Catalysis for a circular economy toward a sustainable society

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The circular economy is vital for a sustainable society. It provides an alternative and greener economic model, considering the limited resources of fossil fuels and their adverse environmental effects. Developing viable technologies with low waste generation and recycling/valorizing the generated waste are the key features of a circular economy. The ultimate success of a circular economy lies in "today's waste is tomorrow's raw material", thus reducing our dependence on fossil fuels and new resources as well as controlling the carbon footprint. India alone produces a huge amount of waste each year from various sectors, including plastic, agriculture, food processing, chemical industries, etc. Improper waste management can lead to environmental pollution and cause a serious threat to the ecosystem, which is already being witnessed in all places of the world. Thus, the concept of "waste-to-valorization" has gained global attention in recent times.

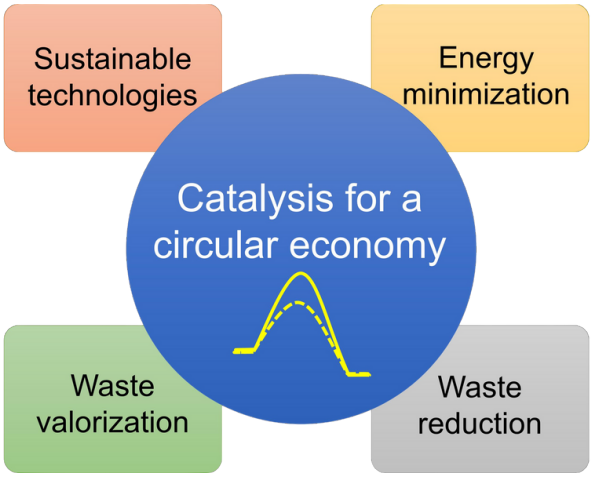

Figure-1: Pivotal Areas of Catalysis for Circular Economy

Catalysis is a pivotal research area of modern science and technology. It is a part of our daily lives to facilitate activities smoothly. Catalysis can be classified as homogeneous and heterogeneous, and the name itself reflects the same phase of reactants/catalysts (liquids) and different phases of catalysts (solids) and reactants (gases or liquids), respectively. Biocatalysis, also known as enzymatic catalysis, uses enzymes as catalysts for chemical reactions. Amongst, heterogeneous solid catalysts are of significant interest to chemical, pharma, and plastic industries because of their salient features, such as easy synthesis, high chemical/ thermal stability, efficient recovery/ reusability, and lower waste generation. The applications of catalysis can be found in most of the energy and environmental sectors, including fossil fuel processing, air/water pollution control, drug design, CO_2 conversion, sensing, hydrogen production/utilization, and renewable energy utilization. Catalysis is an essential step in more than 80% of chemical synthesis processes. Thus, it significantly contributes to the GDP growth of several countries. The uniqueness of any catalyst is that it can speed up the process without being consumed with a minimal amount of energy utilization and low waste generation. Moreover, catalysis provides promising approaches for transforming waste materials, such as plastic, biomass, and CO_2, into raw materials, new products, and fuels/chemicals. These prevalent advantages enabled catalysis as an essential technology to achieve a truly circular economy.

The purpose of any research is to develop new technologies with minimal energy consumption to meet the increasing global demand without compromising the sustainability of future generations. This is the key motive of the research fraternity of the IITH, aiming at cutting-edge research to provide fruitful solutions for various energy and environmental-related issues. Indeed, catalysis has become an indispensable research area in many departments at IITH, including Chemistry, Chemical Engineering, Materials Science, Biotechnology, Climate Change, and Civil Engineering. Thus, catalysis provides a vibrant platform at IITH to foster inter- and trans-disciplinary collaborations among the different departments from fundamental catalysis science to generate innovative technology transfer, in line with the circular economy goals. The scientific community of catalysis at IITH possesses vast expertise and experience in all aspects of catalysis, including the rational design of novel catalysts, in-depth understanding of the catalysts at the molecular and nanoscale, advancing the existing methodologies, developing new catalytic processes, process optimization, and scalable reactor design with the ultimate goal of providing feasible opportunities for circular economy fit for a greener future.

Over the last ten years, IITH has strategically expanded its transformative journey from basic science to applied research in various fields and witnessed groundbreaking contributions in catalysis. The institute encourages research scholars and faculties working in catalysis research to come up with innovative strategies focusing on four pivotal areas to achieve a truly circular economy **(Figure-1):** (i) developing sustainable technologies using less hazardous materials and renewable energy, (ii) new chemical and plastic processing methods with minimal utilization of energy and easily recyclable end products, (iii) advancing the catalytic processes of chemical production with low waste generation, and (iv) efficient catalytic processes for the valorization of waste feedstock (plastic, biomass, and CO_2) into monomers, new materials, chemical building blocks, and biofuels. The institute aims to continue its quest in the catalysis field for the betterment of the world.

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