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Nanotechnology and Catalysis Process

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Introduction

Through the technique of catalysis, a chemical reaction can be hastened without the catalyst being consumed. In order to improve the catalytic process, nanomaterial-based catalysts are typically heterogeneous catalysts that have been divided into metal nanoparticles. High surface area metal nanoparticles can boost catalytic activity. Catalysts made of nanoparticles can be easily recycled and separated. They are mainly employed in mild environments to stop the nanoparticles from disintegrating. The high surface area to volume ratio of nanotechnology, which enables the catalysts at the nanoscale to interact with the reactants more effectively due to the availability of a large number of atoms on surfaces, has a significant impact on enhancing the catalytic activity [1].

Description

For the hydrogenolysis of C-Cl bonds, such as polychlorinated biphenyls, nanoparticle catalysts are effective. Hydrogenation of halogenated aromatic amines is another reaction that is crucial for the production of diesel fuel, herbicides, and insecticides. In organic chemistry, the aromatic ring is labelled specifically for use in investigations involving the kinetic isotope effect by hydrogenation of a C-Cl bond with deuterium. These nanoparticles promoted the hydrogenation of benzene to cyclohexane as well as the dehalogenation of aromatic compounds. The hydrogenation of cinnamaldehyde and citronellal can also be done using nanoparticles that have been stabilised by polymers [2].

The use of nanomaterials as catalysts for various homogeneous and heterogeneous catalysis applications constitutes the fast expanding subject of nanocatalysis. The use of nanoparticles of metals, semiconductors, oxides, and other substances has been common in heterogeneous catalysis, one of the earliest industrial applications of nanoscience [3].

The majority of commercial catalysts are still made by "mixing, shaking, and baking" mixtures of multiple components; their nanoscale structures are poorly controlled, and the relationships between synthesis-structure-performance are poorly understood, despite the significant contributions surface science studies have made to our fundamental understanding of catalysis. Even characterisation of the numerous active sites of the majority of commercial catalysts becomes challenging because of their complicated physico-chemical characteristics at the nanoscale scale [4].

Due to their potent photocatalytic activity, titanium dioxide nanoparticles are utilised in water treatment. A group of semiconductor materials with narrower band-gaps includes titanium dioxide. It can excite an electron from the valence band to the conduction band and absorb visible light. The electron causes a hole to form in the valence band and gives the conduction band a negative charge. It is possible for redox reactions to occur in liquid solutions. Due to the antibacterial qualities of silver nanoparticles, the possibility of covering polyurethane foam with them to avoid bacterial contamination in water filters has also been investigated [5].

Conclusion

Different materials can be used to create the nanostructures needed for electrocatalysis. Electrocatalysts can achieve strong physical-chemical stability, high activity, good conductivity, and low cost by utilising nanostructured materials. Transition metals are frequently used to create metallic nanostructures (mostly iron, cobalt, nickel, palladium, platinum). Because each metal has unique properties, multi-metal nanostructures exhibit new properties. The benefits include an increase in activity, selectivity, stability, and cost savings. Metals can be mixed in a variety of ways, such as in the core-shell bimetallic structure, where the most active metal—typically a noble metal—forms the shell and the least expensive metal serves as the core.

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