Onion-type multi-lamellar vesicles as an innovative tool for the preparation of metal-based heterogeneous catalysts

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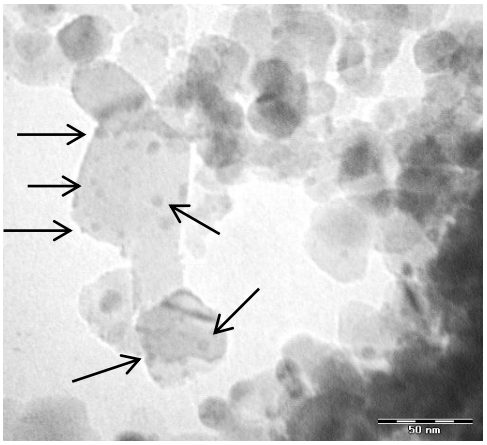
Onion-type multilamellar vesicles (MLV) have been widely studied in the perspective of biomedical applications. Onions are made of concentric bilayers of surfactants up to the core of the vesicle. The amphiphilic surfactants that enter the composition layers can be phospholipids, just as those in the membranes of living cells. Onions have become a tool of predilection because they are described as possible vectors in biological or medical application (delivery of drugs, cell tracking, etc.). In this context, Faure and co-workers have successfully used onions for the spontaneous intravesicular formation of silver [1] and gold [2-4] nanoparticles. Nanoparticles containing onions could serve as a tracer in biological matrixes. Gold nanoparticles for example offer sufficient contrast for electronic imaging.

Numerous catalytic applications demand large active surface area, and thus small particles [5]. Especially in metal-based catalysts, the size of the active particles is a crucial parameter along with accessibility, thermal stability, nature of the support. Because small metallic particles tend to sinter already at relatively low temperatures, efforts are made in order to develop materials that are thermally stable and that maintain high dispersion of the metal load. Nevertheless, the existing approaches are often based on processes that include a thermal treatment step (e.g.: the decomposition of the metal precursor salt) during which sintering phenomena are hardly controlled.

A new route for the preparation of metal-based catalysts has thus been investigated. Onion-grown silver and gold nanoparticles have been deposited onto a TiO_2 support. As micro reactors for the synthesis of the metal nanoparticles, onions offer the possibility to control the size and shape of the nanoparticles. As previously evidenced the synthesis is spontaneous and doesn't require any addition of a strong reducing agent. The catalyst support is "decorated" through the direct impregnation of the loaded onions. No further thermal treatment is required to obtain the active metal nanoparticles.



TEM images coupled with an X-ray probe attest of the presence of metal nanoparticles on the TiO_2 powder. The catalysts have also been characterized by XPS, TGA, XRD and ICP-AES. The catalytic total combustion of benzene – as a representative toxic pollutant of air – has been selected as the test reaction. Our new materials show very promising behavior in this environmental catalysis application.

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