

Aerosol based fabrication of Polymer-Coated Inorganic Nanoparticles

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Aerosol-polymerization possesses great potential for encapsulation of inorganic nanoparticles with a polymer shell without any solvent required. In contrast to conventional wet methods, continuous aerosol-based process is simpler and requires fewer unit operations.

Among the inorganic core materials, silver and silica have attracted much attention due to their interesting properties and potential applications in technological fields [1, 2]. On the other hand, glycidyl methacrylate (GMA) is a monomer of particular interest due to its dual functionality, resulting from the presence of two polymerizable groups of methacrylic and epoxy in the same molecule. Such groups can react with a wide variety of initiators to produce the desired polymer [3].

To produce core-shell nanoparticles, the inorganic nanoparticle-laden nitrogen flow was bubbled through a monomer liquid kept usually at relatively high temperature. In the subsequent cooling behind the bubbler back to room temperature a supersaturation with a saturation ratio of 4.5 was achieved resulting in the condensation of GMA vapor on the surface of inorganic nanoparticle. Finally, the ammonia vapour was added to the GMA-coated inorganic nanoparticles to initiate polymerization (Figure 1).

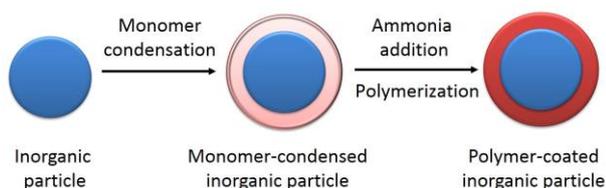


Figure 1. Simplified schematic representation of polymer-coated inorganic nanoparticles.

TEM images of the resulting coatings for particles with different materials are shown in Figure 2. The silver and silica particles were covered with polymer shells for all cases. However, the coating was not uniform all over the silver core surface and core-shell nanoparticles were produced with the cores concentrically (Figures 2a) or eccentrically (Figures 2b) positioned inside polymer shells.

Moreover, Ag nanoparticles were coated with a GMA monomer and then mixed with vapor of ammonia as an initiator in order to find the effect of the initiator (Figure 3). The condensed GMA monomer layer is thermally not stable without the addition of an initiator (Figure 3b), while the condensation of GMA and the addition of ammonia lead to a stable shell on the Ag particles (Figure 3c) [4].

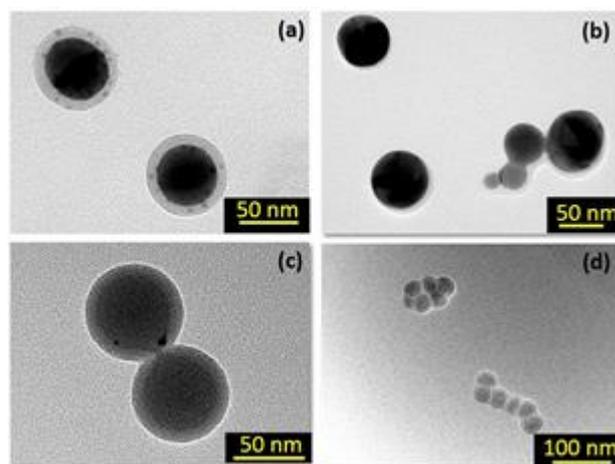


Figure 2: TEM micrographs of the polymer-coated nanoparticles: (a–b) silver and (c–d) silica nanoparticles.

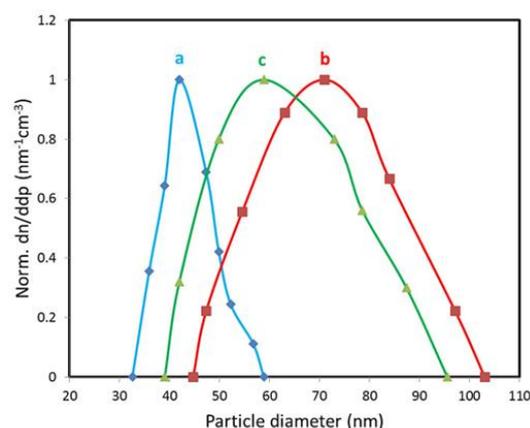


Figure 3: Evolution of the size distribution of 40 nm spherical Ag nanoparticles: (a) in original state, (b) GMA condensation, (c) GMA condensation + ammonia addition + evaporation furnace.

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