2. Self-assemblies and new hybrid architectures

Silica hybrids

The group had previously developed, a new method of silica synthesis in aprotic organic medium (as opposed to conventional routes in alcoholic medium), thus allowing an easy association with apolar compounds, in particular oxidizable metal nanoparticles (NPs). Various silicon composites have been synthesized taking advantage of the potential of this method. In the field of astrophysics, part of our work is devoted to understanding the cycle of interstellar matter. We have highlighted the inadequacy of classical models to explain the complexity of the optical behavior of interstellar dust (spectral range FIR / mm and temperatures 4K-100K). After demonstrating this in the case of amorphous silicates, the range of samples (interstellar grain analogues) studied has been extended to amorphous silicate mixed oxides, in particular Fe and Mg silicates. (Astro & Astrophys 2017, Astro & Astrophys 2017, ANR project « CIMMES », coll. IRAP, IAS, UMET).

For oncology or catalysis, we have elaborated composite objects combining silica and metallic NPs (synthesized by the organometallic route developed in our team). We have thus been able to encapsulate magnetic NPs (Fe or FeCo alloy) by a silica matrix without inducing significative oxidation, thus preserving the initial magnetic properties of the NPs. The stability of the magnetization is ensured in water for more than 24 hours, thus opening perspectives for biomedical applications such as localized hyperthermia cancer treatment (RSC Adv 2018). In collaboration with H. Martinez (IPREM) we have also studied gold shells coated with porous silica, serving as a reservoir of therapeutic molecules. We have elucidated the organization of the different entities (grafts, silanol surface terminations, macrocycle cucurbit [6] uril) thus bringing for the first time a detailed description of these nanovalve systems (PCCP 2015). Finally, we used silica as a heterogeneous catalysis support, by the formation of NPs of Pt and Pd (organometallic route) on the surface of silica NPs (Figure 1). The compatibility of the synthesis media (aprotic) allows employing a simple protocol ("one-pot") forming nanomaterials of "raspberry" type, Pt or Pd @ silica, the latter being an efficient catalyst in C-C coupling reactions (coll. C. Cornejo – Univ. Navarre, New J Chem 2014).

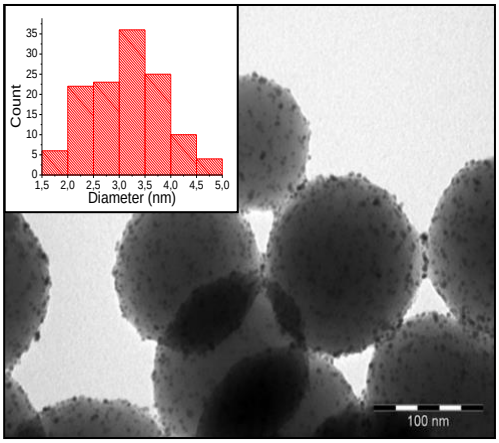

Fig. 1 : TEM image of Pt NPs grafted onto silica NPs