July 2023

CSI Communication

Monthly Newsletter of Catalysis Society of India

Circulated to all CSI Members

Important Announcement:

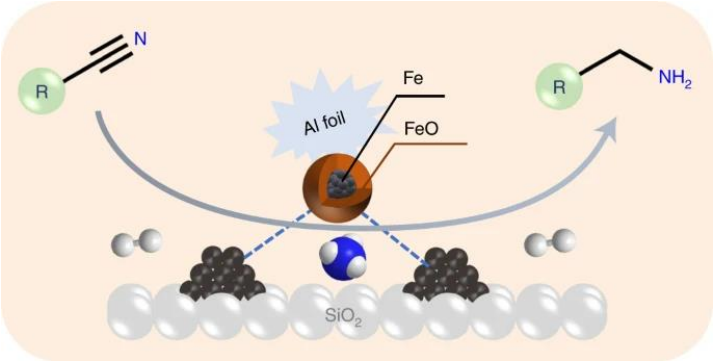
CSI newsletter shall be pleased to publish half a page write-up under the title, Centre of Excellence in Catalysis Research in India from any Indian Academics, Research laboratories or Industrial organizations. You may send your brief write-up on your research activities to us which will be published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

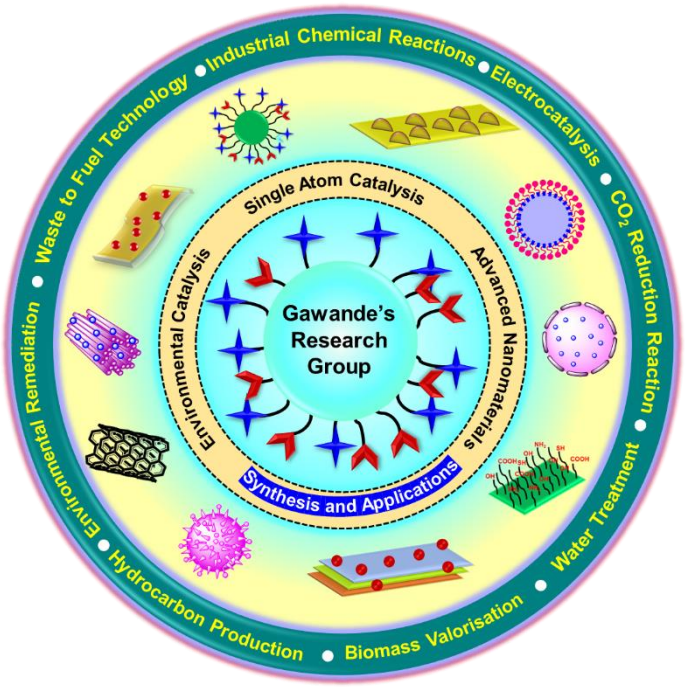
Dr. Manoj B. Gawande's Research Group from Institute of Chemical Technology, Mumbai, Marathwada Campus, Jalna @ Prof. Manoj B. Gawande

Dr. Manoj B. Gawande, PhD, Docent (Habil), FICS, FMASc, FRSC (UK), Associate Professor, is the Principal Investigator of Gawande's Research Group at the Institute of Chemical Technology Mumbai, Marathwada Campus, Jalna (ICT-MARJ), Maharashtra, India. A key focus of Gawande's Research Group is the development of advanced functional materials like N-doped carbon catalysts, mesoporous nanomaterials, and single-atom catalysts (SACs) with well-defined size, coordination, composition, 2 or 3D arrangement, porosity, & surface properties from eco-friendly resources to contribute environmental sustainability. Considering the need for efficient and sustainable catalytic protocols for industrial organic transformations, biomass valorization, carbon dioxide (CO_2) utilization and hydrogen production, his group is actively working on the design and development of SACs for different thermo-, electro- and photocatalytic applications.
A heterogeneous catalysts are a pillars of various contemporary benign innovations, and understanding the relationship between its structure and properties is crucial to its progress. Several sophisticated synthetic methodologies, such as control synthesis of atomically precise heterogeneous catalysts and their utilization for different important applications in organic catalysis, energy, and environmental remediation, have been developed over the last decade. The ability to modify precise atomic-scale control of catalysts has allowed for a significant increase in activity and selectivity. The use of atom scale chemistry to numerous energy and environmental technologies, such as fuel cells, chemical reactors for organic synthesis, & environmental remediation, has proven to be beneficial.
Recently, Gawande's Research Group has developed highly efficient catalytic protocols using highly active mesoporous graphitic carbon nitride (mpg-CN) and metal atom decorated CN SACs for removing toxic industrial dyes and pharmaceutical pollutants. They made notable achievements in the fields of green hydrogen production for organic reactions and hydrogen

storage. They also fabricated magnesium oxide/chitosan/Au nanoparticles (MgO/CS/Au) nanocomposites with a porous structure for electrochemical hydrogen storage. These achievements can help reduce energy demand considering environmental conditions, and the photocatalyst Pd-g-C_3N_4 facilitated hydrogenation with excellent yield and selectivity for a wide range of olefins and nitro compounds. Global energy demand increases day by day due to the rising of population and industrialization.

To overcome the energy crisis, nowadays scientists are focused on employing hydrogenation a molecular hydrogen-based reaction, to produce numerous compounds utilized in the pharmaceutical, agricultural, petrochemical, and food industries. Gawande's research group in collaboration with the research groups of Prof. Jagadeesh Rajenahally and Prof. Matthias Beller, from Germany, and Prof. Radek Zbořil developed reusable Fe/Fe–O@SiO_2 catalyst with a well-defined structure comprising the fayalite phase at the Si–Fe interface, and α-Fe nanoparticles are explored for hydrogenation of different types of nitriles to amines represents an important and widely used industrial process due to the broad applicability of the resulting products in pharmaceutical chemistry and other industrial applications.





In current scenario, energy production and utilization are mostly depended on the combustion of carbonaceous fuels like coal, petroleum and natural gas, resulted into CO_2 emission, which alters earth's carbon cycle. Gawande's research group working on CO_2 to fuel strategy to minimizes the CO_2 emissions in the atmosphere as a result of excessive fossil fuel usage. To effectively resolve, convert emission of CO_2 to platform chemical like methanol they developed copper and ruthenium single-atom catalysts for photocatalytic and electrochemical reduction of CO_2. In addition, Gawande's Research Group has published several studies on photocatalytic applications in organic chemistry, electrocatalysis (oxygen evolution reaction (OER), oxygen reduction reaction (ORR), and hydrogen evolution reaction (HER), as well as the synthesis of pharmaceutical and industrially significant intermediates.

Overall, the efforts of Gawande's research group are to promote research in terms of development of sustainable industrial technology for commercial applications like hydrogenation, CO_2 utilization and green hydrogen production. The number of publications indicate a baby step towards the sustainable development of catalysis and its practical applicability in industrially relevant reactions.

Prof. Gawande awarded with the "STE Green Excellence Award, 2022" on January 13, 2023

Recently, Professor Manoj B. Gawande has been awarded the prestigious "STE Green Excellence Award, 2022" for his exceptional contributions towards the human health and environment via substantial scientific efforts in nanocatalysis and organic synthesis. The award ceremony held in the 4th annual meet of STE and online International Conference on Environment, Water, Agriculture, Sustainability and Health (EWASH-2022): Strategizing, A Greener Future.

Recent Selected Publications:

- Photocatalytic One-Pot Conversion of Aldehydes to Esters and Degradation of Rhodamine B Dye Using Mesoporous Graphitic Carbon Nitride, Rahul P. Gaikwad, Dhanaji R. Naikwadi, Ankush V. Biradar, and **Manoj B. Gawande*** *ACS Applied Nano Materials*, **2023**, DOI: 10.1021/acsanm.2c04846
- Application of Biowaste and Nature-Inspired (Nano) Materials in Fuel Cells Babak Jaleh, Mahmoud Nasrollahzadeh, Atefeh Nasri, Mahtab Eslamipanah, Jacky Advani, Paolo Fornasiero and Manoj B. Gawande* Journal *of Materials Chemistry A*, **2023**, DOI: 10.1039/D2TA09732J
- Silica-supported Fe/Fe–O nanoparticles for the catalytic hydrogenation of nitriles to amines in the presence of aluminium additives, Vishwas G. Chandrashekhar, Thirusangumurugan Senthamarai, Ravishankar G. Kadam, Ondřej Malina, Josef Kašlík, Radek Zbořil, * **Manoj B. Gawande*,** Rajenahally V. Jagadeesh* and Matthias Beller* *Nature Catalysis,* **2022**, 5, 20-29 This important work is also highlighted in "ICT News" https://news.ictmumbai.edu.in/UserPanel/NewsDetails.aspx?nEid=co
- Interface Engineering of SRu-mC_3N_4 Heterostructures for Enhanced Electrochemical Hydrazine Oxidation Reactions, Ajay Munde, Priti Sharma, Somnath Dhawale, Ravishankar G. Kadam, Subodh Kumar, Hanumant B. Kale, Jan Filip, Radek Zboril, Bhaskar R. Sathe, * **Manoj B. Gawande*** *Catalysts* **2022**, 12(12), 1560
- Synthesis and Photocatalytic Applications of Functionalized Carbon Quantum Dots, Nisha Yadav, Rahul P. Gaikwad, Vivek Mishra,* and **Manoj B. Gawande***, *Bulletin of the Chemical Society of Japan*, **2022**, 95, 11, 1638-1679

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Commercial & Policies

- **RIL's Olefins Removal Catalytic (REL-ORCAT) Technology**

Reliance has developed and commercialized an olefins removal catalytic (REL-ORCAT) technology. The heart of the technology is thermally, and mechanically stable high-performance proprietary catalyst having tuned porosity architecture and requisite surface acidity. The technology has been developed to substitute presently used clay catalysts in Aromatics plants. This catalyst reduces the amount of hazardous solid waste generated with clay treaters resulting due to frequent catalyst change. The performance provided by the new technology has led to significantly reduced operating costs as well as opportunities to increase plant capacity. The development was awarded Best Catalyst Technology developed by Hydrocarbon Processing in the year 2022.
Source: https://www.hydrocarbonprocessing.com/magazine/2023/july-2023/special-focus-catalysts/development-and-commercialization-of-an-olefins-removal-catalytic-technology/

- **Tata Chemicals obtains technology from CSMCRI to produce biodiesel from microalgae**

The Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar has licensed its technology to extract crude oil from a species of microalgae to Tata Chemicals Limited (TCL), for production of automobile fuel. CSMCRI will help TCL set up a facility in Mithapur, Gujarat to cultivate an identified microalga species of chlorella genus in open marine environment and process the harvested microalgae biomass to extract crude oil.
Source: //www.csir.res.in/sites/default/files/26%20To%2030%20June%202023.pdf

- **Indian government introduces draft for Green Credits, to reward environmental initiatives**

The Ministry of Environment, Forest and Climate Change (MoEFCC) has also notified the draft 'Green Credit Programme (GCP)' implementation rules 2023. To create a mass movement around environmental positive actions and realize the vision of "Mission LiFE" through pro-planet-people

and entities to achieve India's net zero goal of 2070, the Indian government is coming up with Green Credits. The Green Credits Programme is designed to incentivize voluntary environmental actions undertaken by individuals, private sectors, small scale industries, cooperatives, forestry enterprises and farmer-produce organizations for their environmental actions.
Source: https://www.businesstoday.in/latest/economy/story/indian-government-introduces-draft-for-green-credits-to-reward-environmental-initiatives-387559-2023-06-29

- **BPCL approves ₹18,000 cr rights issue for clean energy transition and capital raise**

Bharat Petroleum Corporation (BPCL) board has approved a rights issue for raising up to ₹18,000 crore. It has targeted to reach 1 gigawatt (GW) of renewables by 2025 and 10 GW by 2040. Earlier this year, the company said it signed a memorandum of understanding (MoU) with the Rajasthan government to set up a 1 GW renewable energy (RE) power plant in the state.

issue-for-clean-energy-transition-and-capital-raise/article67019452.ece

- **India identifies 30 critical minerals to push for low-carbon economy**

The Indian government has identified 30 critical minerals including lithium, cobalt and copper, stating that the listed minerals are essential for the country's economic development and national security. The 30 minerals listed by the government include Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, PGE, Phosphorous, Potash, REE, Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium and Cadmium.
The ministry will be revisiting the critical mineral list periodically.
Source: https://www.moneycontrol.com/news/business/india-identifies-30-critical-minerals-to-push-for-low-carbon-economy-10875591.html

- **Axens builds on ExxonMobil MTBE Decomposition Technology for high purity isobutylene production**

ExxonMobil Catalysts and Licensing LLC and Axens have signed an exclusive licensing alliance agreement allowing Axens to include ExxonMobil's MTBE Decomposition Technology for high purity isobutylene in its portfolio. Used in the production of high-reactivity polyisobutylene and butyl rubber, this technology enables Axens' customers to better address the growing demand for petrochemical intermediates. This alliance builds on collective expertise to provide customers with isobutylene purity of at least 99.99 wt% via an integrated unit with MTBE and MTBE Decomposition technologies or through a standalone unit using MTBE Decomposition technology.
Source: https://www.hydrocarbonprocessing.com/news/2023/06/axens-builds-on-exxonmobil-mtbe-decomposition-technology-for-high-purity-isobutylene-production/

- **Asia continues to dominate global refinery FCCU capacity additions**

Asia is expected to witness the highest refinery fluid catalytic cracking unit (FCCU) capacity additions globally during 2023 – 2027, contributing approximately 58% of the total capacity additions by 2027, says GlobalData. Asia is expected to witness a total FCCU capacity addition of

1 828 000 bpd by 2027. Of this, 1 421 000 bpd is likely to be from new-build refineries while the rest is from the expansion of existing refineries. In Asia, China is expected to add the highest capacity addition of 513 000 bpd from seven refineries during 2023 – 2027. India follows next with 388 mbd of capacity additions during the same period. Vadinar refinery, located in India, is the largest upcoming FCCU project in the region that is likely to add a capacity of 187 000 bpd in 2024. The Nayara Energy Ltd, the operator of the Vadinar refinery, is expanding the FCC as part of the company's plans to diversify its petrochemicals portfolio .
Source: Hydrocarbon Engineering, 11 July 2023

- **Johnson Matthey to build a new production plant in China for catalyst-coated membranes**

Johnson Matthey plc, has signed an investment agreement with the Jiading District in Shanghai to help accelerate the hydrogen economy in China. They announced plans to build a new catalyst coated membrane (CCM) production facility, providing CCM production capability for multiple proton exchange membrane (PEM) fuel cell applications and PEM electrolyzers. The facility which will have an initial capacity of up to 5GW, will occupy 22,000 m^2 in the Jiading district of Shanghai, in a designated Hydrogen industrial zone and is due to be operational in 2025.
Source: https://www.chemengonline.com/johnson-matthey-to-build-a-new-production-plant-in-china-for-catalyst-coated-membranes/?printmode=1

- **Avantium and SCGC partner to bring CO_2-based polymers to pilot phase**

Avantium N.V., announces that it has agreed to partner with SCG Chemicals Public Company Limited ("SCGC"),. Under this partnership, Avantium and SCGC agreed to further develop CO2-based polymers and to scale-up to a pilot plant with an indicative capacity of 10 tonnes per annum.
Source: www.avantium.com

- **Aramco to partner Aker Carbon Capture to deploy CCUS modular solutions in Saudi Arabia**

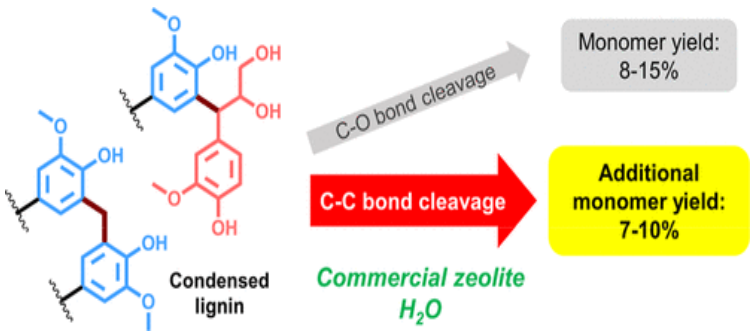
Norway-based Aker Carbon Capture and Aramco signed a deal to explore partnership opportunities to deploy carbon capture, utilization and storage (CCUS) and industrial modularization in Saudi Arabia. As part of the agreement, the two companies will focus on reducing carbon emissions and removal from industries and energy solutions through CCUS by offering modular carbon capture plants and aftermarkets services. Source: https://akercarboncapture.com/?cision_id=0F48832CB9D3BCB8

Scientific Updates

- **Depolymerization of Methylene Linkage in Condensed Lignin with Zeolite in Water**

  Lignin, an aromatic polymer, is a crucial component of lignocellulosic biomass and is a significant source of renewable aromatics found in nature. Lignin constitutes up to 30 wt % of lignocellulosic biomass and is generated in excess of 100 million tons per year from global paper and bio-ethanol industries. Unfortunately, most technical lignin produced in this manner is burned as a heat source, without any value-added valorization. The conversion of technical lignin into valuable compounds can significantly increase the profitability of biorefineries.

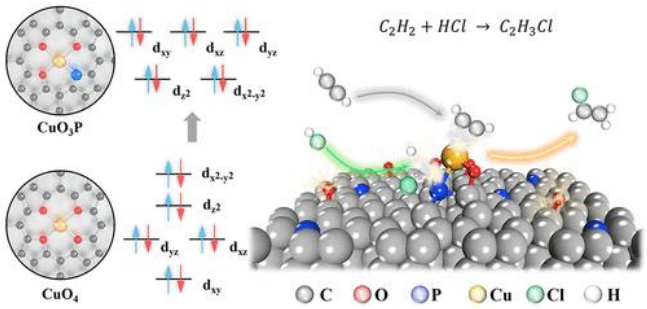
However, the productivity of this process is constrained by the severe lignin condensation that occurs during extraction procedures, resulting in the formation of robust C–C bonds, such as methylene linkages, which lead to monomer yields of only 8–15%. Herein, authors present an approach to overcome this limitation by producing well-defined aromatic monomers from condensed lignin fractions. The approach employs commercial zeolite-catalyzed cleavage of methylene linkages with water as both the reacting medium and the reactant. Up to 7–10% of additional aromatic monomers can be obtained from various types of technical lignin, thus increasing the total monomer yields by 59–102%.



Source: ACS Catalysis 2023, https://pubs.acs.org/doi/10.1021/acscatal.3c02384

- **Carbothermal Shock Method for Efficient Vinyl Chloride Synthesis over Carbon Supported Cu Catalysts**

Typically, in the synthesis of vinyl chloride (VCM) by acetylene hydrochlorination, a limited understanding of the optimal architecture for carbon-supported Cu catalysts at the nanoscale greatly restrains their further development and application. To achieve this, Cu single-atom (Cu-O3P) with identical coordination environments and Cu/Cu3P nanoparticles with uniform size were tailored via advanced carbothermal shock method, and their catalytic structure–activity relationships were explored in the acetylene hydrochlorination reaction. In detail, a platform of nanostructured copper catalysts was constructed by the precursor-assisted carbothermal shock method, and the relationship between the coupling structure and electron properties of copper sites and their catalytic performance is correlated.



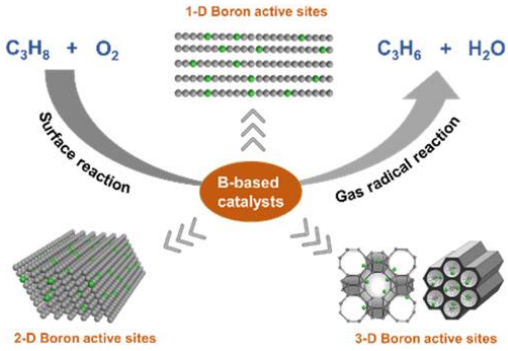
Source: ACS Catalysis, 2023, https://pubs.acs.org/doi/10.1021/acscatal.3c01527.

- **Boron-Based Catalysts for Oxidative Propane Dehydrogenation: Structure and Mechanism**

The superiority of boron-based (B-based) catalysts in inhibiting olefin peroxidation has shed light on the industrialization landscape of the oxidative dehydrogenation of propane (ODHP) technology. However, owing to the complexity of the structure and reaction network of B-based catalysts, systematic understanding of the structure performance relationship and the relevant mixed surface gas radical mechanism remains limited. In this review, we summarize the latest research advances in the performance of different B-based catalysts and the ODHP reaction mechanism in different spatial dimensions. The construction of active sites from one-dimension

(1-D) to three-dimension (3-D) of different catalysts and their ODHP catalytic performances were analyzed in detail, and the structure–activity relationship of the catalysts was elucidated.

In addition, potential strategies for enhancing the space–time yield of the catalysts were discussed. Furthermore, this review also thoroughly analyzes the ODHP mechanism about the reaction pathways, key intermediates, rate-determining steps, and catalytic kinetics at the 1/2-D surface active sites and the 3-D gas phase.



Source: ACS Catalysis 2023
https://pubs.acs.org/doi/10.1021/acscatal.3c00728

Catalysis Research out of India

1. K.Mantri, J.K.Reddy, K.B.Sidhpuria, R.V.Jasra, A.V.Sapre, "Development and commercialization of an olefins removal catalytic technology" **Hydrocarbon Processing, July 2023**.
2. Xiaojin Dong , Xuecheng Li , Hua Tan, Jiaping Zhu, Gang Wang, Suhua Wang, Wenyu Xie, Tong Zhan, Vivek Polshettiwar, "The d band center dependent catalytic activity of n-doped carbon nanospheres with wrinkled cages supported PdPt alloy catalysts in transfer hydrogenation of bicarbonate with glycerol" **Molecular Catalysis, 2023, 547, 113369**
3. Vitthal B Saptal, Swapna M Gade, Gianvito Vilé, Jędrzej Walkowiak, Bhalchandra M Bhanage "Organocatalytic Reductive Functionalization of Carbon Dioxide" **Sustainable Utilization of Carbon Dioxide: From Waste to Product 2023,** 1-36, Springer Nature Singapore
4. Poonam Sutar, Ramdas Kadam, G. D Yadav "Process simulation-based life cycle assessment of the six-step Cu-Cl Cycle of green hydrogen generation and comparative analysis with other Cu-Cl cycles", **The International Journal of Life Cycle Assessment,2023,** 28 (6) 651-668
5. A.Bisarya, R.V.Jasra, Akshai Kumar, "NNN Pincer-Manganese-Catalyzed Guerbet-Type β-Alkylation of Alcohols under Microwave Irradiation" **Organometallics, 2023,** https://doi.org/10.1021/acs.organomet.3c00132
6. Preeti Sahu, Soumya B Narendaranth, Ayyamperumal Sakthivel," Cerium Containing Siliceous MCM-22: Preparation, Characterization and its Potential Application towards Oxidation of Isoeugenol to Vanillin" **Current Materials Science: Formerly: Recent Patents on Materials Science** 2023, 16(4) 416-430
7. Ajayan Vinu Ahmad Tabish, Sujanya Maria Ruban, Stalin Joseph, Sathish Clastinrusselraj Indirathankam, Mercy Bezingar, Kavitha Ramadass, Jae-Hun Yang, Naroth P. Nimisha, Sakthivel Ayyamperumal, Yoshihiro Sugi "The isopropylation of naphthalene over ordered mesoporous aluminosilicate AlSBA-1: The formation of diisopropylnaphthalene and triisopropylnaphthalene isomers" **Molecular Catalysis ,2023** https://doi.org/10.1016/j.mcat.2023.1133

8. L. Nishana, A. Sakthivel, M. R Prathapachandra Kurup," Syntheses, structural characterizations, and catalytic activities of manganese (II)-aroylhydrazone complexes" **Journal of Molecular Structure, 2023,** 135128
9. Dharmesh J. Machhi, Bharat Modhera, Parimal A. Parikh, "Catalytic cracking of low-density polyethylene dissolved in various solvents: product distribution and coking behavior", **Journal of Material Cycles and Waste Management , 2023** https://doi.org/10.1007/s10163-023-01734-4

▪ Upcoming Symposium/Conferences/Seminars

1. SusChemE 2.0, International Conference on Sustainable Chemistry & Engineering 2023 is being organized in Institute of Chemical Technology (ICT) Mumbai, India along with the Catalysis Society of India during **14th-16th September 2023. Last date for Abstract Submission is 31st July 2023**
2. Indian Membrane Society is organizing an International Conference on "Membrane based Separations: Past, Present & Future" during **16th-18th October 2023** at MS University of Baroda along with CSIR-CSMCRI, Bhavnagar.
3. 6th International Oil & Gas Chemistry, Chemicals & Additives Conference (IOGCA 2023) from **12-13th September 2023** at Ahmedabad http://oilfieldchemical.org/
4. 15th European congress on Catalysis [Europacat-15] Prague, Czech Republic, **August 27 – September 1, 2023.** https://www.europacat2023.cz/
5. International Conference on Organometallics and Catalysis from **30th – 2nd Nov 2023** at Goa, India https://www.icoc2023.com
6. 2nd International Conference on Catalysis and Chemical Engineering, November 09-10, 2023 Millennium Hotel Paris Charles De Gaulle, Paris, France https://scisynopsisconferences.com/catalysis/
7. 9th Conference of the Federation of the European Zeolite Associations (FEZA 2023) Portorož-Portorose, Slovenia **02nd - 06th July 2023** https://www.feza2023.org/en/
8. 4th International, Refinery & Petrochemical Technology, Conference & Exhibition on **8th & 9th August** 2023 in New Delhi.
9. International Catalysis Conference ICC 2023 from **15th-17th September 2023** at Miami USA https://www.catalysisworldconference.com/
10. 17th Edition of International Conference on Catalysis, Chemical Engineering and Technology" (Catalysis 2023) as Hybrid Event, **October 26th-28th, 2023,** at Boston, Massachusetts, USA.

❖ Quote of the Month

"No matter what people tell you, words and ideas can change the world."- **Robin Williams**

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