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CSI Communication

Monthly Newsletter of Catalysis Society of India

Circulated to all CSI Members

Commercial & Policies

- **Ministry of Coal Constitutes Task Force and Expert Committee to Prepare Road Map for Coal based Hydrogen Production**

Coal is one of the important sources of hydrogen making (Brown Hydrogen). Production of hydrogen from coal will have challenges in terms of high emissions and CCUS will play an important role. However, when the carbon monoxide and carbon dioxide formed during coal to hydrogen process are trapped and stored in an environmentally sustainable manner (CCS and CCUS), then, Indian coal reserves could become a great source of hydrogen. Considering the above, Ministry of Coal has constituted 2 Committees one to oversee the program and another of experts to give guidance to the Ministry. Task Force constituted under the Chairmanship of Shri Vinod Kumar Tiwari, Additional Secretary Coal along with the experts from research laboratories and industries is expected to submit the report in three months.
https://pib.gov.in/PressReleasePage.aspx?PRID=1752915

- **Niti Aayog, WRI Launch Forum for Decarbonizing Transport Sector**

Niti Aayog and World Resources Institute (WRI), India have jointly launched the ''Forum for Decarbonizing Transport'' in the country. This is part of the NDC-Transport Initiative for Asia (NDC-TIA) project. The project aims at bringing down the peak level of GHG (greenhouse gas) emissions by the transport sector in Asia. The virtual launch was inaugurated by Niti Aayog CEO Amitabh Kant. India has a massive and diverse transport sector, which is also the third most CO_2 emitting sector. In his keynote address, Kant said the stakeholder forum on transport decarbonisation is a defining milestone for the electric mobility ecosystem in the country. It will bring together CEOs, researchers, academics, multilateral agencies, financial institutions as well as the central and state governments on a common platform, he added. The project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) support the initiative based on a decision adopted by the German Bundestag. Niti Aayog is the implementing partner for the India component of the project.
https://economictimes.indiatimes.com/industry/transportation/roadways/niti-aayog-wri-launch-forum-for-decarbonising-transport-sector/articleshow/85593245.cms?from=mdr

- **India Proposes to Mandate Green Hydrogen in Fertilizers and Refining**

India is proposing to mandate using green hydrogen in fertilizers and refining and this is part of the government's commitment towards replacing grey hydrogen with green hydrogen, said Union Minister for power and MNRE R. K. Singh in a telephone call with John Kerry, U.S. Special Presidential Envoy for Climate (SPEC). He suggested to him that India and the USA could work together in the areas of innovations for power and technology, pointing out the requirement of bringing down the cost of storage of renewable power. Singh also informed Kerry that the National Hydrogen Energy Mission has been launched to enable cost competitive green hydrogen production. He added that India would be conducting competitive bids for green hydrogen in the next 3-4 months to pave the road for viable usage of hydrogen as a fuel. India is looking at bids for 4,000 MW of electrolysers capacity. The other countries need to come up with more electrolyser plants to bring down the costs. Source: Indian Chemical News, 8/28/2021.

- **NTPC Floats EoI for Hydrogen Blending with Natural Gas**

At Leh, a solar plant is also being set up to power hydrogen fuelling station. NTPC Limited, India's largest integrated power generating company, has floated a global Expression of Interest (EoI) to set up a pilot project on hydrogen blending with natural gas in City Gas Distribution (CGD) Network in India. A dedicated 1.25 MW solar plant is also being set up at Leh by NTPC REL to power the hydrogen fuelling station. "This pilot on hydrogen blending with natural gas will be the first of its kind in India and would explore the viability of decarbonising India's natural gas grid. NTPC with its ambition of playing a key role in India's transition to hydrogen economy would later take this up at a commercial scale across India," the company said.

NTPC Limited is also keenly exploring the production of green ammonia to decarbonise the fertilizer industry and possibly fulfil the government's upcoming mandate of using a certain percentage of green hydrogen in fertilizer and refinery sector, it added.

https://www.thehindubusinessline.com/companies/ntpc-floats-eoi-for-hydrogen-blending-with-natural-gas/article35910695.ece

- **IOC to Invest Rs 1 lakh cr to Expand Refining Capacity**

India's top oil firm Indian Oil Crop (IOC) on Friday said it will invest close to Rs 1 lakh crore to raise its refining capacity by almost a third in the next 4-5 years as it saw fuel demand continuing to grow in near future. Addressing the company's annual meeting of shareholders, IOC Chairman Shrikant Madhav Vaidya said petrol demand is already back at pre-COVID levels and diesel - the most used fuel in the country - should return to normal levels by Diwali.

"Forecasts by various agencies see Indian fuel demand climbing to 400-450 million tonnes by 2040 from the present 250 million tonne. This offers enough legroom for all forms of energy to co-exist," he said. To cater to that demand surge, IOC is aggressively rolling out new projects. "These translate into refining capacity expansion of over 25 million metric tonne per annum, including (subsidiary) CPCL, and an investment commitment of close to Rs 1 lakh crore over the next 4 to 5 years," he said. IOC operates 11 refineries that convert crude oil into valued fuels such as petrol and diesel. These have a combined capacity of 81.2 million tonne. It plans to raise the

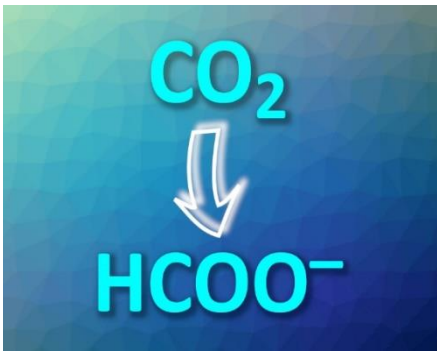
capacity of its Koyali refinery in Gujarat to 18 million tonnes from the current 13.7 million tonne while the same at Panipat refinery in Haryana is planned to go up to 25 million tonne from the current 15 million tonne. "In fact, integration projects, like the upcoming Styrene Monomer Project at Panipat or the Lube Integration Project at Gujarat Refinery will also reduce India's import dependence and strengthen the promise of an Aatmanirbhar Bharat," he said. https://www.financialexpress.com/industry/ongc-eyes-offshore-wind-energyprojects/2320583/

- **Sasol and UCT Researchers Collaborate on the Use of Commercial Iron Catalysts to Convert Hydrogen and CO_2 Into Green Jet Fuel and Chemicals**

A team of researchers from Sasol and the Catalysis Institute at the University of Cape Town (UCT) has made advancements in the use of commercial iron catalyst, produced cheaply and at large scale at Sasol's Secunda plant, which would enable conversion of unavoidable or biogenically-derived carbon dioxide (CO_2) and green hydrogen directly to a variety of green chemicals and jet fuel. This development is a significant step towards the implementation of CO_2 hydrogenation technology in South Africa. With its announced intention to leverage its existing FT technology and skillset to lead the development of South Africa's hydrogen economy, Sasol and UCT have been working on finding innovative ways to use this chemistry to convert CO_2 and hydrogen into a range of useful and green products. The collaboration with UCT has revealed that Sasol's iron catalyst can achieve CO_2 conversions greater than 40%, producing ethylene and light olefins which can be used as chemical feedstocks, and significant quantities of kerosene-range hydrocarbons (jet fuel). In recent years, the university has also been working on CO_2 conversion technology and has built up extensive experience in CO_2 hydrogenation. Source: Sasol, 9/6/2021.

Scientific Updates

- **Stable Electrocatalyst for the Reduction of CO_2 to Formate**



CO_2 is a greenhouse gas and contributes to climate change. Carbon capture and utilization (CCU) could help to mitigate the impacts of carbon emissions. The electrochemical reduction of CO_2 to give formate is one way to use CO_2 to make useful products. This requires selective and stable electrocatalysts. However, developing catalysts that favor the formation of HCOO– and remain stable during operation has been challenging. Tin-based catalysts

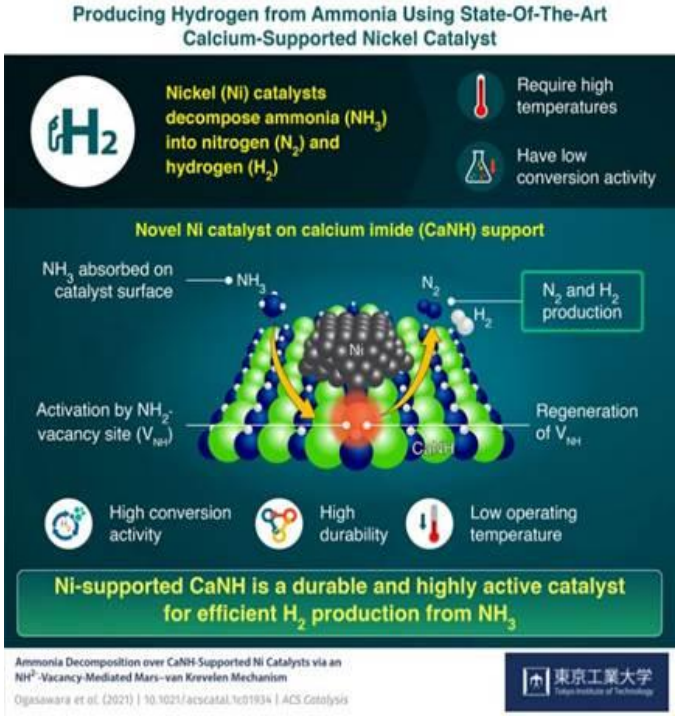
are promising candidates, but their selectivities and formate production rates can be improved.

Hao Dong, Miao Zhong, Nanjing University, China, Edward H. Sargent, University of Toronto, Canada, and colleagues have developed improved catalysts for the electrochemical reduction of CO_2 to formate. The team combined p-block elements with different electronegativities to improve the stability of the catalysts. They used a bismuth–tin alloy of the type Bi0.1Sn as a precatalyst, which was prepared by co-evaporating Sn and Bi onto polytetrafluoroethylene (PTFE) substrates. Then they used his alloy as a working electrode in the electrochemical reduction of CO2 and found that SnO2 was formed on the catalyst.

The resulting active BiSn: SnO_2 surfaces turned out to be stable during extended operation (over 100 days) and allow for the efficient production of formate. The researchers propose that the stabilized active sites provide an optimized binding energy for a key intermediate in the creation of formate, *OCHO. The improved catalyst provides a Faradaic efficiency of 95 %.

Source: Nature Communication 2021 https://doi.org/10.1038/s41467-021-25573-9

- **Tokyo Tech Scientists Develop Catalyst to Convert Ammonia to H_2**



Recently, scientists from Tokyo Institute of Technology (Tokyo Tech) have developed a calcium imide (CaNH)-supported Ni catalyst that can decompose ammonia at temperatures 100°C lower than what conventional Ni catalysts require. In a recent study published in *ACS Catalysts*, a team of researchers from Tokyo Tech led by Associate Professor Masaaki Kitano described a solution to overcome the issues faced by Ni-based catalysts. The team discovered that the presence of CaNH resulted in the formation of NH_2- vacancies (VNH) on the surface of the catalyst. These active species resulted in the improved catalytic performance of the Ni/CaNH at reaction temperatures that were 100°C lower than those necessary for the functioning of Ni-based catalysts. The researchers also developed computational models and conducted isotope-labeling to understand what is happening on the catalyst surface. The calculations proposed a Mars–van Krevelen mechanism that involved adsorption of ammonia onto the CaNH surface, its activation at the NH_2- vacancy sites,

formation of nitrogen and hydrogen gas, and finally regeneration of vacancy sites promoted by Ni nanoparticles. The highly active and durable Ni/CaNH catalyst can be successfully deployed for the generation of hydrogen gas from ammonia. Also, the insight into the mechanism of catalysis provided by this study can be utilized to develop a new generation of catalysts. Source: H2 Tech, 9/2021.

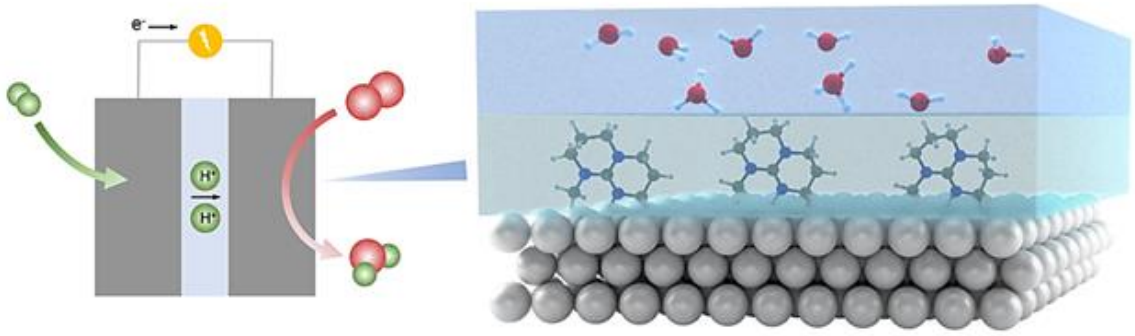
- **Spanish Firms Develop Electrolysis-Free Green Hydrogen Technology**

Spanish energy companies Repsol and Enagas have developed a new technology that can produce green hydrogen through the direct use of solar energy without the need for electrolysis. The roadmap for the technology, called photoelectrocatalysis, sees it competing on cost with both green and blue hydrogen by 2030, according to Repsol. "The device receives direct solar radiation and, using photoactive material, generates electrical charges that cause the separation," says Maria Dolores Hernandez, co-leader of the project, which Repsol began researching in 2021. This resulting simplification of infrastructure and equipment will reduce the capital cost of the technology relative to electrolysis-based systems. The technology is more efficient than electrolysis as it avoids the losses associated with the transport and transformation of electricity. And it has the advantage of not being subject to fluctuations in electricity prices—a key component of green hydrogen production costs. The next step will be the launch of a demonstration plant in 2024 at Repsol's Puertollano industrial complex with a production target of 100kg/d of green hydrogen. Phase two is the installation of an industrial-scale plant in 2028 at the same location with a capacity of 10t/d. Repsol and Enagas have so far invested €8mn ($9.4mn) in the project, which has also received support from the European Commission's Innovation Fund. The two companies have created a joint venture into which they plan to incorporate other investment partners with the aim of accelerating the industrial roll-out of the technology. Source: Hydrogen Economist, 8/25/2021.

- **Making Catalytic Surfaces More Active to Help Decarbonize Fuels and Chemicals**

A new production process yielded catalysts that increased the efficiency of the chemical reactions by fivefold, potentially enabling useful new processes in biochemistry, organic chemistry, environmental chemistry, and electrochemistry. The findings are described in the journal *Nature Catalysis*, in a paper by Yang Shao-Horn, an MIT professor. The process involves adding a layer of what's called an ionic liquid in between a gold or platinum catalyst and a chemical feedstock. Catalysts produced with this method could potentially enable much more efficient conversion of hydrogen fuel to power devices such as fuel cells, or more efficient.
In this research, the team added a thin layer in between the catalyst and the electrolyte, the active material that participates in the chemical reaction. The ionic liquid layer, they found, regulates the activity of protons that help to increase the rate of the chemical reactions taking

place on the interface. Because there is a great variety of such ionic liquids to choose from, it's possible to "tune" proton activity and the reaction rates to match the energetics needed for processes involving proton transfer, which can be used to make fuels and chemicals through reactions with oxygen.
conversion of carbon dioxide into fuels. At present, oxygen reduction reaction that powers such fuel cells is limited by its inefficiency.



This diagram illustrates the new process for enhancing reaction rates in an electrocatalytic process. The catalyst layer, made of gold or platinum, is shown as gray spheres at the bottom, and the material to be catalyzed is shown as the red spheres at the top. Adding a layer of ionic liquid in between, shown as the hexagonal lattices, can increase reaction rates by fivefold. At left, a detail of how oxygen (red) and hydrogen (green) can combine to form water at an enhanced rate through this process. Image Credit: Courtesy of the researchers, edited by MIT News

Source: Massachusetts Institute of Technology (MIT), 9/7/2021.

Catalysis Research out of India

1. Anjali Patel and J. Patel, Cesium salt of iron substituted phosphomolybdate: Synthesis, characterization, room temperature hydrogenation of styrene and its mechanistic evaluation" **Molecular Catalysis** 513,111827, **2021**
2. D. Pithadia and Anjali Patel, "Conversion of bioplatform molecule, succinic acid to value-added products via esterification over 12-tungstosilicic acid anchored to MCM-22" Biomass **and Bioenergy** 151, 106178, **2021**
3. Anjali Patel, R. Sadasivan and J. Patel, " Chiral Phosphotungstate Functionalized with (S)-1-Phenylethylamine: Synthesis, Characterization, and Asymmetric Epoxidation of Styrene" **Inorganic Chemistry** 60, 15, 10979, **2021**
4. Apoorv P Parikh, Vihang P Parikh, Parimal A Parikh, "Comparison of Catalyst Life and Performance employing the Conversion Capacity Concept" 2021 **Int. J. Chem. Kin.** Doi: 10.1002/kin.21523
5. AK Jana, M Chakraborty, PA Parikh, "treating crude oil storage tank sludge by catalytic process and recovering valuable hydrocarbons" **Chemical Papers,** 75 2021,4285-4296.
6. Enxin Cui, Haibin Li, Chen Zhang, Dan Qiao, Manoj B Gawande, Chen-Ho Tung, Yifeng Wang, "An Advanced Plasmonic Photocatalyst Containing Silver (0) Single Atoms for Selective Borylation of Aryl Iodides" **Applied Catalysis B: Environmental,** 2021, 120674.

7. Murugan Subaramanian, Palmurukan M Ramar, Ganesan Sivakumar, Ravishankar G Kadam, Martin Petr, Radek Zboril, Manoj B Gawande, Ekambaram Balaraman, "Convenient and Reusable Manganese-Based Nanocatalyst for Amination of Alcohols" **ChemCatChem, 2021** https://doi.org/10.1002/cctc.202100635
8. Rakesh Kumar Sharma, Sneha Yadav, Sriparna Dutta, H. B. Kale, I. R. Warkad, Radek Zbořil, R. S. Varma* and Manoj B. Gawande," Silver nanomaterials: synthesis and (electro/photo) catalytic applications" **Chemical Society Reviews, 2021**, DOI: 10.1039/d0cs00912a

Upcoming Symposium/ Conferences/Seminars

1. September 27-28, 2021- International Conference on Heterogeneous Catalytic Materials and Processes, Istanbul, Turkey
2. REFINING INDIA 2021 October 20-21, 2021 | Online Event https://refiningindia.com
3. CHEMCON-2021, December 27 - 30, 2021, Bhubaneswar, India https://www.chemcon2021.com
4. 6thInternational Conference on New Energy and Future Energy System (NEFES 2021), November 1-4, 2021. Xi'an, China http://www.intergridconf.org
5. XVth International Symposium on Environment, Catalysis and Process Engineering (ECGP-2021) November 23-25, 2021 Marrakech, Morocco. https://ecgpmorocco.com

Announcements

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

Name	Achievement
Dr. Manoj B. Gawande Associate Professor, Institute of Chemical Technology, Mumbai-Marathwada Campus, Jalna, MH, INDIA 	Elected as a Life Fellow of Indian Chemical Society (ICS) July 2021
	Awarded with the prestigious RSC Research Fund Grant for the year 2021 by the Royal Society of Chemistry (RSC), Cambridge, UK.

Quote of the Month

"Be the servant while leading. Be unselfish. Have infinite patience, and success is yours."
— Swami Vivekananda

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