April 15, 2021

CSI Communication

Monthly Newsletter of Catalysis Society of India

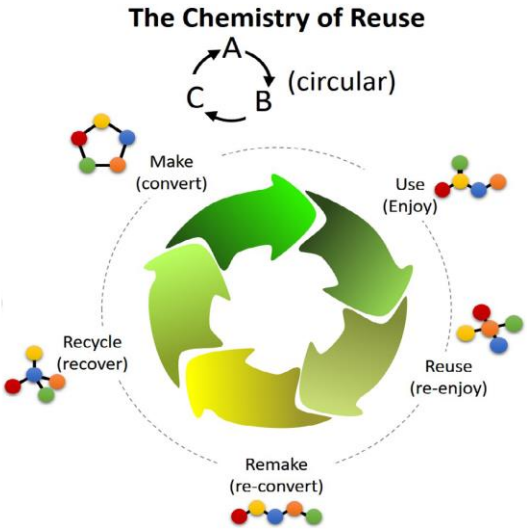
Circulated to all CSI Members

Catalysis & Circular Economy

Circularity in chemicals, as part of the general concept of circular economy is a topic of increasing industrial relevance for chemical industry, and as consequence also for manufacturers of catalysts, because catalysis plays a crucial role in the development of many new routes to enable circularity.

A circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems



Angew. Chem. Int. Ed. 2021, 60, 2–7

Commercial & Policies

- **Clariant, India Glycols form JV for Renewable Ethylene-oxide Derivatives**

Clariant AG and India Glycols Limited (IGL), a leading company in the manufacturing of green technology-based chemicals, announced a strategic partnership to establish a 51-49% joint venture in renewable ethylene oxide (EO) derivatives.

Under the terms of the proposed agreement, India Glycols will contribute its renewable Bio-EO Derivative business to the joint venture, which includes a multipurpose production facility including an alkoxylation plant located in Kashipur, Uttarakhand (India). In return, Clariant will contribute its local Industrial and Consumer Specialties business in India, Sri Lanka, Bangladesh and Nepal, held by Clariant India Ltd., as well as a net cash payment to attain a 51% stake and thus majority ownership.

"This opportunity to partner with India Glycols is an important step in Clariant's journey to strengthen our core portfolio, while adding value with sustainability. It enhances the capacity of our Industrial and Consumer Specialties business in India and beyond, whereas the access to

renewable Ethylene Oxide broadens our global offering to customers and this makes Clariant a leader in "green" Ethylene Oxide Derivatives", said Conrad Keijzer, CEO of Clariant
Source: https://kemicalinfo.com/clariant-india-glycols-form-jv-for-renewable-ethylene-oxide-derivatives/.

- **Praj wins order from HPCL to set up biogas plant in UP**

Industrial biotechnology company Praj Industries on Tuesday said it has bagged an order from Hindustan Petroleum Corporation (HPCL) for setting up a compressed biogas (CBG) project at Badaun in Uttar Pradesh. The project with a capacity to process 35,000 tonnes of rice straw as feedstock to generate 5,250 tonnes of CBG annually will also generate 23,000 tonnes high-quality solid bio-manure and 3,50,000 tonnes of liquid bio-manure for Fert irrigation, Praj said in a statement. This project has a potential to save up to 15,000 tonne of CO_2 emissions per year and will be completed and commissioned within 12 months. Source:https://energy.economictimes.indiatimes.com/news/oil-and-gas/biotechnology-company-wins-order-from-hpcl-to-set-up-biogas-plant-in-up/81422734

- **Technip Energies Awarded a Significant Contract by Indian Oil Corporation to Upgrade the Barauni Refinery in India**

Technip Energies has been awarded a significant Engineering, Procurement, Construction and Commissioning (EPCC) contract by Indian Oil Corporation Limited (IOCL) for its BR9 Expansion Project in Barauni, Bihar, in the Eastern part of India. This EPCC contract covers the installation of a new Once-through Hydrocracker Unit (OHCU) of 1 million metric tonnes per annum (MMTPA) capacity, a Fuel Gas Treatment Unit (FGTU) and the associated facilities. The OHCU, in combination with downstream refinery units, will enable production of BS VI Grade fuels – similar to Euro VI Grade fuels – and petrochemicals. The BR9 Expansion project shall enhance refinery capacity from 6 MMTPA to 9 MMTPA and will add petrochemicals such as Polypropylene into Barauni refinery's product portfolio. Source: Technip Energies, 4/6/2021.

- **Indian Oil Inks Pact with Dorf Ketal Chemicals**

Indian Oil Corporation Ltd. (IOCL) announced its partnership with Dorf Ketal Chemicals India Pvt Ltd, wherein IOCL's Patented Drag Reducing Additive (DRA) technology will be utilized to manufacture the product at Dorf Ketal's manufacturing unit at Dahej, Gujarat, India. The Licensing and Supply Agreement (LSA) covers supply of DRA not only for usage in IOCL's crude and finished product pipelines, but also to other companies in India and abroad. Mr. Sudhir Menon (CMD) Dorf Ketal said, 'we see a major synergy through this significant partnership

between IOCL R&D and Dorf Ketal and with this commercialization of DRA technology will achieve market agility'. IOCL is a diversified, integrated energy major with presence in almost all the streams of oil, gas, petrochemicals, alternative energy sources, is the largest refiner and pipeline operator in India. Source: ET Auto, 3/24/ 2021.

- **SABIC to Launch Recycled Ocean Bound Plastics Portfolio**

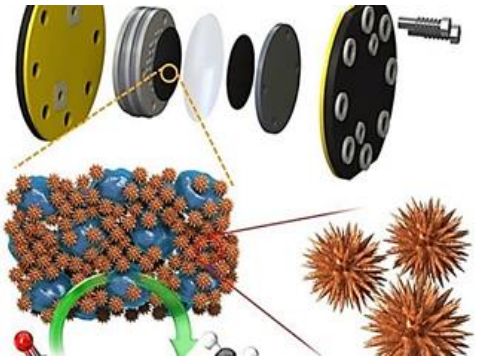
SABIC announced the launch of a new recycled material made from ocean bound plastic which has been recovered from ocean-feeding waterways and inland areas within a 50 kilometer radius of the ocean. The ocean bound material is mechanically recycled and converted into components for new consumer goods and electronics applications, such as TV remote controls and electronic razors. It has the potential to also be used in other industries in the future, such as automotive. Part of SABIC'S TRUCIRCLE™ portfolio and services, the new recycled material is a XENOY™ PC/PET compound comprising of a minimum 10% recycled ocean bound PET blended with polycarbonate. The new material, part of SABIC's engineering thermoplastics (ETP) product range, offers potentially significant reductions in carbon footprint of up to 7% and energy consumption of up to 11% compared to its virgin grade. Source: SABIC, 4/1/2021.

Scientific

- **Engineers Unveil Large Scale CO_2 Conversion System**

Engineers in South Korea have developed a large-scale electrochemical CO_2 conversion system, as well as a scalable method for producing the catalyst.

The new sea urchin-shaped nano copper catalyst electrode is able to convert CO_2 into large quantities of ethylene, a hydrocarbon used to make plastics, synthetic rubber and common materials. The copper catalyst features an array of irregular spines long and short, thin and thick recalling the appearance of a sea urchin. The catalyst's unique shape helps it convert CO_2 with greater efficiency while using less electricity. Equally as important, production of the stackable catalyst can be easily scaled.

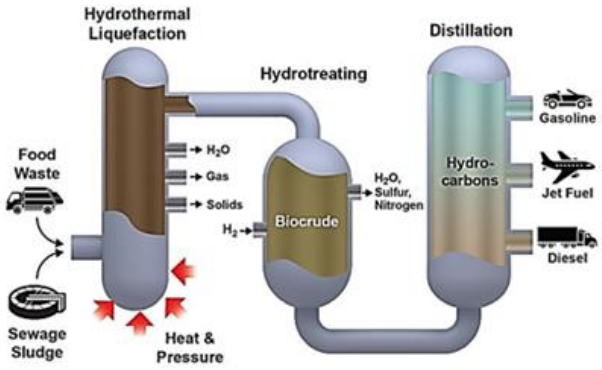


Scientists have developed a stackable copper catalyst that efficiently converts CO2 into ethylene and ethanol. Photo by Korea Institute of Science and Technology

Researchers were able to boost the efficiency of the catalyst by adding copper hydroxide and copper oxide, a pair of alkaline substances. Real-time imaging instruments, including X-ray absorption spectroscopy, revealed the benefits of the catalyst's unique chemical properties during the reactive process. "Our findings provide a new strategy for converting CO_2 to C_2H_4, which is expected to accelerate the commercialization of high-value chemical production through electrochemical CO_2 reduction," the researchers wrote in their paper. The scientists said they plan to scale their technology in follow up tests, with the hopes of preparing the catalyst for commercialization. Source: United Press International (UPI), 4/7/2021.

▪ Biocrude Passes the 2,000-hour Catalyst Stability Test

A large-scale demonstration converting biocrude to renewable diesel fuel has passed a significant test, operating for more than 2,000 hours continuously without losing effectiveness. Scientists and engineers led by the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) conducted the research to show that the process is robust enough to handle many kinds of raw material without failing.

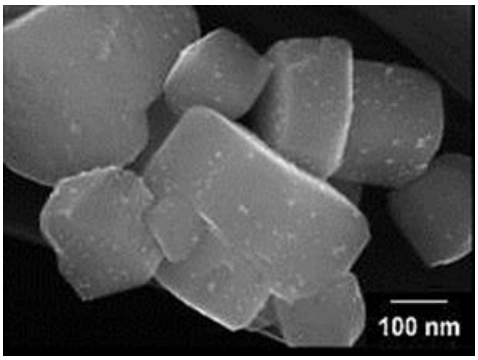


Wet wastes from sewage treatment and discarded food can provide the raw materials for an innovative process called hydrothermal liquefaction, which converts and concentrates carbon-containing molecules into a liquid biocrude. This biocrude then undergoes a hydrotreating process to produce bio-derived fuels for transportation. (Illustration by Michael Perkins | Pacific Northwest National Laboratory)

For 83 days, reactor technician Miki Santosa and supervisor Senthil Subramaniam fed a constant flow of biocrude into carefully honed and highly controlled reactor conditions. The hydrotreating process introduces hydrogen into a catalytic process that removes sulfur and nitrogen contaminants found in biocrude, producing a combustible end-product of long-chain alkanes, the desirable fuel used in vehicle engines. Chemist Marie Swita analyzed the biofuel product to ensure it met standards that would make it vehicle ready. The purpose of this project was to show that the commercially available catalyst could stand up to the thousands of hours of continuous processing that would be necessary to make biofuels a realistic contributor to reducing the world's carbon footprint. The next steps for the research team include gathering more sources of biocrude from various waste streams and analysing the biofuel output for quality. Source: Pacific Northwest National Laboratory (PNNL), 3/25/2021.

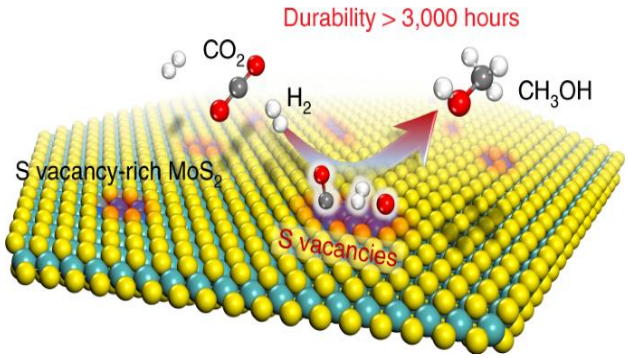
▪ Simple, Cost-Effective Solution for Splitting Water into Hydrogen and Oxygen

Developing a photocatalyst that can efficiently make use of visible light, which forms a huge part of solar energy, in the water decomposition reaction is crucial. As part of this study, carried out under the guidance of the Research Initiative for Supra-Materials of Shinshu University, the co-catalyst fine particles were discovered to be highly dispersed on the surface of the single crystal fine particles of $BaTaO_2N$ produced by the flux technique when the photo deposition method and the impregnation reduction method were employed consecutively.



Thus, the efficiency of the hydrogenation reaction with the $BaTaO_2N$ photocatalyst was enhanced by almost 100 times when compared to the traditional one. There has also been an improvement in the efficiency of the two-step excitation type (Z-scheme type) water decomposition reaction together with the oxygen generation photocatalyst. It was verified that the use of $BaTaO_2N$, produced using a suitable flux and with a low density of defects, is also essential for promoting a highly dispersed Pt co-catalyst. This study drastically improved the activity of the $BaTaO_2N$ photocatalyst and elucidated its mechanism. Source: AZoMaterials, 3/31/2021.

- **Sulfur Vacancy Rich MoS_2 as a Catalyst for the Hydrogenation of CO_2 to Methanol**



The low-temperature hydrogenation of CO_2 to methanol is of great significance for the recycling of this greenhouse gas to valuable products, however, it remains a great challenge due to the trade-off between catalytic activity and selectivity. Here, we report that CO_2 can dissociate at sulfur vacancies in MoS_2 nanosheets to yield surface-bound CO and O at room temperature, thus enabling a highly efficient low-temperature hydrogenation of CO_2 to methanol. Multiple in situ spectroscopic and microscopic characterizations combined with theoretical calculations demonstrated that in-plane sulfur vacancies drive the selective hydrogenation of CO_2 to methanol by inhibiting deep hydrogenolysis to methane, whereas edge vacancies facilitate excessive hydrogenation to methane. At 180 °C, the catalyst achieved a 94.3% methanol selectivity at a CO_2 conversion of 12.5% over the in-plane sulfur vacancy-rich MoS_2 nanosheets, which notably surpasses those of previously reported catalysts. This catalyst exhibited high stability for over 3,000 hours without any deactivation, rendering it a promising candidate for industrial application. Source : Nature Catalysis, volume 4, pages242–250(2021)

Catalysis Research out of India

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- Nirmala Thorat, Sujata Borade, Ranjana Varma, Asha Yadav, Suraj Gupta, Rohan Fernandes, Pradip Sarawade, BM Bhanage, Nainesh Patel "High surface area Nanoflakes of P-gC3N4 photocatalyst loaded with Ag nanoparticle with intraplanar and interplanar charge separation for environmental remediation" **Journal of Photochemistry and Photobiology A: Chemistry,** Volume 408, 1 March 2021, 113098

Quote of the Month

"Purity, Patience, and Perseverance are the three essentials to success, and above all: Love." Swami Vivekananda

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