Synthesis of inorganic nanoparticles via a novel o/w microemulsion reaction method with fluorescent properties and their dispersion

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A novel method for the synthesis of inorganic nanoparticles, based on oil-in-water microemulsions has been recently developed [1]. The method consists in the use of organometallic precursors dissolved in nanometric oil droplets, stabilized by surfactant, and dispersed in a continuous water phase (Figure 1). Contrary to the conventional method based on water-in-oil microemulsions (w/o), the advantage of this new approach is the use of water as the external phase; hence the main component is water instead of organic solvents. Therefore, it represents a major advantage for the environment as well as for economic reasons. In addition, the synthesis of nanoparticles via w/o and o/w microemulsion reaction method allows for the preparation of various types of materials with a high control of the nanoparticle size using soft reaction conditions (room temperature, atmospheric pressure) [2, 3].

In our previous studies, the method was applied successfully to the synthesis of a variety of metallic (Pt, Rh, and Pd) [1] as well a metal oxide nanoparticles (CeO_2 and several transition metal oxides) [1, 4]. In the present study, this method is used for the synthesis of inorganic nanoparticles containing Cu and Zn in a 1/1 ratio.

First, a preliminary phase behaviour study was carried out in order to find the appropriate conditions for o/w microemulsion formation. The synthesis was carried out by increasing pH up to specific values. In this one-pot reaction, the synthesis of various types of nanoparticles can be performed according to the pH value. At lower pH, the blue $ZnO/Cu(OH)_2$ nanoparticles are synthesized whereas at higher pH, the brown ZnO/CuO nanoparticles are obtained. The nanoparticles were characterized by Dynamic Light Scattering (DLS), X-Ray Diffraction (XRD), High Resolution Transmission Electron Microscopy (HRTEM) and Fluorescence Spectroscopy. Indeed, the structure of $ZnO/Cu(OH)_2$ is crystalline. ZnO nanoparticles are elongated with a diameter of ~10 nm and ~40 nm of length. $Cu(OH)_2$ nanoparticles have a globular shape with an approximate diameter of 7 nm. In order to explore potential applications, a study was carried out to disperse the nanoparticles in organic solvents; this was achieved in tetrahydrofurane by addition of an anionic surfactant (Figure 2). In addition, fluorescence spectroscopy measurements of the nanoparticle dispersion revealed the fluorescent nature of the nanoparticles (figure 3) which is likely linked to the ZnO nanoparticles [5]. The results obtained demonstrate the versatility of the novel oil-in-water microemulsion method for the preparation of nanoparticles with interesting and varied potential applications.

References

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Figures

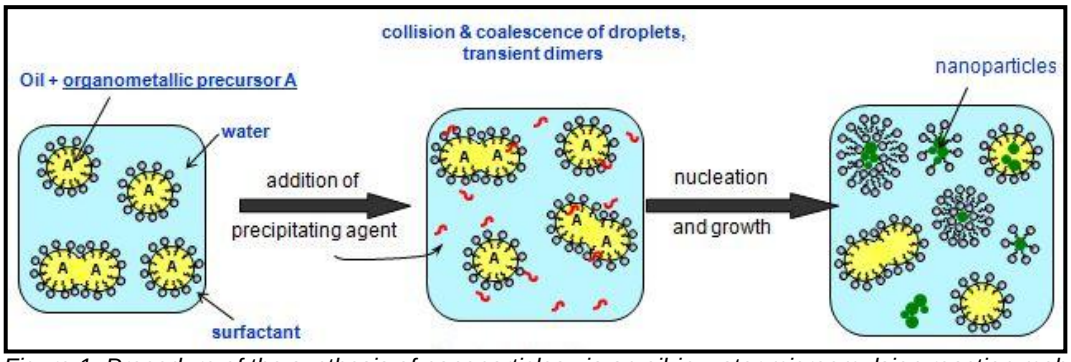

Figure 1: Procedure of the synthesis of nanoparticles via an oil-in-water microemulsion reaction mehod

wt% dried NPs	0.96%	1.45%	2.21%	2.69%	3.43%
wt% AOT	0.8%	0.6%	0.6%	0.7%	0.6
Aspects					

Figure 2: Aspect of dispersion of $ZnO/Cu(OH)_2$ in THF using an anionic surfactant (AOT)

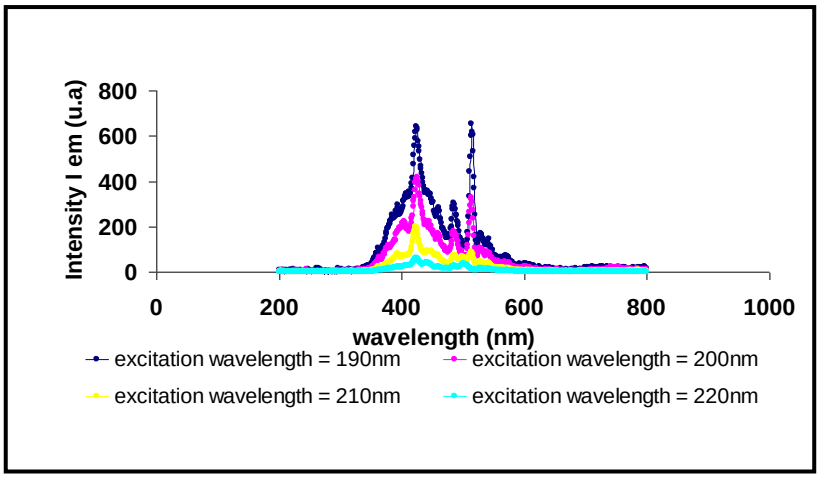

Figure 3: Fluorescent emission spectra of $ZnO/Cu(OH)_2$ nanoparticles (3.43 wt%) dispersed in THF at various excitation wavelengths.