

Editorial

Metal Nanoparticle Catalysis

Patricia Lara ^{1,*}  and Luis M. Martínez-Prieto ^{2,*} 

¹ Centro de Innovación en Química Avanzada (ORFEO-CINQA), Departamento de Química Inorgánica, Instituto de Investigaciones Químicas (IIQ), CSIC—Universidad de Sevilla, 41092 Sevilla, Spain

² Instituto de Tecnología Química (ITQ), Universitat Politècnica de València (UPV), Av. de los Naranjos S/N, 46022 Valencia, Spain

* Correspondence: patricia@iiq.csic.es (P.L.); luismiguel.martinez@csic.es (L.M.M.-P.)

In recent years, the catalytic use of metal nanoparticles (MNPs) has experienced a growing interest. This fact is mainly due to the special features of MNPs as catalysts, which combine the advantages of homogeneous and heterogeneous catalysis. MNPs display the characteristic high stability and recyclability/reusability of heterogeneous catalysts but with a higher activity due to their small size and large number of surface active sites. These specific properties make MNPs perfect catalysts for many catalytic processes. In this context, the incorporation of new reactions, novel catalysts and recent advances in this research area is of great interest for the scientific community.

In this Special Issue, the methods of preparation and characterization of a $\text{WO}_3 \cdot 0.33\text{H}_2\text{O}$ hierarchical microstructure (HWHMS) constituted of nanorods are described [1]. This microstructure exhibits a larger BET surface area and a narrower bandgap than separated $\text{WO}_3 \cdot 0.33\text{H}_2\text{O}$ nanorods. Essays carried out by the authors showed that the crystalline phase and the surface area of the catalyst have a remarkable influence on the photocatalytic activity. Further applications of these kinds of materials in photocatalysts, gas sensors, field-emission devices, electrochromic devices and solar-energy devices are also highlighted.

Ni- Fe_3O_4 nanoparticles as catalysts for Suzuki cross coupling reactions are also reported in this Special Issue by Siamaki et al. [2] The authors describe the preparation of these MNPs by a straightforward methodology, which implies mechanical grinding of a nickel salt, Fe_3O_4 NPs and multi-walled carbon nanotubes (MWCNTs) using a ball-mill mixer. The magnetic properties exhibited by Ni- Fe_3O_4 nanoparticles facilitate their isolation and recovery with no loss of catalytic activity, thus simplifying the purification procedure and increasing the economic value of the catalyst.

The influence of the presence of rare earth metals in Ni-based mesoporous materials for CO_2 methanation reaction at low temperature is explored in this issue by Xu and coworkers [3]. The authors describe that the addition of La, Sm, Pr, Yb modifies the electronic properties of the catalysts, increasing their surface basicity and promoting the chemisorption and activation processes.

On the other hand, Ananikov et al. report the preparation of different Pd/C catalysts for the hydrogenation of S-, O- and N-vinyl derivatives using molecular H_2 under mild reaction conditions [4]. They were able to modulate the activity and selectivity of the catalytic process by modifying the carbon support and the palladium precursor. This procedure represents a general methodology for the sustainable hydrogenation of vinyl groups.

Pleixats and coworkers describe the synthesis and characterization of water-soluble Rh NPs stabilized by PEGylated imidazolium and tris-imidazolium salts through the reduction of RhCl_3 with NaBH_4 in H_2O . These colloids were evaluated as catalysts in the hydrosilylation of internal alkynes and in the reduction of nitroaromatics compounds to yield anilines using ammonia-borane as a hydrogen source [5]. It is noteworthy to mention that in both catalytic processes, the Rh NPs were successfully recycled and reused up to five times.



Citation: Lara, P.; Martínez-Prieto, L.M. Metal Nanoparticle Catalysis. *Catalysts* **2021**, *11*, 1210. <https://doi.org/10.3390/catal11101210>

Received: 29 September 2021

Accepted: 5 October 2021

Published: 9 October 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

As has been previously mentioned, the use of MNPs in catalysis has generated a lot of interest due to the many advantages of these nanostructures over heterogeneous traditional materials. However, despite their high activity, MNPs exhibit a great variety of surface active sites, which can transform the substrates in different ways and make it difficult to control the MNP selectivity. An effective method of controlling the activity and selectivity of MNPs is the use of ancillary ligands, which, in the same way than in organometallic chemistry, transform the MNP surface modifying their electronic and steric properties and thus their catalytic performance. In this regard, *N*-heterocyclic carbenes (NHCs) have been demonstrated to be efficient stabilizing ligands, able to modify the catalytic properties of MNPs. Martínez-Prieto et al. centered their revision work on NHC-stabilized MNPs prepared by organometallic synthesis, highlighting the great versatility of NHC ligands as MNP stabilizers, as well as their influence on MNP catalysis [6].

References

1. Li, W.; Wang, T.; Huang, D.; Zheng, C.; Lai, Y.; Xiao, X.; Cai, S.; Chen, W. Hexagonal $\text{WO}_3 \cdot 0.33\text{H}_2\text{O}$ Hierarchical Microstructure with Efficient Photocatalytic Degradation Activity. *Catalysts* **2021**, *11*, 496. [[CrossRef](#)]
2. Folsom, S.K.; Ivey, D.J.; McNair, F.S.; Siamaki, A.R. Nickel- Fe_3O_4 Magnetic Nanoparticles Supported on Multiwalled Carbon Nanotubes: Effective Catalyst in Suzuki Cross Coupling Reactions. *Catalysts* **2021**, *11*, 495. [[CrossRef](#)]
3. Yang, Z.; Cui, Y.; Ge, P.; Chen, M.; Xu, L. CO_2 Methanation over Rare Earth Doped Ni-Based Mesoporous $\text{Ce}_{0.8}\text{Zr}_{0.2}\text{O}_2$ with Enhanced Low-Temperature Activity. *Catalysts* **2021**, *11*, 463. [[CrossRef](#)]
4. Mironenko, R.M.; Saybulina, E.R.; Stepanova, L.N.; Gulyaeva, T.I.; Trenikhin, M.V.; Rodygin, K.S.; Ananikov, V.P. Sustainable Hydrogenation of Vinyl Derivatives Using Pd/C Catalysts. *Catalysts* **2021**, *11*, 179. [[CrossRef](#)]
5. Fernández, G.; Pleixats, R. Rhodium Nanoparticles Stabilized by PEG-Tagged Imidazolium Salts as Recyclable Catalysts for the Hydrosilylation of Internal Alkynes and the Reduction of Nitroarenes. *Catalysts* **2020**, *10*, 1195. [[CrossRef](#)]
6. Cerezo-Navarrete, C.; Lara, P.; Martínez-Prieto, L.M. Organometallic Nanoparticles Ligated by NHCs: Synthesis, Surface Chemistry and Ligand Effects. *Catalysts* **2020**, *10*, 1144. [[CrossRef](#)]