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Biography

Catherine ESPECEL is professor at the Institute of Chemistry Materials and Natural Resources of Poitiers (IC2MP). She obtained her PhD in 1997 at the University of Poitiers in heterogeneous catalysis involving supported metallic systems, and in 1998, she did a postdoc at the French Synchrotron Laboratory (LURE-Orsay). In 2008, she was nominated Associate Professor and since 2014, she is the co-head of the SAMCAT group of IC2MP, which comprises 37 permanent staff and around 30 PhD and postdoc researchers. Her main research topics include the preparation of multimetallic catalysts notably by using surface redox reactions, with applications in fine chemistry, energy and biomass valorisation (selective hydrogenation and hydrogenolysis, catalytic reforming, selective ring opening). She has supervised or co-supervised 19 PhD students, 4 postdoc, published as co-author near 80 peer-reviewed journal articles (hindex 26), 3 patents, 3 book chapters, and given around 45 oral communications.

Surface redox reactions for tuning the surface composition of bimetallic nanoparticles and their catalytic properties: the contribution of Poitiers catalysis laboratory

Bimetallic catalysts have emerged as an important class of heterogeneous catalysts since they have played a significant role in petroleum refineries, especially in enhancing the octane number of gasoline. After this discovery, a number of bimetallic catalysts have been reported for a range of reactions including oxidation, hydrogenation, hydrogenolysis, and reforming reactions. The properties of bimetallic catalysts are significantly different from their monometallic analogues. Indeed, the modification of a monometallic catalyst by the addition of a second metal is an important approach for tailoring the electronic and geometric structures of the nanoparticles to enhance their catalytic activity and selectivity. In many cases, bimetallic nanoparticles have higher catalytic efficiencies than their monometallic counterparts, owing to strong synergy between the metals.

Nowadays, many research activities are devoted to the development of new bimetallic catalysts, because of the tremendous demand for high-performance catalysts for various practical applications. Because of the presence of a second metal component, the complexity in preparing these materials increases, and in many cases it is the method of preparation which determines the final structure, and hence properties, of these materials.

During this presentation, the preparation of various supported bimetallic systems for applications in the transformation of bio-renewable substrates and in energy will be presented, with a focus on the surface redox reactions developed in our research group since the 1990s. The preparation of bimetallic M1-M2 catalysts by surface redox reactions occurs at the surface of the monometallic M1 nanoparticles and an oxidized form of the M2 modifier and is governed by the electrochemical potential of the species implied in the reaction. This process can be direct (direct redox reaction or galvanic replacement) or may involve an intermediate reducing agent activated at the surface of M1, as H2, for reducing the oxidized form of the M2 modifier (refilling or catalytic reduction).

Keywords:

Bimetallic catalysts; surface redox reactions; galvanic replacement; refilling; catalytic reduction

References

[1] J. Barbier, Catalytica Studies Division, Advances in Catalysts Preparation, Study Number 4191 CP, 1992.
[2] F. Epron, C. Especel, G. Lafaye, P. Marécot, in Nanoparticles and Catalysis (Ed. Didier Astruc), Wiley-VCH, pp 279-302, 2008.
[3] B.K. Ly, B. Tapin, M. Aouine, P. Delichere, F. Epron, C. Pinel, C. Especel, M. Besson, ChemCatChem, 7 (2015) 2161-2178.
[4] D. Messou, L. Vivier, C. Especel, Energ. Convers. Manage., 127 (2016) 55-65.
[5] X. Di, G. Lafaye, C. Especel, F. Epron, J. Qi, C. Li, C. Liang, ChemSusChem, 12 (2019) 807-823.