

Editorial

Metal Catalysts Recycling and Heterogeneous/Homogeneous Catalysis

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Heterogeneous metal catalysts rather than homogeneous ones are recommended for industrial applications after considering their performance in activity, separation, and recycling [1]. The recycling of metal catalysts is important from economic and environmental points of view. When supported and bulk metal catalysts are used in liquid-phase organic reactions, there is a possibility that active metal species are leaching away into the liquid phases [2,3]. The metal leaching would make it difficult for the catalysts to maintain their desired initial performance for repeated batch reactions and during continuous ones. The metal leaching would also cause some undesired contamination of products by the metal species dissolved in the reaction mixture, and the separation of the metal contaminants would be required to purify the products. Therefore, various novel methods have been proposed so far to immobilize/stabilize the active metal species and to separate/collect/reuse the dissolved metal species [4]. In addition, knowledge on the heterogeneous and homogeneous natures of organic reactions using heterogeneous catalysts is important to discuss their reaction mechanisms and catalytically working active species.

This Special Issue deals with the above-mentioned subject and contains interesting original and review articles on such organic synthetic reactions as CO₂ conversion, biomass conversion, selective hydrogenation, C-C coupling, and reductive amination reactions. The design of magnetic catalysts is one of the most efficient strategies for the synthesis of durable and reusable catalysts, which can be easily recovered by magnetic forces and recycled. Shokouhimehr [5] reviews the design, preparation, recyclability of various nanostructured magnetic catalysts for, in particular, the reduction of nitro aromatic

compounds. Cheng *et al.* [6] report the promotional effect of SnO_x on the catalytic performance of Ru/Al₂O₃ catalysts in the selective hydrogenation of *m*-dinitrobenzene to *m*-nitroaniline. They explain that electron transfer between active Ru species and SnO_x additives modifies the adsorption of the nitro group of the substrate, influencing the product selectivity, and also improves the stability of the catalysts. Li *et al.* [7] report the catalytic performance of phosphorus-doped Ni/Al₂O₃ catalysts for the hydrogenolysis of a biomass-derived compound of glycerol. These are recyclable and selective catalysts for the production of 1, 2-propanediol. The relative amounts of Ni and NiO species, which depend on the presence of a phosphorous dopant, are significant in determining the catalytic performance; a slight loss in activity occurs due to the deposition of carbonaceous materials on the catalyst surface. Ohtaka *et al.* [8] report that linear polystyrene-stabilized Pd nanoparticles are active and recyclable catalysts for a series of C-C coupling reactions in water. In these reactions, some Pd species leach and the dissolved Pd species are stabilized in the presence of tetrabutylammonium bromide and may participate in the catalytic processes. These Pd species may redeposit onto the polystyrene support and are recyclable even though a slight increase in the size of supported Pd particles occurs during the reaction. Ekbote *et al.* [9] report a polymer supported triphenylphosphine-palladium acetate complex catalyst for the indirect reductive amination of aldehydes. The catalyst is highly selective to the formation of the desired products and can be recovered and recycled without loss in the activity. Liu *et al.* [10] report a catalyst containing guanidine hydrochloride and ZnI₂ for the environmentally benign synthesis of cyclic carbonates under mild reaction conditions. The catalyst gives a high yield of propylene carbonate and can be recycled, which is versatile for the cycloaddition of CO₂ to other epoxides.

We would like to thank all authors who contributed to this Special Issue, as they have reported interesting results showing current progress in the design, preparation, and application of active, stable, and reusable heterogeneous catalysts. We are grateful to Professor Keith Hohn, Editor-in-Chief, for providing an honorable choice of guest editors and to Mary Fan and her staff in the *Catalysts* editorial office for their kind and patient cooperation with us.

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