Extended Abstract

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Metal-based nanoparticles in environmentally-friendly media: From design to synthesis

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Abstract:

Metal-Based Nanoparticles (MNPs) have been largely studied in the last decades due to their distinctive properties, which found applications in several fields (microelectronics, medicine, catalysis). “Nano catalysis” emerged as a new concept that combines both colloidal catalysis and catalysis based on engineered Nano-objects, showing defined structures and composition. Like most MNPs, aggregation during the catalytic reaction can lead to structure modifications, precluding their unique properties and then the lack of the expected reactivity. A way to avoid these drawbacks is to use solid supports in order to immobilize the nano catalysts, favoring their recycling, but adding plausible effects due to the metal-support interactions. With the aim of preserving the surface state, the immobilization of MNPs in a liquid phase has been considered. Besides environmentally friendly properties, glycerol is characterized by a complex supramolecular network, permitting to trap the catalyst and easily extract the organic products; the catalytic phase can be then recycled, obtaining metal-free target molecules. Our team has proved the glycerol ability for the synthesis of both mono- (Pd, Cu and Cu2O, Ni) and bi-metallic nanoparticles (Pd/Cu), leading to stable colloidal catalytic solutions in the presence of polymers (such as PVP), phosphine’s and biomass-based stabilizers such as cinchona derivatives . In particular, bimetallic nanoparticles have opened new horizons in energy conversions and organic transformations, thanks to cooperative effects between the two counterparts, due to structure-reactivity relationships (alloy, core shell, hetero-dimer…). In this lecture, an account of our work in this field will be presented, from the synthesis and full characterization of metal-based nanoparticles in different media (including glycerol and solid supports), to catalytic applications, with the final goal of obtaining target molecules of interest for the fine chemistry sector. With the advent of Nanotechnology, nanoparticle usage has increased tremendously in various applications because of their unique properties and enhanced functionalities. In order to meet the elevated demands for nanomaterial in the commercial market, industrial sector is involved in the mass production of different types of nanoparticles by using numerous fabrication methods such as physical/chemical techniques. But these methods are energy inefficient, costly, and use hazardous chemicals. Therefore a novel green synthesis biological approach is being adopted for the fabrication of metallic nanoparticles that is much safer and effective in terms of cost, time and functionality. Recently, a biological approach to synthesizing materials via environmentally friendly green chemistry-based techniques involving natural materials such as plants, bacteria, fungi, seaweed, polysaccharides, biodegradable polymers, plant-derived materials and algae has been employed as an alternative method for the synthesis of metal and metal oxide nanoparticles. With increasing enthusiasm for efficient green chemistry, biosynthetic routes for fabricating nanoparticles have aroused much interest because they are environmentally benign, simple, economic, and clean technology; they do not involve hazardous chemicals, and they have zero contaminants and by-products. Of these bio-entities, plant extracts have received great attention due to their ability to reduce and stabilize metal nanoparticles in a single-step synthesis using their distinct natural traits. Due to their diverse and complex compositions, natural organic phytoconstituent biomolecules existing in plant extracts such as alkaloids, flavonoids, saponins, steroids, terpenoids and tannins act as reducing and stabilizing agents. This paper provides an updated review of recent literature on metal and metal oxide nanoparticles, such as those containing silver, gold, palladium, platinum, zinc oxide, iron, titanium, ceria and magnetite, and the transformations, directions and current uses of green synthesis methods using plant extracts.

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