Size-controlled Platinum nanoparticles and their catalytic activity

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Nanoparticles are widely used in heterogeneous catalysis and generally, they are supported on oxides such as silica or alumina. Unfortunately, strong interactions between support and particles exist and lead to the modification of the particles' properties which means that no unique active sites are obtained. Other side phenomena like diffusion or migration of adsorbed atoms towards the support surface are observed and undesired reactions (isomerization, cyclization,…) with the acid sites take place. These side effects can be eliminated using unsupported metal nanoparticles.Their properties can be modified depending on their size especially in the order of magnitude between 1 and 10 nm. This makes unsupported nanoparticles interesting candidates for fine chemical catalytic applications since no side phenomena occur and active sites are well defined.

Surface Organometallic Chemistry on Metals [1] allows controlling the coordination sphere of the active metal by an organometallic fragment. By changing "at will" the steric and electronic properties of the organometallic fragment, it is possible to influence the chemio- , stereo- and regio-selectivity of reactions catalyzed by metallic surfaces.[2] Pt is considered to be a very good catalyst for selective hydrogenation; in particular for enantioselective hydrogenation of alpha ketoesters [3] and it is believed to be less hydrolyzing than Ru.

Therefore, unsupported platinum nanoparticles were prepared by the Surface Organo-Metallic Chemistry on Metal route following the procedure already described for Ru,[4, 5] using $Pt(dba)_2$ as precursor and using octylsilane ($C8SiH_3$) or vinylphenylmethylsilane (VPMSiH) as stabilizer. The size and the structure of the nanoparticles were determined by TEM and the grafted organometallic fragments were characterized by XPS, IR and elementary analysis. Interestingly, the size of the nanoclusters thus obtained has a remarkably narrow distribution and their size is about 2 nm in diameter. The particles are crystalline with a shape fitting quite well with a cubo-octahedron of 201 atoms (3 edge atoms).

These nanoparticles are active and chemio-selective in the hydrogenation of cetopentoylactone into the corresponding alcohol and their properties were compared to silica supported Pt.

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