

Editorial

# Special Issue “Metal Nanoparticles as Catalysts for Green Applications”

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This Special Issue of *Processes* on “Metal Nanoparticles as Catalysts for Green Applications” collects recent works of researchers on metal nanoparticles as catalysts for green applications. All applications that deal with designing chemical products and processes that generate and use less (or preferably no) hazardous substances, by applying the principles of green chemistry, were welcome for this Special Issue. Despite the interdisciplinary nature of the different applications involved, ranging from pure chemistry to material science, from chemical engineering to physical chemistry, in this Special Issue there are common characteristics connecting the areas together, and they can be described by two words: sustainability and catalysis. We are convinced that a strategic goal of our world is the development of a sustainable society, which is one that “meets the needs of the current generation without sacrificing the ability to meet the needs of future generations” [1]. Catalysis, which represents probably the oldest application of nanotechnology, has a key role on the road to sustainability. Therefore, we are proud to contribute to the knowledge and deepening of these two concepts.

The journal *Processes* covers a wide range of materials related topics including the formulation of catalysts, process technology, and applications. Such diversity is reflected in this Special Issue through eight contributions.

We believe that the advances described by the different investigations have appreciably helped with reaching toward the target of meaningful sustainability. In fact, most of the papers deal with reactions for biomass valorization, covering a wide range of applications, which highlights the versatility of the subject matter. For instance, guaiacol has been upgraded by hydrodeoxygenation [2], glucose by aqueous phase reforming [3], 5-hydroxymethylfurfural (HMF) by selective oxidation [4], and ethanol by steam reforming [5].

The biomasses have been used also by themselves for the formulation of innovative catalysts, as in the case of green leaves for the synthesis of iron particles [6].

Another issue that has been faced up to is hydrogen production [5,7] since it is considered the future energy vector, and energy is a top concept in a sustainable vision.

On the topic of biomasses valorization, the paper by Nga Tran et al. [2] investigates the hydrodeoxygenation of guaiacol over Pd-Co and Pd-Fe catalysts supported on Al-MCM-41, with a focus on stability and regeneration, which are of great importance in bio-oil upgrading. The authors found that the bimetallic Pd-Co and Pd-Fe showed a higher yield and stability than monometallic Co and Fe, since the coke formation was reduced. In particular, the Pd-Fe catalyst presented even a higher stability and regeneration ability than the Pd-Co catalyst.

In the paper by Taghavi et al. [3], glucose was upgraded to valuable biochemicals such as fructose, levulinic acid, ethanol, and hydroxyacetone by aqueous phase transformation. Different MCM-41-supported metallic and bimetallic (Co, Co-Fe, Co-Mn, Co-Mo) catalysts, as well as different catalysts under different reaction conditions, were synthesized and characterized by numerous techniques. The authors demonstrated that reaction conditions,



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bimetals synergetic effects, and the amount and strength of catalyst acid sites were the key factors affecting the catalytic activity and biochemical selectivity. Best results (i.e., the highest carbon balance and the desired product selectivity in mild reaction condition) were obtained using a sample with weak acid sites.

HMF to 2,5-furandicarboxylic acid as a model reaction for the conversion of renewable molecules was investigated by Bonincontro et al. [4]. Attention was focused on innovative nanofibrous membranes based on Pd-Au catalysts immobilized via electrospinning onto different polymers. The type of polymer and the method used to insert the active phases in the membrane were demonstrated to have a significant effect on catalytic performance. In particular, the authors demonstrated that the hydrophilicity and the glass transition temperature of the polymeric component are key factors for producing active and selective materials. These results underline the promising potential of large-scale applications of electrospinning for the preparation of catalytic nanofibrous membranes to be used in processes for the conversion of renewable molecules.

In their communication, Francy et al. [6] analyzed the performances of nanoscale zero-valent iron (nZVI) particles synthesized from green leaves, which is an example of low-cost biomass. These nanoparticles proved to be effective in the remediation of chlorinated compounds and heavy metals (Pd and Ni) from contaminated soil. Thus, this is an example of the upgrading of biomasses to catalysts, which supports the goal of a circular economy.

Two papers in the Special Issue were devoted to hydrogen production, via partial oxidation of CH<sub>4</sub> [7] or ethanol steam reforming [5].

Regarding methane partial oxidation, Fakeeha et al. investigated Ni, Co, and Ni-Co catalysts supported on binary oxide ZrO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub>, which were characterized by proper techniques such as XRD, BET, TPR, TPD, TGA, SEM, and TEM. It was observed that increasing the calcination temperature and the addition of ZrO<sub>2</sub> to Al<sub>2</sub>O<sub>3</sub> enhances Ni metal-support interaction, improving the catalytic activity and sintering resistance. Furthermore, ZrO<sub>2</sub> provides higher oxygen storage capacity and stronger Lewis basicity, which was observed to contribute to coke suppression, eventually leading to a more stable catalyst.

Regarding ethanol steam reforming, which is one of the most promising ways to produce hydrogen from biomass, a collaboration between groups from Italy and Spain aimed at investigating robust, selective, and active catalysts for this reaction. Pizzolitto et al. studied nickel-ceria catalysts synthesized by two different techniques: microemulsion and precipitation. The effects of lanthanum doping were investigated too. Again, attention was focused on the stability of these samples, because coke deposition is a major issue in these systems.

The stability issue is also investigated in the paper by Nguyen et al. [8], where an iron and nickel bimetallic metal-organic framework material was studied for the Michael addition amidation of 2-aminopyridine and nitroolefins. The catalyst can be reused without a substantial reduction in catalytic activity, with 77% yield after six times of reuse.

Of course, hydrogen is not only a sustainable energy vector, but also a classic green reducing agent. In the paper by Dehghani et al. [9], hydrogen was used in the acetylene hydrogenation process over Pd-Ag supported  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> catalysts. The work presents an experimental approach to the mechanism-, kinetic-, and decay- related factors in order to predict catalyst activity and proposes a detailed reaction network.

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We kindly invite you to read this Special Issue of *Processes*, focused on the following two words: sustainability and catalysis. We believe that through catalysis, it is possible to engineer a greener world.

You can find the papers for free at [https://www.mdpi.com/journal/processes/special\\_issues/metal\\_nano\\_catal](https://www.mdpi.com/journal/processes/special_issues/metal_nano_catal).

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