GNITED MINDS
Journals

Journal of Advances in Science and Technology

Vol. VII, Issue No. XIV, August-2014, ISSN 2230-9659

SYNTHESIS AND CHARACTERIZATION OF NANOSTRUCTURED SINGLE-SITE HETEROGENEOUS CATALYSTS

AN
INTERNATIONALLY
INDEXED PEER
REVIEWED &
REFEREED JOURNAL

www.ignited.in

Journal of Advances in Science and Technology
Vol. VII, Issue No. XIV, August-2014, ISSN 2230-9659

Synthesis and Characterization of Nanostructured Single-Site Heterogeneous Catalysts

Pawan Pal[1] Dr. Arun Kumar Sathor[2] Dr. Pramod Kothari[3]

[1]Research Scholar, Jodhpur National University, Rajasthan

[2]Assistant Professor

[3]Assistant Professor

Abstract – In this paper we present about Nanostructured single-site heterogeneous catalysts possess the advantages of classical solid catalysts, in terms of easy recovery and recycling, together with a defined tailored chemical and steric environment around the catalytically active metal site. Catalytic properties could benefit from the synthesis of nanostructured materials not only through the preparation of nanoparticles with high surface to volume ratio and narrow size distribution but also through the possibility to produce nanoparticles with well-defined morphology and surface structure.

Keywords – Heterogeneous catalysis, single sites, nanostructure oxides, selectivity

◆

INTRODUCTION

In a single-site heterogeneous catalyst (SSHC), active sites are well defined and evenly distributed entities (*single sites*). They have distinct chemical surroundings, as in conventional homogeneous systems, but they also show all the advantages of heterogeneous systems, in terms of easy separation, recover and recyclability. Single sites are usually (although not necessarily) located over solid supports with high surface area and they show the following general peculiarities:

(i) They consist of a limited and defined number of atomic species, i.e. one atom (as in truly ‘single’ sites) or few atoms

(ii) They are spatially isolated from each other,

(iii) They all have identical energy of interaction between the site itself and a reactant, and

(iv) They are structurally well characterized.

The use of inorganic oxide supports with selected shape and porosity at a nanometric level may have a relevant impact on the region and stereochemistry of the catalytic reaction. Analogously, by choosing the optimal preparation techniques to obtain spatially isolated and well-characterized active sites, it is possible to achieve performances that are comparable to (or, in the most favorable cases, better than) those obtained with homogeneous systems. Such catalysts are therefore particularly suitable for the transformation of highly-functionalized fine chemicals and some relevant examples where high chemo, region and stereo selectivity are crucial will be described.

SINGLE-SITE HETEROGENEOUS CATALYSTS ON INORGANIC SUPPORT

Redox-active zeolitic structures, such as titanosilicalite-1 (TS-1), or transition-metal-containing open-structure aluminophosphates (AlPOs) appeared in the 1980s and can be considered as the first examples of SSHC, as they fulfil the main requirements of isolation, uniform distribution and controlled chemical environment of the active sites (Wilson *et al.* 1982; Weisz *et al.* 1984; Chen *et al.* 1994; Marchese *et al.* 1994; Thomas *et al.*1994; Corma 1997). During the design and engineering steps that led to these catalytic systems, a major role was played by *in situ* characterization methods for solid catalysts. Then, starting from the 1990s, owing to the development of silica-based mesoporous molecular sieves, larger reactant molecules, which can enter the pore network, react there and leave it, can be transformed within the inner space of porous solids (Xiao 2005; Yang *et al.* 2009). Mesoporous silica materials, such as MCM-41, MCM-48, HMS, KIT-6, SBA-15 or SBA-16, are, indeed, ideal supports for SSHCs, since they exhibit high surface area (600–1300 $m^2 g^{-1}$) and their inner and outer surfaces have a profusion of pendant silanol groups (generally from 1 to 3 OH groups per square nanometer) that are optimal loci for immobilizing transition metal catalytic centres (Rigutto *et al.* 2007). Among them, materials with a good hydrothermal stability, such as HMS or SBA-15, owing to a large pore wall thickness and highly condensed frameworks with limited connectivity defects, are preferable, as they can more easily withstand the strong conditions occasionally experienced during synthesis or catalysis (Zhang *et al.* 2005).

Catalytically active single sites can have a structural role, when they are introduced into the framework of spatially ordered materials, via *direct synthesis* (figure 1). Otherwise, single sites can be added to a pre-existing support by *post-synthesis* techniques.

CONCLUSION:

In this paper we found that a catalyst is a material that increases the rate of a reaction without being consumed during the reaction. A catalyst increases the reaction rate by lowering the activation energy) of the chemical reaction. Catalysts play a vital role in almost every aspect of our lives and are used in the production of fuels, polymers, chemicals, foods, and pharmaceuticals. One challenge facing the heterogeneous catalysis community is the targeted synthesis of dispersed catalyst ensembles.

REFERENCES:

1. Wilson S. T., Lok B. M., Messina C. A., Cannan T. R., Flanigen E. M. 1982Aluminophosphate molecular sieves: a new class of microporous crystalline inorganic solids. J. Am. Chem. Soc **104**, 1146–1147.

2. Weisz P. B., Haag W. O., Lago R. M., 1984 The active site of acidic aluminosilicate catalysts. Nature **309**, 589–591.

3. Chen J., et al.1994 SAPO-18 catalysts and their Brönsted acid sites. J. Phys. Chem **98,** 10216–10224.

4. Marchese L., Chen J., Thomas J.M., Coluccia S., Zecchina A. 1994 Brönsted, Lewis and redox centres on CoAPO-18 catalysts. Vibrational modes of adsorbed water. J. Phys. Chem 98, 13350–13356.

5. Corma A. 1997 From microporous to mesoporous molecular sieve materials and their use in catalysis. Chem. Rev 97, 2373–2420.

6. Xiao F. S. 2005 Ordered mesoporous materials with improved stability and catalytic activity. Top. Catal 35, 9–24.

7. Yang Z., Lu Y. 2009 Mesoporous materials: tunable structure, morphology and composition. Chem. Commun **2009**, 2270–2277.

8. Rigutto M. S., van Veen R., Huve L.2007 Application of mesoporous molecular sieves in catalysis and separation. Stud. Surf. Sci. Catal **168**,837–854.

9. Zhang F., Yan Y., Yang H., Meng Y., Yu C., Tu B., Zhao D 2005 Understanding effect of wall structure on the hydrothermal stability of mesostructured silica SBA-15. J. Phys. Chem. B 109, 8723–8732.

10. http://rspa.royalsocietypublishing.org/content/468/2143/1904.full