Organometallic synthesis of water-soluble Pt and Ru nanoparticles

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In the last few decades, the synthesis and catalytic application of nano-scaled particles prepared from Group VIII elements have been widely explored and have achieved promising results.[1] The use of these nanoparticles (NPs) as catalysts provide new opportunities since NPs offer an efficient combination of conventionally used homogenous and heterogeneous catalyst advantages.[2] Classical homogeneous catalysts raise extraction and recycling difficulties when dealing with metal complexes and/or ligands, whereas heterogeneous catalysts generally require more drastic experimental conditions, such as high temperatures and high pressures, to be effective. The separation of expensive transition metal catalysts from substrate(s) and product(s) mandatory for industrial applications of homogeneous catalysis has led to the development of several concepts for low-cost catalyst recovery. These include the use of multiphase reaction systems like liquid/liquid biphasic systems, where the two solvents have a low miscibility. Most often the catalyst is soluble in water while the substrate(s)/product(s) are soluble only in the organic phase, hence providing a feasible separation process. Therefore, the use of water-soluble NPs catalysts instead of conventional catalytic systems is a breakthrough owing to their improved handling and considering environmental and economic aspects.[3]

In our team, the research activity has been focused for years on the preparation of well defined metallic NPs stabilized by various ligands for application in the field of catalysis and others. The synthesis methodology consists in an organometallic approach.[4] Stable transition-metal NPs with average sizes of less than 5 nm and narrow size distributions can be conveniently prepared from organometallic precursors that are decomposed in mild conditions under reactive gas (H_2, CO…). Recent studies on the use of phosphorous containing ligands to stabilize NPs[5] have led us to test 1,3,5-triaza-7-phosphaadamantane as NPs stabilizer which is well known for the formation of water-soluble complexes.[6] Special attention has been devoted to Ru and Pt NPs synthesis for their interest in catalysis and in NMR investigations to understand NPs surface reactivity. Thus, the synthesis and the characterization (TEM, WAXS, NMR…) of water soluble Pt and Ru NPs from organometallic complexes will be described. To our knowledge, this is an innovative way to obtain aqueous colloidal solutions. These NPs are of interest for application in catalysis like arene hydrogenation.[7]

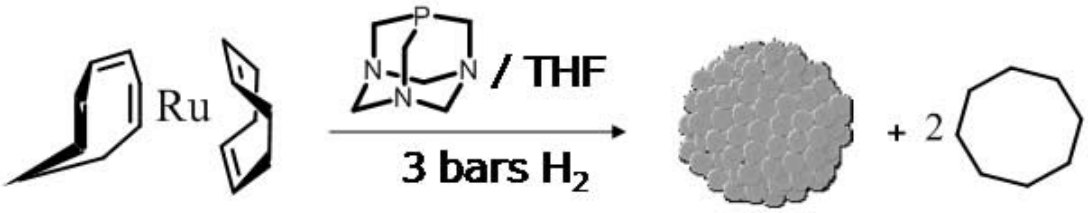

Figure 1: synthesis of Ru NPs by decomposition of Ru(COD)(COT) under H_2

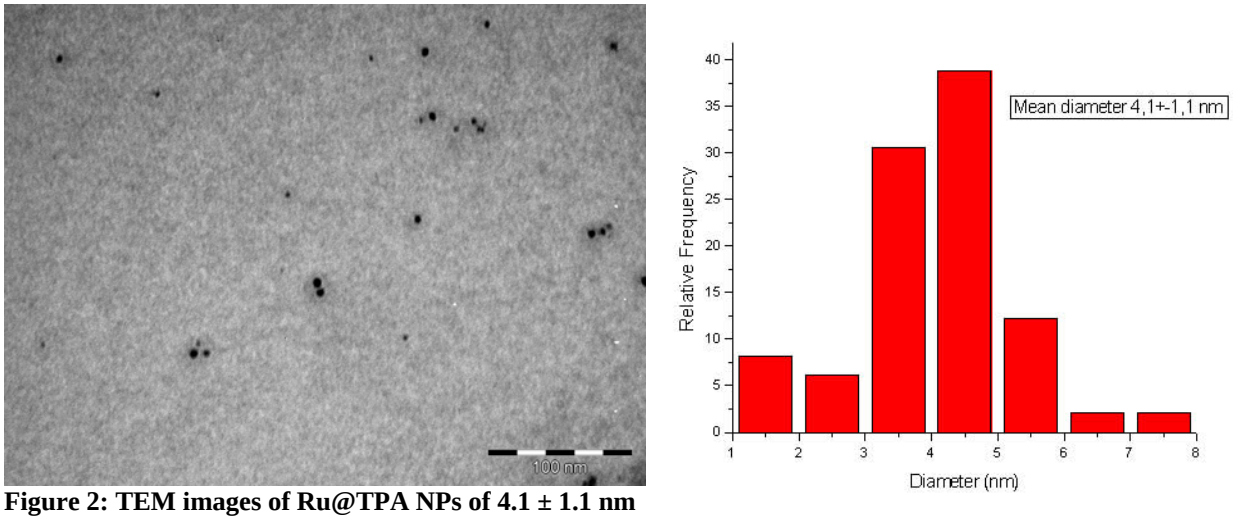

Figure 2: TEM images of Ru@TPA NPs of 4.1 ± 1.1 nm

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