Nanoparticles for environment, energy and health

Some challenges and research projects

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Nanoparticles are a class of materials with unique physico-chemical properties distinct from those of their bulk material. Their reactivity, easy functionalisation and remarkable optical properties, among others, have made them best candidates for various applications, such as electronics, biomedical, pharmaceutical, cosmetic, environmental technologies, depollution or energy conversion, catalysis, and materials applications.

A critical review of some examples showing the synthesis and the use of nanoparticles, but also their counterpart, will be presented.

Very reactive, metal nanoparticles constitute the active phase of catalysts for hydrocarbon conversion or pollutant oxidation under mild conditions. Special attention will be put to gold, which under the form of small nanopaticles (< 10 nm), displays remarkable catalytic activity in CO oxidation or selective hydrogenation.

Nanoparticles (Nps) have also been widely applied for medical diagnostic in various ways, taking advantage of their unique optical, electronic, magnetic properties. Gold Nps of various shapes and sizes, permit considerable enhancement of some analytical techniques, like Surface Plasmon Resonance, fluorescence spectroscopy or Surface Enhanced Raman Spectroscopy (SERS) for instance. Nanoparticles have been applied, combining diagnostic and therapeuty (« theragnostic »), for tumor care. We are here talking about an *in vivo* use of nanoparticles which of course requires both an extremely precise targeting and a controlled toxicty towards human tissues. Examples of sophisticated chemical modification of either gold or magnetic oxide nanoparticles, used to improve the detection of chemical or biochemical analytes, will be presented.

Now coming to the general questiopn whether inorganic nanoparticles are inocuous or not for biomedical applications, more and more data are now available for various types of nanoparticles, carbon-, oxide- or semi-conductors. As an example, gold nanoparticles have been reported to induce little toxicity, a large question left to address is the toxocy- size, shape, and surfactant-toxocity relationship. At the current stage, it is impossible to ascertain, and overall evaluate, that using nanoparticles in human environment, or for clinical use, is dangerous. Further work is urgently needed to develop both the best conditions to apply nanoparticles successfuly, and develop cytotoxivcity testing relevant and standardized. This represents a considerable novel field of investigation… little is known… and almost nothing regulated.