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Editorial

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Sustainable Nanocatalysts for Organic Synthetic Transformations

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Nanocatalysis is recently growing field and is crucial component of "sustainable technology and organic transformations" applicable to almost all types' catalytic organic transformations [1,2-6]. Among nanocatalysts, several forms such as magnetic nanocatalysts, nano mixed metal oxides, core-shell nanocatalysts, nano-supported catalysts, graphene-based nanocatalysts have been employed in catalytic applications [3,7,8]. Magnetic nanocatalysts stand apart in this group of reusable nanocatalysts due to their low preparation cost, excellent activity, great selectivity, high stability, efficient recovery, and good recyclability (Figure 1).

The field of benign organic synthesis has lately embraced various innovative scientific developments accompanied by improved and effective synthetic practices that avoid the use of toxic reagents reactants [9,10]. The tuning of important organic transformations and these newer generation of nanocatalysts worked very well together to achieve important products [11-13]. These versatile semi heterogeneous nanocatalysts with high surface area are the best alternatives to conventional catalysts, the highest catalytic activity, selectivity, and stability can be achieved by their shape, size, composition, and nature of nanocatalyst structure [8,14,15]. These noteworthy advantages of nanocatalysts are depending on the nanosize effect; catalytic performance generally increases with decreasing size of nanostructures. Though, when the size of the active site is reduced to nanoscale dimensions, the surface free energy is greater than before. This results in the aggregation of the particles into small bunches and reduces the catalytic productivity. Also, the isolation and recovery for the catalysts become difficult as their size decreases to nanoscale dimensions; in most cases, separation through traditional filtration is not an easy task. So, it is important to used appropriate support materials/nanomaterial to design an effective, reusable and recycling nanocatalysts [16].

Till date these nanostructured materials are employed in various types of organic transformations including hydrogen transfer reactions, chemo-selective oxidations, coupling reactions, oxidative aminations, asymmetric hydrogenations, C-H activations, Mannich reactions Oxidative esterification's and more. A wide variety of nanostructures including morphology dependent nanocatalysts, magnetic nanocomposites, graphene-supported nanocatalysts, hybrid nanostructured catalysts, integrated nanocatalysts and core-shell nanocatalysts were employed for various catalytic applications (Figure 2) [1,17].

Notable development has been made using these nanocatalysts in terms of diversity of the organic reactions, activity, selectivity, and reusability. Still, the leaching of metal in nanocatalysts under harsh conditions or continuous flow reactions in flow reactor remains the major concern yet to be solved. The design and development of new more robust, and advanced multifunctional nanomaterials and imperative protocols for decoration of homogeneous metals, organic ligands or catalysts entities are still requisite in order to overcome these difficulties.

In conclusion, it is believed that these well-defined nanostructures with various energy sources such as microwave technology, ball-milling, ultrasonication and recently emerged microwave-continuous flow reactors, will help the accomplishment of benign and sustainable chemical processes.

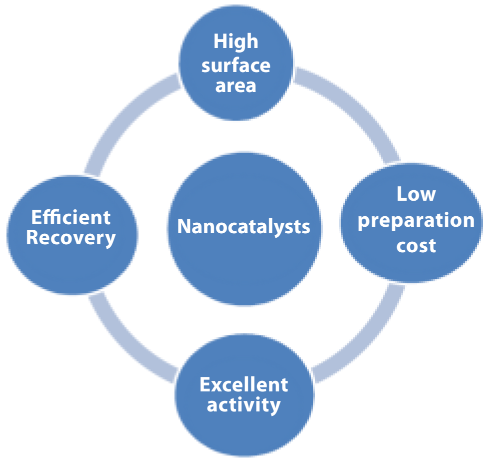

Figure 1: Characteristics of nanocatalysts

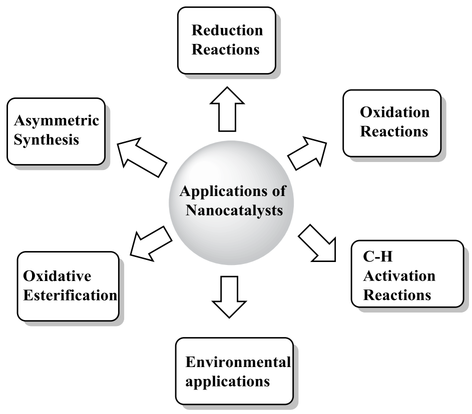

Figure 2: Applications of Nanocatalysts

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References

1. Gawande MB, Branco PS, Varma RS (2013) Nano-magnetite (Fe3O4) as support for recyclable catalysts in the development of sustainable methodologies. Chemical Society Reviews 42: 3371-3393.
2. Astruc D, Lu F, Aranzaes JR (2005) Nanoparticles as recyclable catalysts: The frontier between homogeneous and heterogeneous catalysis. Angewandte Chemie-International Edition 44: 7852-7872.
3. Gawande MB, Shelke SN, Zboril R, Varma RS (2014) Microwave-Assisted Chemistry: Synthetic Applications for Rapid Assembly of Nanomaterials and Organics. Accounts of Chemical Research 47: 1338-1348.
4. Varma RS (2014) Journey on greener pathways: from the use of alternate energy inputs and benign reaction media to sustainable applications of nano-catalysts in synthesis and environmental remediation. Green Chemistry 16: 2027-2041
5. Gellman AJ, Shukla N (2009) Nano-catalysis: More than speed. Nat Mater 2009, 8: 87-88
6. Wang D, Astruc D (2014) Fast-Growing Field of Magnetically Recyclable Nanocatalysts. Chemical Reviews 114: 6949-6985
7. Gawande MB, Pandey RK, Jayaram RV (2012) Role of mixed metal oxides in catalysis science-versatile applications in organic synthesis. Catalysis Science & Technology 2: 1113-1125.
8. Chng LL, Erathodiyil N, Ying JY (2013) Nanostructured Catalysts for Organic Transformations. Accounts of Chemical Research 46: 1825-1837
9. Gawande M, Rathi A, Branco P, Varma RS (2013) Sustainable Utility of Magnetically Recyclable Nano-Catalysts in Water: Applications in Organic Synthesis. Applied Sciences 3: 656-674.
10. Gawande MB, Bonifacio VDB, Luque R, Branoc PS, Varma RS (2013) Benign by design: catalyst-free in-water, on-water green chemical methodologies in organic synthesis. Chemical Society Reviews 42: 5522-5551
11. Gawande MB, Rathi A, Nogueira ID, Ghumman CAA, Bundaleski N, et al. (2012) A Recyclable Ferrite-Co Magnetic Nanocatalyst for the Oxidation of Alcohols to Carbonyl Compounds. Chempluschem 77: 865-871.
12. Gawande MB, Rathi A, Nogueira ID, Varma RS, Branco PS, et al. (2013) Magnetite-supported sulfonic acid: a retrievable nanocatalyst for Ritter reaction and multicomponent reactions. Green Chemistry 15: 1895-1899
13. Gawande MB, Rathi AK, Branco PS, Nogueira ID, Velhinho A, et al. (2012) Regio- and Chemoselective Reduction of Nitroarenes and Carbonyl Compounds over Recyclable Magnetic Ferrite-Nickel Nanoparticles (Fe3O4-Ni) by Using Glycerol as a Hydrogen Source. Chemistry – A European Journal 18: 12628-12632.
14. Roduner E (2006) Size matters: why nanomaterials are different. Chemical Society Reviews 35: 583-592.
15. Molnár Á (2011) Efficient, Selective, and Recyclable Palladium Catalysts in Carbon−Carbon Coupling Reactions. Chemical Reviews 111: 2251-2320.
16. Li Y, Shen W (2014) Morphology-dependent nanocatalysts: Rod-shaped oxides. Chemical Society Reviews 43: 1543-1574.
17. Shi J (2012) On the Synergetic Catalytic Effect in Heterogeneous Nanocomposite Catalysts. Chemical Reviews 113: 2139-2181