February 15, 2021

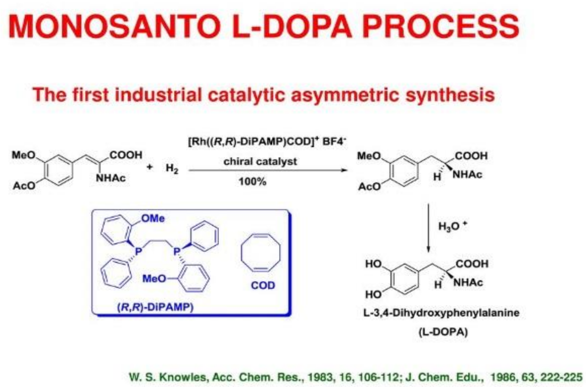
CSI Communication

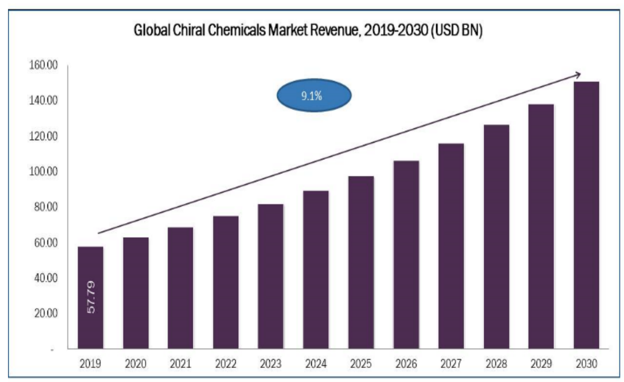
Monthly Newsletter of Catalysis Society of India

Circulated to all CSI Members

Catalysis & Health Security

Catalysis has played significant role towards health security of humankind. Catalysis is employed in eco-friendly & economic synthesis of many over the counter drugs like Naproxen, Ibuprofin and drug intermediates. However, the landmark contribution of catalysis towards health care security happened with the advent of selective synthesis of specific enantiomer through asymmetric catalysts. This has given a big impetus to the Chiral Drugs Industry. Nobel Prize in Chemistry in 2001 was awarded to three scientists: Dr. William S. Knowles and Prof. K. Barry Sharpless in USA and Prof. Ryori Nyori in Japan, for their development of asymmetric synthesis using chiral catalysts in the production of single enantiomer drugs or chemicals.





The Global Chiral Chemicals Market size is estimated to be USD 57.79 billion in 2019 and is predicted to reach USD 150.64 billion by 2030 with a CAGR of 9.1% from 2020-2030. The market is classified into the pharmaceuticals, agrochemicals, flavours/fragrances, and other applications. More than half of the total drugs existing today are chiral compounds. The fastest growing chiral end-uses include antihistamines, cancer therapies, antivirals, antibiotics, anorexics, and antidiabetics.

Commercial and Policies

IOC to Set up Rs 29,000 crore Refinery at Nagapattinam in Tamil Nadu

Indian Oil Corporation (IOC) has received its board's approval for setting up a new refinery in Nagapattinam in Tamil Nadu at an estimated cost of Rs 29,361 crore. The plant will be established by IOC's subsidiary, Chennai Petroleum Corporation Limited (CPCL), to meet the demand of

petroleum products in southern India. The new refinery will have an annual refining capacity of 9 million metric tonnes. According to IOC Chairman and Managing Director SM Vaidya, the plant will be completed within 48 months from the dates of investment approval and statutory clearances. The refinery is expected to source 80 per cent of materials and services indigenously, he said, adding that it will produce diesel and petrol meeting Bharat Stage VI standards.
Source: Business Today, January 31, 2021

- **Suzuki, Toshiba to Make Gujarat Li-ion Unit an Export Hub**

Suzuki Motor Corp., Toshiba Corp., and Denso Corp. plan to turn their joint manufacturing facility for lithium-ion (Li-ion) cells in Gujarat into a global export hub. The factory, the first such in India for manufacturing Li-ion cells, is set to open around April with assembling of battery packs, before graduating to producing Li-ion cells around 2024-25.

Lithium cells are considered the heart of an electric vehicle (EV) and other gadgets such as mobile phones and laptops. Most EV makers currently buy batteries and cells from China, the world's largest producer of Li-ion cells.

Meanwhile, in a boost to efforts to manufacture Li-ion cells locally, the Indian government on Wednesday confirmed the presence of 1,600 tonnes of lithium reserves in the Mandya district of Karnataka. To promote local manufacturing and curb imports from China, the government earmarked ₹18,000 crore to subsidize advanced chemistry cell (ACC) manufacturers such as Li-ion cell makers through the scheme.
Source: Livemint.com (e-paper), February 5, 2021.

- **Innovation and R&D Highlights of Union Budget 2021-22**

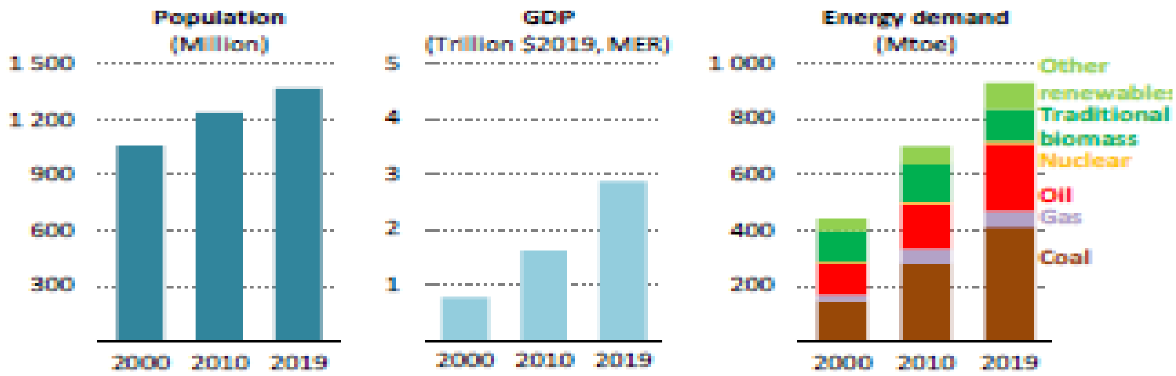
The Union Budget 2021-22 announced on 1st February 2021, including for the first time, a pillar dedicated to Innovation and R&D. Announcement to establish a National Research Foundation (NRF) was made in 2019. The modalities of the NRF have been laid down and the Budget 2021-22 provides an NRF outlay of Rs 50,000 crore over five years. It will ensure the overall research ecosystem in the country is strengthened with a focus on identified national priority thrust areas.

The Budget announced the launching of a Hydrogen Energy Mission in 2021-22 for generating H_2 from green power sources. By ushering in the hydrogen economy, India is expected to gain significantly by promoting the usage of green H_2 in power generation & power storage, transportation, industrial heating, and fertilizer production. The mission will have an R&D component to help to attain energy security and reducing the carbon footprint of the country.
Source: https://www.psa.gov.in/web/article/innovation-and-rd-highlights-union-budget-2021-22/2529

- **India Energy Outlook 2021**

India is a major force in the global energy economy. India's continued industrialization and urbanization will make huge demands of its energy sector and its policy makers. The Covid-19 pandemic has disrupted India's energy use.

Selected indicators for India, 2000, 2010 and 2019



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Rising population and incomes since 2000 have underpinned a doubling of energy use in India, but per capita energy use is still less than 40% of the world average.

Over 80% of India's energy needs are met by three fuels: coal, oil, and solid biomass. Natural gas and modern renewable sources of energy have started to gain ground.

India is the third-largest global emitter of CO_2, despite low per capita CO_2 emissions. India has a wide range of policies in place that aim to bring about a secure and Sustainable energy future. Source: https://www.iea.org/reports/india-energy-outlook-2021

- **IIT Delhi Researchers Generate Clean Fuel Hydrogen from Water at Low-Cost; Demonstrates Successful Pilot-Plant**

IIT Delhi in collaboration with the ONGC Energy Centre, India have reported successful splitting of water by Sulphur-Iodine (SI) thermochemical hydrogen cycle to generate low-cost, clean hydrogen fuel for industrial consumption. One of the challenges in the low-cost conversion taken-up by the IIT Delhi researchers in this work, was to design a suitable catalyst for the energy intensive, corrosive step of sulphuric acid conversion to sulphur-dioxide and oxygen. The in-house catalyst developed by them meets these criteria and is now patented, and a process based on these is developed and demonstrated in the Institute. The modified iron oxide catalyst dispersed on silica surface on a silicon-carbide support catalyst is not only cost-effective, it is also functional under the high temperature and corrosive conditions of the reaction.

Source: Indian Institute of Technology Delhi (IIT Delhi), 2/8/2021

- **Largest PEM Electrolyzer for Green Hydrogen**

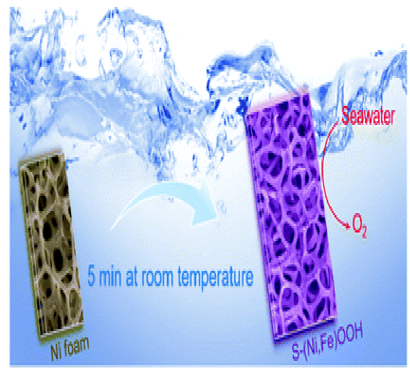
Linde will build, own, and operate the world's largest PEM (Proton Exchange Membrane) electrolyzer plant at the Leuna Chemical Complex in Germany. The new 24-megawatt electrolyzer will produce green hydrogen. The plant is due to start production in the second half of 2022 and will be built by ITM Linde Electrolysis GmbH, a joint venture between Linde and ITM Power, using high-efficiency PEM technology.

Most of the world's hydrogen production is generated by Steam Methane Reforming (SMR), a CO_2 intensive process. If a process that uses renewable electricity is used, "green" or CO_2 neutral hydrogen is produced.

Source:https://www.chemistryviews.org/details/news/11284797/Largest_PEM_Electrolyzer_for_Green_Hydrogen.html

Scientific

- **Ultrafast Room Temperature Synthesis of Porous S-doped Ni/Fe (oxy)hydroxide Electrodes for Oxygen Evolution Catalysis in Seawater Splitting**

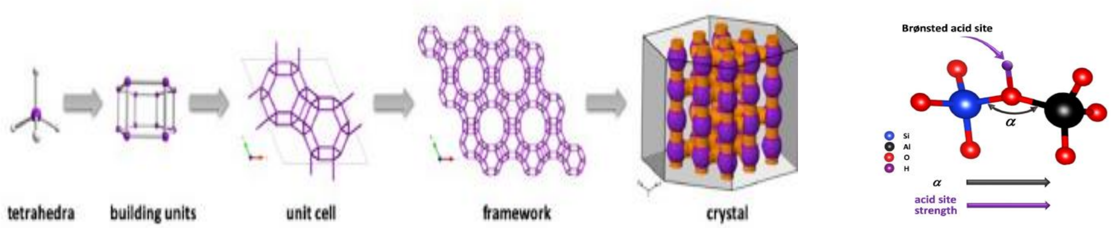


A cost-efficient surface engineering method to steer commercial Ni foam into robust OER catalysts for seawater electrolysis, which has important implications for both the hydrogen economy and environmental remediation is reported. One-step approach to grow highly porous S-doped Ni/Fe (oxy) hydroxide catalysts on Ni foam in several minutes under room temperature is reported. This ultrafast method effectively engineers the surface of Ni foam into a rough S-doped Ni/Fe (oxy)hydroxide layer, which has multiple levels of porosity and good hydrophilic features and exhibits extraordinary oxygen evolution reaction (OER) performance in both alkaline salty water and seawater electrolytes.

Specifically, the S-doped Ni/Fe (oxy) hydroxide catalyst requires low over potentials of 300 and 398 mV to deliver current densities of 100 and 500 mA cm^{-2}, respectively, when directly used as an OER catalyst in alkaline natural seawater electrolyte. Using this OER catalyst together with an efficient hydrogen evolution reaction catalyst, authors achieved the commercially demanded current densities of 500 and 1000 mA cm^{-2} at low voltages of 1.837 and 1.951 V, respectively, for overall alkaline seawater electrolysis at room temperature with good durability.
Source: Luo Yu et al, Energy Environ. Sci. 2020, 13, 3439-3446

- **Analysis and Control of Acid Sites in Zeolites**

The exceptional catalytic performance of zeolites is due to the presence of active sites in a shape-selective environment, i.e., in micropores with molecular dimensions. This review provides a comprehensive analysis of active sites in zeolite frameworks.



Schematic representation of zeolite structure formation & Zeolite Bronsted acid sites strength as a function of the T-O-T bond angle.

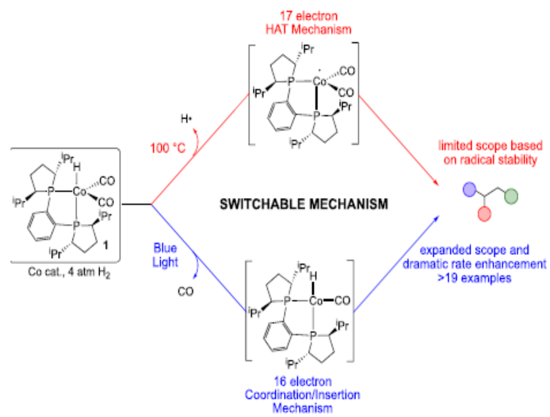
It is focused on the active sites generated by the Al incorporation in the framework. The inclusion of other heteroatoms in the zeolite framework is also addressed.

The data presented herein provide guidelines for making zeolite materials by design in terms of acidity. After the introduction of zeolite-type materials and a discussion of the structure-properties relationship in zeolites the central part of the review is devoted to i) the analytical methods and their complementarity for the evaluation of the number, strength, and position of active sites and ii) the *in situ* and post-synthesis methods of acid sites assessment and control.

Source: Ana Palčića, Valentin Valtchev, Applied Catalysis A, General 606 (2020) 117795

- **Visible Light Enhanced Cobalt Catalyzed Hydrogenation: Switchable Catalysis Enabled by Divergence between Thermal and Photochemical Pathways**

The catalytic hydrogenation activity of the readily prepared, coordinatively saturated cobalt(I) precatalyst, (R,R)-(iPrDuPhos)Co(CO)2H ((R,R)-iPrDuPhos=(+)-1,2-bis[(2R,5R)- 2,5-diisopropylphospholano]benzene), is described. While efficient turnover was observed with a range of alkenes upon heating to 100 °C, the catalytic performance of the cobalt catalyst was markedly enhanced upon irradiation with blue light at 35 °C.

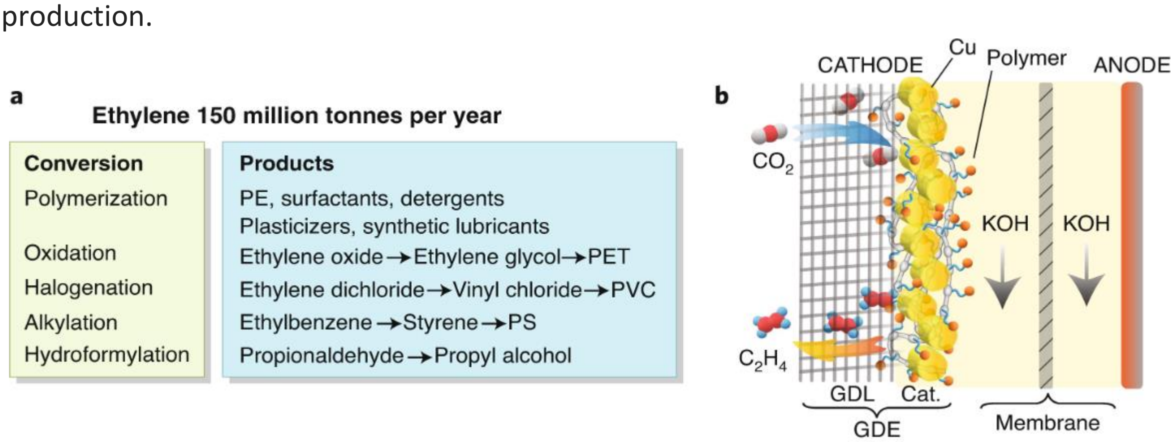


This improved reactivity enabled hydrogenation of terminal, di-, and trisubstituted alkenes, alkynes, and carbonyl compounds.

Source: Lauren N. Mendelsohn, et al., ACS Catal. 2021, 11, 1351–1360

- **Electrochemical CO_2 to Ethylene Conversion on Polyamine Incorporated Cu Hybrid Catalyst**

Andrew A. Gewirth & team present here a Cu–polyamine hybrid catalyst, developed through co-electroplating, that significantly increases the selectivity for ethylene production.



The Faradaic efficiency for ethylene production is 87% ± 3% at −0.47 V versus reversible hydrogen electrode, with full-cell energetic efficiency reaching 50% ± 2%. entrainment of additives containing little or no amine functionality.

Raman measurements indicate that the polyamine entrained on the Cu electrode results in higher surface pH, higher CO content and higher stabilization of intermediates compared with entrainment of additives containing little or no amine functionality. More broadly, this work shows that polymer incorporation can alter surface reactivity and lead to enhanced product selectivity at high current densities.
Source: Enrico Andreoli, Nature Catalysis | VOL 4 | January 2021 | 8–9

Catalysis Research out of India

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- A. M. Ranjekar & G.D. Yadav, "Steam Reforming of Methanol for Hydrogen Production: A Critical Analysis of Catalysis, Processes, and Scope*" Industrial & Engineering Chemistry Research 2021, 60, 1, 89-113 (Review)* *DOI: 10.1021/acs.iecr.0c05041*
- A. M. Ranjekar & G.D. Yadav, Dry "Reforming of Methane for Syngas Production: A Review and Assessment of Catalyst Development and Efficacy" Journal of the Indian Chemical Society, 2021 https://www.sciencedirect.com/science/article/pii/S0019452221000029
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- J.K. Reddy, K. Mantri, G. Raman, S. Lad, J. Das, R.V. Jasra, "Synthesis of Ce-MCM-22 and its enhanced catalytic performance for the removal of olefin from aromatic streams" *Journal of Porous Materials, 27,1649–1658, 2020*
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- A. Khan,S, Saif Ali, V. P. Chodimella, S. A. Farooqui, M. Anand, and A.K. Sinha, "Catalytic Conversion of Dicyclopentadiene into High Energy Density Fuel: A Brief Review", Ind. Eng. Chem. Res. XXXX, XXX, XXX−XXX. https://dx.doi.org/10.1021/acs.iecr.0c06168.

Announcements

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

Name	Achievement
Prof. Sushil Kumar Kansal Dr. S. S Bhatnagar University Institute of Chemical Engineering & Technology, Panjab University, Chandigarh, INDIA 	Elected as Fellow of Royal Society of Chemistry (FRSC) January 2021
Prof. Biswajit Chowdhury Indian Institute of Technology, (ISM), Dhanbad, Jharkhand, INDIA 	Elected as Fellow of Royal Society of Chemistry (FRSC) January 2021
Prof. A. Sakthivel Department of Chemistry School of Physical Science, Central University of Kerala, Kasaragod, INDIA 	Elected as Fellow of Indian Chemical Society (ICS) February 2021
Prof. Bhalchandra M. Bhanage Professor of Industrial and Engineering Chemistry, Department of Chemistry, Institute of Chemical Technology Mumbai, INDIA 	Elected as Fellow of Indian Chemical Society (ICS) October 2020
Prof. V. K. Rathod Department of Chemical Engineering Institute of Chemical Technology, Mumbai, INDIA 	Elected as Fellow of Indian Chemical Society (ICS) October 2020

Quote of the Month

" You must **be the change** you **wish to see** in the world."   Mahatma Gandhi

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