarbonize its mobility and power sectors by 2030, and lithium-ion batteries will meet the majority of this demand. Recently, 5.9 million tons of lithium is inferred in the Reasi district of Jammu and Kashmir. The CEEW study recommends focusing on the strategic sourcing of critical minerals and pushing for research, development, and demonstration in all technologies to retain competitiveness. At the same time, reducing the cost of manufacturing batteries by innovating and updating manufacturing processes, and making policy changes to lower the cost of cell components are important.
Source: https://www.ceew.in/press-releases/india-will-need-inr-33750-crore-investment-to-achieve-domestic-lithium-ion-battery-manufacturing-targe

- **Indian Oil Board Approves Setting up Paradip Petrochemical Complex**

The Indian Oil Board has accorded 'Stage-I' approval for setting up Paradip Petrochemical Complex at Paradip, Odisha at an estimated cost of Rs 61,077 crore (about $8 billion USD). This mega project will be largest-ever investment of Indian Oil at a single location. The petrochemical complex shall include a world-scale cracker along with downstream process units for producing several petrochemical products including polypropylene (PP), high density polyethylene (HDPE), linear low-density polyethylene (LLDPE), polyvinyl chloride (PVC), etc. It shall also facilitate production of niche chemicals and petrochemicals like phenol and isopropyl alcohol.
Source: https://iocl.com/NewsDetails/5935

- **Chevron Lummus Global licenses its Hydro finishing technology to the Mumbai Refinery**

Chevron Lummus Global LLC (CLG) announced that Bharat Petroleum Corp. Ltd. (BPCL) has selected its ISOFINISHING technology for a catalytic processing unit at the Mumbai Refinery in Mumbai, India. Once complete, the unit will have a capacity of 200,000 metric tons per year (m.t./yr) and will be the first catalytic process unit to manufacture de-aromatized solvents and white oil in India. These specialty products will meet India's domestic standards and international standards, and will serve as a substitute for these types of products that are currently being imported into India. CLG's project scope includes the technology license, engineering services, proprietary equipment, and catalyst supply. ISOFINISHING is CLG's proprietary hydro finishing technology. CLG's noble-metal catalysts provide higher activity at lower temperatures than base-metal catalysts to produce highest quality de-aromatized solvents and white oils that have most stringent aromatic and color specifications.

Source:https://www.chemengonline.com/chevron-lummus-global-licenses-process-technology-to-the-mumbai-refinery/

- **GAIL signs MoU with Shell to explore ethane import**

GAIL (India) Limited has signed a Memorandum of Understanding (MoU) with Shell Energy India Private Limited to explore opportunities in different facets of energy value chain. For GAIL, this is a step towards achieving improved sustenance in Business operations. In a bid towards diversification of the feedstock for its petrochemical plant, GAIL is looking to import ethane from ethane-surplus countries with matured export terminal infrastructure through water borne transportation to India and transport it further through GAIL's pipeline systems to demand centres. The MoU envisages to explore prospects in import and handling of different hydrocarbons which are important chemical and petrochemical precursors, LNG for road transport, regasification of imported LNG, renewables, etc.

Source:https://www.indianchemicalnews.com/petro-chemical/gail-signs-mou-with-shell-to-explore-ethane-import-16

- **Aramco and Linde Engineering to develop ammonia cracking technology**

A potential differentiator of this new technology is the ammonia cracking catalyst, jointly developed by Aramco and the King Abdullah University of Science and Technology (KAUST), which will be evaluated against other catalysts.

Through this agreement, Aramco, and Linde Engineering plan to build a demonstration plant in northern Germany to showcase this new ammonia cracking technology. Linde Engineering intends to offer this ammonia cracking technology to current and new customers, creating new commercial opportunities within the global lower-carbon energy supply chain. The emerging lower-carbon ammonia business may prove to be key in bridging the gap between a country's domestic renewable energy production capacity and total energy demand.

Source: https://www.aramco.com/en/news-media/news/2023/aramco-and-linde-engineering-to-develop-ammonia-cracking-technology

- **ExxonMobil Begins Operations at Mega Advanced Plastic Recycling Facility in USA**

ExxonMobil recently announced the successful startup of one of the largest advanced recycling facilities in at the company's integrated manufacturing complex in Baytown, Texas. It uses proprietary technology to break down hard to recycle plastics and transform them into raw materials for new products. It is capable of processing more than 80 million pounds of plastic waste per year, supporting a circular economy for post use plastics and helping divert plastic waste currently sent to landfills.
Source:https://www.process-worldwide.com/exxonmobil-begins-operations-at-mega-advanced-recycling-facility-in-usa-a-bccf31e4684674dc062ea838773e5115/?cmp=nl-206&uuid=980cb2250b5726386eb679fdb5e5a4b6e

- **Johnson Matthey and BP to license Fischer-Tropsch (FT) CANS™ technology for renewable diesel fuel plant to Strategic Biofuels**

Johnson Matthey (JM) and BP announced that their co-developed, award-winning Fischer-Tropsch (FT) CANS™ technology has been selected by Strategic Biofuels for their project which aims to produce the world's lowest carbon footprint liquid fuel. The technology has been licenced to Strategic Biofuels, a leader in developing negative carbon footprint biofuels plants, for the company's Louisiana Green Fuels project (LGF) in Caldwell Parish, Louisiana. LGF plant plans to convert 1 million tons of forestry waste feedstock into cleaner-burning renewable diesel and is projected to produce 31.8 million gallons of biofuels per year once in operation. The aim is to increase production to over 165 million gallons per year of renewable diesel and sustainable aviation fuels over 10 to 12 years.
Source: https://matthey.com/jm-and-bp-strategic-biofuels-project

- **Evonik invests into fumed aluminium oxide plant expansion for battery applications**

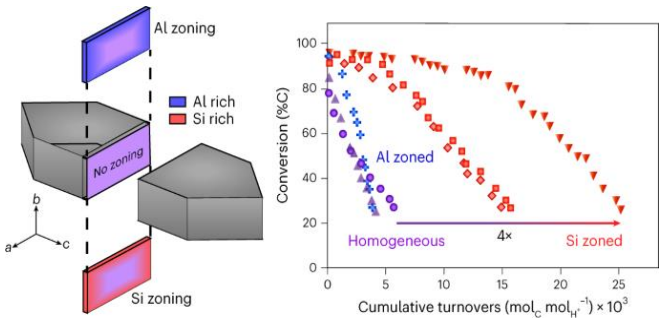
Evonik invests in a production plant expansion for fumed aluminium oxide at its site in Yokkaichi, Japan. The facility will be the company's first alumina plant in Asia, focusing on the production of specialty solutions for lithium-ion battery technologies, used for electric vehicles. The fumed aluminium oxide production expansion is part of a network of eight fumed oxide production sites globally and a key milestone of the strategic growth plan on specialty applications.
Source: https://www.silica-specialist.com/en/service-center/press-releases/evonik-invests-into-fumed-aluminum-oxide-production-plant-expansion-for-battery-applications-in-yokk-192580.html

Scientific Updates

- **Elemental zoning enhances mass transport in zeolite catalysts for Methanol to Hydrocarbons**

Mass transport limitations in zeolite catalysts pose major hurdles for their optimal performance in diverse chemical reactions. Most approaches to reduce these restrictions focus on the synthesis of either hierarchical or nanosized zeolites. Here we demonstrate that the existence of a siliceous, catalytically inactive exterior rim on ZSM-5 particles dramatically reduces the diffusion limitations, which leads to an enhanced catalyst lifetime for the methanol-to hydrocarbon reaction. Authors reveal that binary inorganic and organic structure directing agents enable a

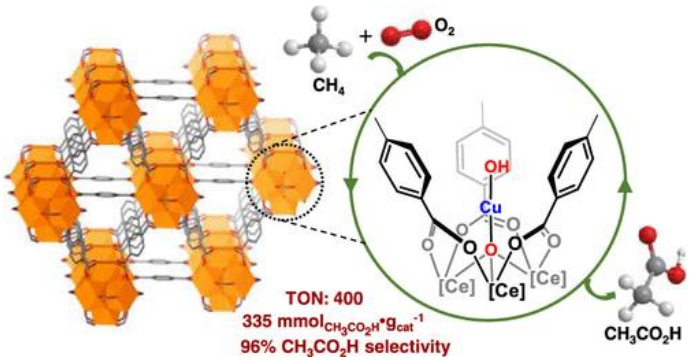
one-pot synthesis of Si-zoned ZSM-5 catalysts with diffusion properties that are characteristic of particles with a much smaller size. Molecular dynamics simulations to assess the diffusion of methanol and benzene in siliceous pores and in those with Brønsted acids reveal substantially reduced transport limitations in zoned regions, consistent with the improved catalyst activity of Si-zoned zeolites relative to that of ZSM-5 with a homogeneous acid-site distribution.



Source: Nature Catalysis, 2023, 6, 254–26

- **Selective Methane Oxidation to Acetic Acid Using Molecular Oxygen over a Mono-Copper Hydroxyl Catalyst**

Acetic acid is an industrially important chemical, produced mainly via carbonylation of methanol using precious metal-based homogeneous catalysts. As a low-cost feedstock, methane is commercially transformed to acetic acid via a multistep process involving energy intensive methane steam reforming, methanol synthesis, and, subsequently, methanol carbonylation.



Direct single-step conversion of methane to acetic acid using molecular oxygen (O_2) as the oxidant under mild conditions over a mono copper hydroxyl site confined in a porous cerium metal–organic framework (MOF), Ce-UiO-Cu(OH) is reported. The Ce-UiO MOF-supported single-site copper hydroxyl catalyst gave exceptionally high acetic acid productivity of 335 mmolgcat^{-1} in 96% selectivity with a Cu TON up to 400 at 115 °C in water. Spectroscopic and theoretical studies and controlled experiments reveal that the conversion of methane to acetic acid occurs via oxidative carbonylation, where methane is first activated at the copper hydroxyl site via σ-bond metathesis to afford Cu-methyl species, followed by carbonylation with in situ-generated carbon monoxide and subsequent hydrolysis by water. This work may guide the rational design of heterogeneous abundant metal catalysts for the activation and conversion of methane to acetic acid and other valuable chemicals under mild and environmentally friendly reaction conditions.

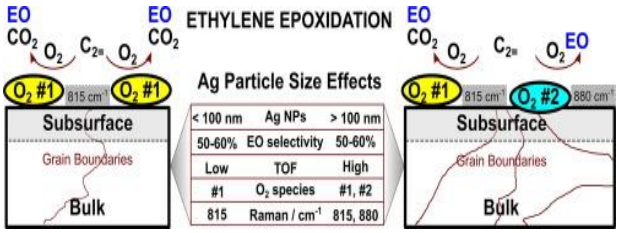
Source: Journal of the American Chemical Society, 2023, 145, 11, 6156-616

- **Continuous flow electrosynthesis of ammonia by nitrogen reduction and hydrogen oxidation**

Ammonia is a critical component in fertilizers, pharmaceuticals, and fine chemicals and is an ideal, carbon-free fuel. Recently, lithium-mediated nitrogen reduction has proven to be a promising

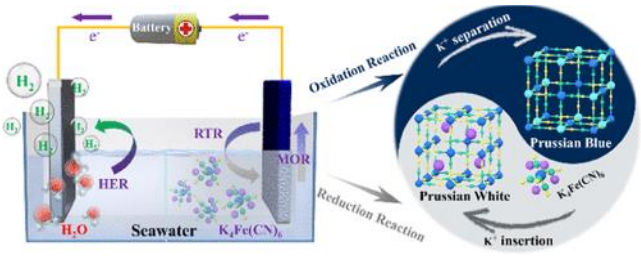
route for electrochemical ammonia synthesis at ambient conditions. In this work, author report a continuous-flow electrolyzer equipped with 25–square centimeter–effective area gas diffusion electrodes wherein nitrogen reduction is coupled with hydrogen oxidation. The classical catalyst platinum is not stable for hydrogen oxidation in the organic electrolyte, but a platinum-gold alloy lowers the anode potential and avoids the decremental decomposition of the organic electrolyte. At optimal operating conditions, at 1 bar, a Faradaic efficiency for ammonia production of up to 61 ± 1% and an energy efficiency of 13 ± 1% at a current density of 6 milliamperes per square centimeter is achieved.
Source: https://www.science.org/doi/10.1126/science.adf4403

- **In situ Raman spectroscopy study of silver particle size effects on unpromoted Ag/α-Al_2O_3 during ethylene epoxidation with molecular oxygen**



In situ Raman spectroscopy and parallel fixed bed reactor studies were conducted under ethylene epoxidation conditions with O_2 at 1 atm and 200 °C on unpromoted Ag/α-Al_2O_3 catalysts with different Ag particle sizes. It was found that for Ag particles of 20–50 nm, the weight normalized conversion rate decreased rapidly with increasing Ag particle size but remained almost constant above 50 nm. On the other hand, the apparent TOF increased with increasing Ag particle sizes in the 20–170 nm studied range, while ethylene oxide selectivity at zero residence time was nearly constant (55 ± 4%). Raman bands at 815 (all Ag sizes) and 880 (Ag sizes > 100 nm) cm^{-1} were identified and assigned to active molecular oxygen species. The 880 cm^{-1} species was assigned to a molecular oxygen complex structure stabilized by subsurface oxygen. The presence of the 880 cm^{-1} oxygen species likely explains the higher apparent TOF in larger Ag particles (>100 nm).
Source: Journal of Catalysis, 2023, 418, 225; https://doi.org/10.1016/j.jcat.2023.01.016

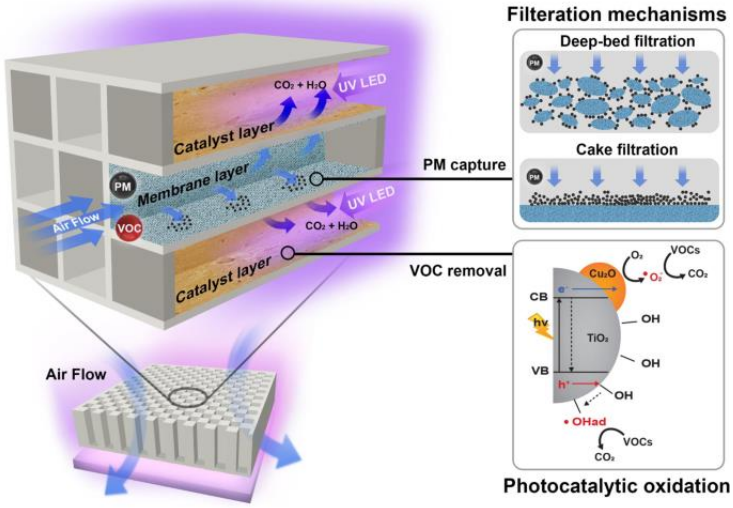
- **Coupling Ferrocyanide Assisted PW/PB Redox with Efficient Direct Seawater Electrolysis for Hydrogen Production**



Direct seawater electrolysis is a promising approach for grid-scale hydrogen mass production. However, the low energy efficiency and detrimental anodic chlorine electrochemistry unlock its practical potential. Here, we present an efficient chlorine-free hydrogen production by coupling the rapid electrode reaction of ferrocyanide assisted Prussian white (PW)/Prussian blue (PB) redox with an onset potential of 0.87 VRHE. The chloride oxidation in our cells is avoided by low cell voltages, enabling high-purity hydrogen production. Operando spectroscopic analysis coupled with theoretical calculations validates that the addition of the $[Fe(CN)6]^{3-}/4^{-}$ redox mediator in the electrolyte can reduce the PB to PW instantaneously, thus completing the cycle of PW/PB redox and making the system recyclable. The assembled electrolyser exhibited

unprecedented performance for direct seawater electrolysis (pH = 8.5), achieving a current density of 320 mA cm^{-2} at 1.7 V. Therefore, the electricity consumed per cubic meter of H_2 produced in the electrolyzer is 3.8 kWh at 200 mA cm^{-2}, and 42% lower energy equivalent input relative to commercial redox-free seawater electrolysis. This work offers a cost-competitive and energy-saving strategy for producing high-purity H_2 directly from unlimited seawater.
Source: ACS Catalysis, 2023, 13, 6, 3692-3701

- **Long-lifetime Water-washable Ceramic Catalyst Filter for Air Purification.**



Particulate matter (PM) and volatile organic compounds (VOCs) are recognized as hazardous air pollutants threatening human health. Disposable filters are generally used for air purification despite frequent replacement and waste generation problems. However, the development of a novel regenerable and robust filter for long term use is a huge challenge. Here, author report on a new class of facile water washing regenerable ceramic catalyst filters (CCFs), developed to simultaneously remove PM (>95%) and VOCs (>82%) in single-pass and maximized space efficiency by coating the inner and outer filter channels with an inorganic membrane and a Cu_2O/TiO_2 photocatalyst, respectively. The CCFs reveal four-fold increase in the maximum dust loading capacity (approximately 20 g/L) in relation to conventional filters (5 g/L) and can be reused after ten regeneration capability with simple water washing retaining initial PM and VOC removal performances. Thus, the CCFs can be well-suited for indoor and outdoor air purification for 20 years, which shows a huge increase in lifetime compared to the 6-month lifespan of conventional filters. Finally, the development and implementation of CCFs for air purification can open new avenues for sustainable technology through renewability and zero-waste generation.
Source: Nature Communication, 2023, 14, 520 https://doi.org/10.1038/s41467-023-36050-w

Catalysis Research out of India

1. Ashish K. Kar, Ranjini Sarkar, A. K. Manal, Ravi Kumar, Sudip Chakraborty, Rajeev Ahuja, Rajendra Srivastava, "Unveiling and understanding the remarkable enhancement in the catalytic activity by the defect creation in UIO-66 during the catalytic transfer hydrodeoxygenation of vanillin with isopropanol", **Applied Catalysis B: Environmental, 2023, 325, 122385**

2. Sharda E Kondawar, Gaytri B Kasar, Angshuman S Khatua, Chandrashekhar V Rode, "Activity performance and kinetics for glycerol carbonylation with urea over Zn-Co mixed metal oxide catalyst", **The Canadian Journal of Chemical Engineering, 2023, 101 (4) 2075-2093**
3. Akshata Vijay Ramteke, Divesh Bhatia, KK Pant, "Conversion of light cycle oil to benzene and alkylated monoaromatics over monometallic and bimetallic CoMo catalysts in the presence of hydrogen donor", **Fuel, 2023, 342,127737,**
4. Farah Naaz, Saurabh Samuchiwal, Vivek Dalvi, Arghya Bhattacharya, Kamal Kishore Pant, Anushree Malik, "Hydrothermal liquefaction could be a sustainable approach for valorization of wastewater grown algal biomass into cleaner fuel", **Energy Conversion and Management, 2023, 283,116887,**
5. Carlos Alberto Huerta-Aguilar, Rajendra Srivastava, Jesús A Arenas-Alatorre, Pandiyan Thangarasu, "Reductive Oligomerization of Nitroaniline Catalyzed by Fe3O4 Spheres Decorated with Group 11 Metal Nanoparticles" **ACS Omega, 2023, 8, 7459–7469**
6. Ganesh Sunil More, Dipika Rajendra Kanchan, Arghya Banerjee, Rajendra Srivastava, "Selective Catalytic Hydrodeoxygenation of Vanillin to 2-Methoxy-4-methyl phenol and 4-Methyl cyclohexanol over Pd/CuFe2O4 and PdNi/CuFe2O4 Catalysts", **Chemical Engineering Journal, 2023, 462, 142110**
7. Sphurti P Kulkarni, Sunil S Joshi, Amol A Kulkarni, "Reaction pathways and kinetics of N-acetyl-d-glucosamine hydrolysis in sub-and supercritical water", **React. Chem. Eng., 2023** https://doi.org/10.1039/D3RE00046J
8. Priyanka V Jawale, Bhalchandra M Bhanage, Synthesis of decanoate compounds in deep eutectic solvent using lipase: Optimization using response surface methodology, kinetic and docking study, **Journal of the Indian Chemical Society, 2023, 100950**
9. Rochak Mittal, Vivek V Ranade, "Intensifying Extraction of Biomolecules from Macroalgae using Vortex based Hydrodynamic Cavitation Devices" **Ultrasonics Sonochemistry, 2023, 94, 106347**
10. Nanda V Ranade, Vivek V Ranade, "ANN based surrogate model for key Physico-chemical effects of cavitation" **Ultrasonics Sonochemistry, 2023, 94, 106327**

Announcements

- **Upcoming Symposium/Conferences/Seminars**

1. 6th International Oil & Gas Chemistry, Chemicals & Additives Conference (IOGCA 2023) from 12-13th September 2023 at Ahmedabad http://oilfieldchemical.org/
2. Catalysis Engineering & Technology (CET) meeting will be held from June-14-16, 2023 in Dubai, UAE along with The Catalysis Society of India (CSI) as Scientific Collaborator. **50% waive off on registration fee to CSI life members.**
3. ENSURE-2023 - International Conference on Environmental Sustainability through Waste and Recycling San Francisco, CA. April 10-12, 2023, https://wasteandrecycling.org/
4. April 13-14, 2023-Chemical Catalyst 2023- 4th Global Summit on Catalysis and Chemical Engineering, Rome, Italy

5. April 17-19, 2023-ISSC-24 - Interdisciplinary Surface Science Conference, Manchester, United Kingdom

- **Achievements/Recognitions**

CSI congratulates the following CSI members on the recognition they have received recently.

Name	Achievement
Dr. Vivek K Srivastava Assistant Vice-President (R&D), Reliance Industires Ltd. Mumbai 	Elected as Fellow of Indian Chemical Society (ICS) March 2023
Dr. Sumeet Sharma General Manager (R&D), Reliance Industires Ltd. Vadodara 	Elected as Fellow of Indian Chemical Society (ICS) March 2023

Quote of the Month

"All you need is the plan, the road map, and the courage to press on to your destination." **— Earl Nightingale**

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Editorial Team

Dr. Sharad Lande

Dr. Raksh Vir Jasra