August 2022

CSI Communication

Monthly Newsletter of Catalysis Society of India

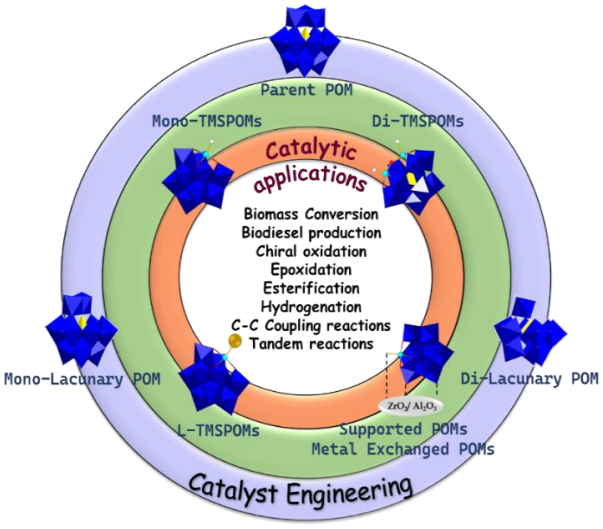
Circulated to all CSI Members

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.

Prof. Dr. Anjali Patel's Research Group Activities @ The Maharaja Sayajirao University of Baroda

Prof. Dr. Anjali Patel is presently working as a full professor (Inorganic Chemistry) at Chemistry department, The Maharaja Sayajirao University of Baroda. Her group is involved in the development of heterogeneous catalyst based on Polyoxometalates and porous materials. Especially, designing of third generation catalytic materials based on supported parent as well as mono/di lacunary POMs, especially Phosphotungstates, Phosphomolybdates and Silicotungstates, transition metal substituted POMs (TMSPOMs), Supported TMSPOMs and Inorganic-organic hybrid POMs. Team has introduced simple and rational procedure for improved targeted synthesis of LPOMs and TMSPOM based catalysts, which play a major role to obtain high selectivity towards desired products. All tailored catalysts have been successfully explored for biodiesel production, potential transformations of a byproduct of biodiesel, biomass conversion, and several other organic transformations, such as C-C coupling, hydrogenation, oxidation, esterification, transesterification, chiral oxidation etc. The research work has been published in the reputed international journals.



Publications, & Patents

Published papers in international journals (134), reviews (5) with highest impact factor, Progress in Material Science IF= 48.165; books (2) and book chapters (7). 1 US & 2 Indian Patents.

Research Accomplishments

- Development of third generation heterogeneous catalysts based on POMs, TMSPOMs, and porous supports.
- Numerous heterogeneous catalysts based on POMs) as well as transition metal (i.e., Fe, Co, Mn, Ni, Cu, Ru) substituted POMs, supported on various support (ZrO_2, Al_2O_3, SiO_2, MCMs, SBA-15 and Zeolite Hβ).
- Successfully utilized as eco-friendly catalysts for carrying out number of organic transformations such as oxidation of alkenes and alcohols, epoxidation of alkenes, esterification, tandem reactions, and hydrogenation reactions.
- First time our group has developed sustainable heterogeneous catalyst based on LPOMs and porous supports for the number of industrial important reaction, for example, oxidation of alcohols and alkene, Biodiesel production, Biginelli reaction. The obtained excellent results are published in international journals e.g., Journal of Cleaner Production, Catalysis Science and Technology, Dalton Transactions, etc.
- **Development of hybrid chiral catalytic materials**
  Inorganic-organic hybrid materials based on chiral ligand ((S)- 1-phenylethylamine and R-(-)-1-cyclohexylethylamine)/transition metal substituted POMs (Cu and Ru) were synthesized. The synthesized material shows superior catalytic activity towards asymmetric epoxidation of styrene.
- **Conversion of Bioplatform molecules to value added products**
  Supported POMs especially, phosphotungstates and silicotungstates were successfully utilized for the transformation of some important bioplatform molecules such as succinic acid, levulinic acid, etc., as well as valorization of glycerol via acetalization, esterification, oxidation, and carboxylation reactions. The obtained victory for this catalysis is reported in Renewable Energy, Biomass and Bioenergy, Fuel, Fuel Processing and Technology etc.
- **Development of nano catalysts based on transition metals especially Pd**
  From last past 6 years group is working in the field of Pd nanoclusters stabilized by POMs and the developed nano catalysts were found to be excellent for C-C coupling as well as hydrogenation of number of alkenes under mild conditions.

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Commercial & Policies

- **India's battery storage potential to be 600 GWh by 2030: Niti report**

India will have a battery storage potential of 600-gigawatt hour (GWh) by 2030, and demand for electric vehicles, stationary storage and consumer electronics will mainly drive adoption of battery storage, a Niti Aayog report said. The report further said a coherent regulatory framework incentivizing all stakeholders to participate in the recycling process will help in the development of a battery recycling ecosystem in the country. The report noted that the electrification of transportation and battery energy storage in electricity grids are expected to be the key drivers in the growth of battery demand.

Source: https://www.business-standard.com/article/pti-stories/india-s-battery-storage-potential-to-be-600-gwh-by-2030-niti-report-122072200618_1.html

- **Exide Energy Solutions to set up Li-ion battery cell manufacturing facility in Bengaluru**

Exide Industries has announced that the company will establish a lithium-ion battery cell manufacturing facility of gigawatt scale in Bengaluru, Karnataka. Exide is the largest lead-acid battery manufacturer in India and the revelations have been made in a regulatory filing by the company. Exide has joined hands in partnership with SVOLT Energy Technology Co Ltd (SVOLT) in the new scheme of things of lithium-ion manufacturing. SVOLT will give Exide the right and license to use, exploit and commercialize SVOLT-owned technology and know-how for lithium-ion cell manufacturing in India.

Source: https://www.saurenergy.com/ev-storage/exide-energy-to-set-up-li-ion-battery-manufacturing-in-bengaluru

- **Godi India to bring out first domestic made lithium-ion cell by August**

Hyderabad-based Godi India is set to become the first Indian company to manufacture lithium-ion cells, by this August. The company has signed a public private partnership deal with CSIR-CECRI (Central Electrochemical Research Institute) to operate and maintain an advanced Lithium-ion cell manufacturing unit in Taramani, Chennai. It is planning to invest about $3 billion over the next five years. “Godi India is the first Indian company to manufacture Made-in-India and Made-for-India Lithium-ion cells, which is certified by BIS (Bureau of Indian Standards).

Source: https://www.business-standard.com/article/companies/godi-india-to-bring-out-first-domestic-made-lithium-ion-cell-by-august-

- **Hindalco, Indian Oil and Israel’s Phinergy join hands to make aluminum air batteries**

Aditya Birla Group’s metals flagship Hindalco Industries signed an agreement with Israel-based Phinergy and IOC Phinergy Private (IOP). The companies will work exclusively with Hindalco in India, on R&D and pilot production of aluminium plates for Aluminum Air batteries. The trio will also investigate recycling of aluminum after usage in these batteries. “India has an abundance of aluminum resources, and this technology can help enhance the nation’s energy and resource

security,". Aluminum-Air technology enables energy generation by combining oxygen from ambient air with metals, specifically aluminum and zinc. Aluminum-Air batteries offer a viable alternative to other battery chemistries and will boost the domestic manufacturing of batteries to meet India's growing demand for energy storage.
Source: https://www.businessinsider.in/business/corporates/news/hindalco-indian-oil-and-israels-phinergy-join-hands-to-make-aluminum-air-batteries/articleshow/92948131.cms

- **Manali Petrochemicals signs commercial deal with UK's Econic Technologies to manufacture eco-friendly polyols**

Manali Petrochemicals Limited (MPL), India's only integrated manufacturer of polyols and a part of the AM International group, has announced the execution of the long form agreement with UK based Econic Technologies. Last year, the companies entered a Memorandum of Understanding (MoU) to introduce more environment-friendly, CO_2 containing polyols into the global $28 billion global polyols market. It will comprise a two-year demo scale-up at the 1,300 litres reactor at the MPL plant one. The following three years will be spent on industrial scale-up of the technology of MPL's 12,000 plus reactors and commercialisation of CO_2 containing polyols by the company.
Source: https://chemindigest.com/manali-petrochemicals-collaborates-with-uk-based-econic-technologies-to-manufacture-polyols/

- **Meghmani Finechem commissions CPVC resin plant in Dahej**

Meghmani Finechem Ltd (MFL) on Monday announced the commissioning of its chlorinated polyvinyl chloride resin (CPVC resin) manufacturing plant at Dahej. The facility with a production capacity of 30,000 tonne per annum is the largest in India. In India, CPVC resin demand is around 1,40,000 tonne per annum, and it is expected to grow by around 13% CAGR over the next five years. The new CPVC manufacturing unit developed at an estimated cost of Rs 190 crore will have 30,000 tonnes per annum (TPA), the only second of its kind plant in India. The first plant of 10,000 TPA was set up by DCW Limited in Tamil Nadu. The commissioning of MFL plant, India's dependence on import of CPVC would reduce by almost 20 to 22%. Currently 95 % of CPVC Resin requirement is met through import only.
Source: https://timesofindia.indiatimes.com/city/ahmedabad/meghmani-finechem-commissions-cpvc-resin-plant-at-dahej/articleshow/92968497.cms

- **GACL and NTPC Renewable Energy Ltd. (NTPC-REL) signed MoU to to collaborate in the field of renewable energy and green chemicals**

Gujarat Alkalies and Chemicals Limited (GACL) and NTPC Renewable Energy Limited (NTPC-REL), a wholly owned subsidiary of NTPC Limited have signed a Memorandum of Understanding (MoU) on 6th July 2022 at New Delhi to explore the business opportunities of mutual interest in the areas of sourcing of renewable power having optimum mix of solar, wind and other clean energy including energy storage solutions to the extent of about 100 MW, as required for the operations and manufacturing of GACL at Vadodara Complex and/or Dahej Complex or any of its other

Complexes and to jointly work on synthesizing Green Chemicals such as Methanol and Ammonia for captive use by GACL using Hydrogen and CO_2 available at GACL.
Source: https://timesofindia.indiatimes.com/gacl-and-ntpc-renewable-energy-ltd-ntpc-rel-signed-mou-to-collaborate-in-the-field-of-renewable-energy-and-green chemicals/articleshow/92719871.cms

- **NRL Selects Lummus' Novolen Technology**

Lummus Technology announced a recent contract award from Numaligarh Refinery Ltd. (NRL). The award is for a new 360 KTA polypropylene (PP) unit using Novolen® technology at NRL's refinery in Golaghat, Assam, India. Lummus' scope includes the technology license, basic design engineering, training, technical services, and catalyst supply. Catalysts are available to licensees to produce high-performance and special PP grades and include Novolen CirPPlus™ recycled polymers, Novolen Enhance™ performance polymers, PPure™ polymers and Novocene® metallocene catalysts. Source: Lummus, 7/18/2022

- **CSIR-NML Jamshedpur transfers technology on Lithium batteries recycling to Recyclib**

Recyclib Pvt. Ltd., Delhi had earlier signed an MoU with CSIR-NMLfor recycling technology of lithium-ion batteries. The MoU was made for technology transfer of recycling of lithium-ion batteries (LIBs) to recover metal/salts of Li, Co, Mn, Ni, Cu, Al, graphite and saleable plastics. "The technological know-how is a closed-loop design to recover Li, Co, Mn, Ni, Cu, Al, plastics and graphite from black cathodic material of spent LIBs. Developed hydrometallurgical process flowsheet to recover Li, Co, Mn, Cu, Ni as metals/salts and graphite from spent LIBs will be fine-tuned by the samples supplied by the PARTY. The party will commercialize the technology as per the transferred Know-How of the CSIR-NM.
Source: https://avenuemail.in/csir-nml-jamshedpur-transfers-tech-on-lithium-batteries-recycling-to-recyclib/

- **Hydrocarbon Processing Announces Finalists for the 2022 Awards Program**

Hydrocarbon Processing (HP) has announced the finalists for its sixth annual awards ceremony. This year, the awards cover 16 key categories in the hydrocarbon processing industry that will be voted on by the HP Awards' esteemed advisory board. Follow the link to see all finalists. Source: Hydrocarbon Processing, 8/2022.

- **Lummus Introduces Industry's First Net Zero Ethane Cracker**

Lummus Technology announced the launch of a major enhancement to its leading ethane feed steam cracker that can achieve zero CO_2 emissions from an ethylene plant. Lummus developed this next generation design as part of its comprehensive strategy to reduce greenhouse gas emissions from all its technology offerings. The cracker, which is the industry's first, is now available for commercial use to decarbonize a process in petrochemical manufacturing that is very carbon intensive. It can be incorporated into both new and existing ethane crackers, and at sites and facilities of different sizes. Lummus' proprietary ethane feed steam cracking process is the most widely applied process to

produce polymer grade ethylene and polymer grade propylene. The process is noted for its performance including high product yield, energy efficiency, low investment cost and industry-leading reliability. Source: Hydrocarbon Processing, 7/14/2022.

- **BASF Introduces PuriCycle® Portfolio of Catalysts and Adsorbents to Enable Plastics Recycling**

BASF launched PuriCycle®, a new line of advanced high-performance products for the purification of most complex waste plastics pyrolysis feeds. The PuriCycle® portfolio includes novel catalysts and adsorbents developed to selectively remove or convert a wide range of impurities in pyrolysis oils and enable downstream processing of circular plastics streams. Purification of pyrolysis oils obtained from waste plastics is among the most demanding technical tasks in chemical plastics recycling. Impurities, such as halogen, nitrogen, oxygen, and sulfur compounds but also higher levels of reactive components such as dienes, complicate the downstream use and impose strict limitations on the further processing of such streams in the production of new materials. Source: BASF, 7/13/2022.

Scientific Updates

- **New Catalyst Leads to More Efficient Butadiene Production**

Researchers at North Carolina State University have developed a new catalyst that improves the efficiency of converting butane, a component of natural gas, into butadiene – a building block in synthetic rubber and a variety of plastics. Existing techniques for converting butane into butadiene either create a bunch of byproducts that nobody wants or convert only a small fraction of the butane into butadiene each time the butane passes through the chemical reactor. As a result, you have to run the butane through the same process repeatedly. Because of this, there are very few plants devoted to producing butadiene.

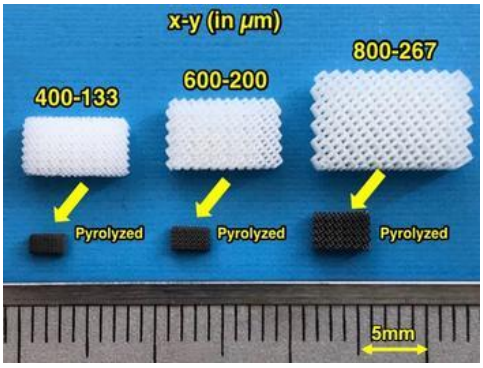
Instead, much of the butadiene used in manufacturing comes from plants where butadiene is collected as a byproduct of other reactions. Specifically, the researchers have engineered a catalyst that converts more butane into butadiene with each pass through the reactor, compared to previous catalysts. The work was done using an oxidative dehydrogenation (ODH) reaction. The catalyst itself is a lithium bromide shell surrounding a core of lanthanum strontium ferrite. The reaction requires a modular reactor, and conversion takes place at between 450 and 500^0C. Source: North Carolina State University, 7/27/2022.

- **Molecular-level Insight into Photocatalytic CO_2 Reduction with H_2O Over Au Nanoparticles by Interband Transitions**

Achieving CO_2 reduction with H_2O on metal photocatalysts and understanding the corresponding mechanisms at the molecular level are challenging. Herein, the authors report that quantum-sized Au nanoparticles can photocatalytically reduce CO_2 to CO with the help of H_2O by electron-hole pairs mainly originating from interband transitions. Notably, the Au photocatalyst shows a CO production rate of 4.73 mmol g^{-1} h^{-1} (~100% selectivity), ~2.5 times the rate during CO_2 reduction with H_2 under the same experimental conditions, under low-

intensity irradiation at 420 nm. Theoretical and experimental studies reveal that the increased activity is induced by surface Au–O species formed from H_2O decomposition, which synchronously optimizes the rate-determining steps in the CO_2 reduction and H_2O oxidation reactions, lowers the energy barriers for the *CO desorption and *OOH formation, and facilitates CO and O_2 production. The authors' findings provide an in-depth mechanistic understanding for designing active metal photocatalysts for efficient CO_2 reduction with H_2O. Source: Nature, 7/6/2022.

- **Micro-engineered electrodes could cut battery manufacturing costs**



As 3D printers gain increasing resolution, sodium ion batteries could eventually outperform lithium-ion ones. Researcher are looking at ways to achieve high-performance, low-cost batteries by increasing the loaded number of active materials used to make a battery into a single battery cell. This would reduce the inactive materials that are used for binding multiple cells together. However, this requires the fabrication of thicker electrodes, which would restrict ion movement and thus that of electric charge within the battery.

Kudo and his team have addressed this by developing an approach that fabricates micro-architected, high performing negatively charged (anode) electrodes.

The approach involves using 3D stereolithography to print micro lattice structures made from resin. The micro lattices are then shrunk by carbonizing them via a process called pyrolysis. The resulting hard carbon anodes were found to allow fast transportation of energy-generating ions. Also, as the team made the lattice structure finer, its performance improved. As 3D printers gain increasing resolution, sodium ion batteries could eventually outperform lithium-ion ones, says Kudo. The team next aims to use this same approach to make positively charged (cathode) electrodes. The goal is to use these finely architected electrodes for making high-performing, cost-effective sodium ion batteries.

Source: Yuto Katsuyama et al.; A 3D-Printed, Freestanding Carbon Lattice for Sodium Ion Batteries; Small; 2022

Catalysis Research out of India

1. Jitendra Bahadur, Swati Mehta, Saideep Singh, Avik Das, Ayan Maity, Tristan Youngs, Debasis Sen and Vivek Polshettiwar, "Interlocking dendritic fibrous nanosilica into microgranules by polyethylenimine assisted assembly: in situ neutron diffraction and CO2 capture studies, **Materials Advances 2022, DOI: 10.1039/d2ma00785a**
2. J.S. Gokhale, M.P. Hude, G.D. Yadav, M. Thomas, J. Kozinski, A.K. Dalai, "Hydrothermal processing of waste pine wood into industrially useful products", **Journal of the Indian Chemical Society,** 2022, 100647

3. Anish Patel, Anjali Patel, "Stabilized catalyst comprising nickel and supported 12-tungstophosphoric acid: synthesis, characterization and aqueous-phase Suzuki–Miyaura cross-coupling" **Transition Metal Chemistry,** 2022, 1-7.
4. D.Dasgupta, M. Das, S. Thakore, Anjali Patel, S. Kumar, S. Seshadri, "Development of a controlled sustainable anticancer drug delivery nanosystem comprising doxorubicin and functionalized MCM-48", **Journal of Drug Delivery Science and Technology**, 2022, 103419
5. Dhruvi Pithadia, Anjali Patel, Vijay Hatiya, "12-Tungstophosphoric acid anchored to MCM-22, as a novel sustainable catalyst for the synthesis of potential biodiesel blend, levulinate ester" **Renewable Energy,** 2022, 187, 933-943.
6. Muzammilanwar S. Khan, Mayur Mane, Amol A Kulkarni, Evaluating suitability of confined impinging jet reactor for exothermic reactions: Hydrodynamics, residence time distribution, and heat transfer, **AICHE JOURNAL,** 2022. DOI: 10.1002/aic.17792
7. G.M. Mule, S. Kulkarni, A. A. Kulkarni, "An assessment of a multipoint dosing approach for exothermic nitration in CSTRs in series" **Reaction Chemistry & Engineering,** 2022,7, 1671-1679
8. B. Jaleh, M. Nasrollahzadeh, M.Eslamipanah, A. Nasri, E. Shabanlou, N. R Manwar, R.Zboril, P. Fornasiero, Manoj B Gawande, "The Role of Carbon-Based Materials for Fuel Cells Performance", **Carbon, 2022, https://doi.org/10.1016/j.carbon.2022.07.023.**

Upcoming Symposium/Conferences/Seminars

1. Conference on Advances in Catalysis for Energy and Environment (CACEE -2022) & CO_2India Network 1st Annual Meet from 31st October to 4th November 2022 at Tata Institute of Fundamental Research (TIFR), Mumbai, INDIA, https://www.cacee.org/
2. "International Conference on Catalysis and Chemical Science (ICCS 2022)" at Rome, Italy, 03-05, October 2022 (https://irisscientificgroup.com/conferences/catalysis-and-chemical-science/home/)
3. International Conference on Sustainable Energy & Clean Technologies, 2-4 September 2022 at PDEU, Gandhi Nagar, Gujarat
4. 2022-9-22: ICCCSTA 2022: 16: International Conference on Carbon Capture, Storage Technologies, and Adsorbents at London.

Editorial Team

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Quote of the Month

"Science knows no country because knowledge belongs to humanity and is the torch which illuminates the world." —**Louis Pasteur**

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