catalysts

Editorial

Nanotechnology in Catalysis, 2nd Edition

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Catalysis is considered a central field in nanoscience and nanotechnology, given that the use of nanoscale structures has played a central role in the development of nanomaterials such as catalysts (nanocatalysts) for decades. A decrease in particle size causes a large number of atoms to become available as active sites on the surface of particles, hence generating highly active catalysts—a phenomenon that has prompted the initial undertaking of these studies. Very generally, nanocatalysts can be classified into three types: (a) metal nanoparticles/metal oxides; (b) exfoliated clays used as supports or modified as active sites for nanocatalysis; and (c) carbon-based nanomaterials that include graphic materials (i.e., fullerenes and carbon nanotubes) and graphenes, which can be used as support for metals or directly used as nanocatalysts if they are chemically modified on their surface. Moreover, the use of enzymes on various forms of nanomaterials is also a case study of its own, and the use of metal oxides as semiconductors is widespread in the field of nanophotocatalysis.

In essence, it can be said that the central aim of nanocatalysis comprises the following: (1) controllable synthesis and the precise characterization of nanocatalysts; (2) understanding the interplay between the chemical composition, size, morphology, and oxidation state of nanocatalysts and their catalytic performance; (3) the rational control of a catalytic reaction by modifying the active site on a nanocatalyst; and (4) the enhancement of the stability and the recyclability of nanocatalysts.

With these objectives as a guide, materials engineering provides the necessary technology to exercise the required control over the size and morphology of nanocatalysts, taking advantage of their unique properties in so doing. In this regard, the development of new synthesis methods such as colloidal methods, precipitation deposition methods, and organometallic chemistry have led to uniform distributions of nanoparticles of very narrow metal particle sizes ranging less than 5–10 nm, which has made it possible to study the relationship of size to the catalytic characteristics of nanocatalysts in a series of heterogeneous reactions. Moreover, the catalytic activity, selectivity, and deactivation of nanocatalysts have been shown to depend largely on the synthesis method used, with some studies relating not only the size but also the shape of the nanoparticles to catalytic activity.

Finally, if we examine recent trends in the last two decades, we can see that they have been focused on improving product selectivity, low energy consumption, and high effectiveness in reaction performance. However, the types of reactions that occur have been shown to be very diverse, even in industrially important sectors such as those centered on obtaining biofuels and/or reduction reactions including those that occur in proton-exchange membrane fuel cells, among others. Additionally, there is a growing trend to design greener and safer processes, with greater control over reactivity.

Nanocatalysis has unequivocally seen a great rise in popularity in the past two decades. A simple search in any scientific search engine (SCIFinder, Web of Science, Google Scholar, etc.) with the key word "nanocatalysis" will clearly show the exponential growth in scientific publications that has occurred in the last 25 years. In particular, this Special Issue, called "Nanotechnology in Catalysis II", will intend to cover various aspects ranging from fundamental investigations to more application-driven research, with the aim of providing

Citation: Sabater, M.J. Nanotechnology in Catalysis, 2nd Edition. *Catalysts* **2024**, *14*, 331. https://doi.org/10.3390/catal14050331

Received: 9 April 2024
Accepted: 17 April 2024
Published: 17 May 2024

the audience with a broad range of topics in addition to an understanding of the depth of the selected topics by highlighting specific illustrative examples.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.