

Synthesis of crystalline aluminum nanoparticles with controlled diameter by combining sono-chemistry and solvo-chemistry

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Colloidal Aluminum nanostructures appear to be a good alternative to gold or silver because of the broad range of their plasmonic resonances (UV to NIR) and their reduced cost. [1][2] The main ways developed to obtain aluminum nanostructures are based on top-down techniques (lithography's, laser ablation...). Contrary to silver, these structures are very stable in air because with oxygen inclusion, a 3nm native passivation alumina layer is created and act as a protective layer. However, deterioration appears in a solvent for these structures [3]. Nevertheless, a lot of biological experiments occur in the UV range, and aluminum nanostructures could help to enhance fluorescence detection. Consequently, it is of first importance to be able to work in organic solvents with colloidal aluminium nanoparticles [4].

Aluminium colloidal synthesis is clearly more complex than other metals because the reduction of aluminium salts is complicated due to its very high redox potential and is poorly documented. Here we present a two-step synthesis based on sonochemistry and solvochemistry techniques. We obtain spherical aluminium nanoparticle with controllable diameter from 15 to 100 nm as illustrated figure 1. In the first place, the powerful method of sonochemistry will destroy and transform aluminium foil due to the cavitation phenomena. Factually, generate ultrasound in a water bath will involve the formation of vacuum bubbles with a tremendous energy, up to 5000 K° and 1800 atm. [5] In the second place, using a homemade autoclave system in the solvochemistry step lead to the transformation of aluminium precursors into nanoparticle. [6] By controlling the solvent and the temperature, we manage to control the growth of our nanoparticles and we obtain a broad range of size, with low dispersion.

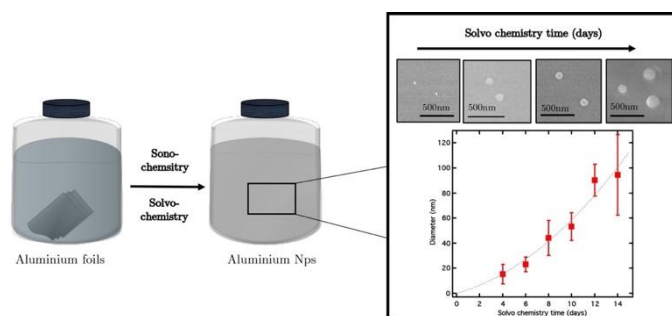


Fig. 1 Sono and Solvo chemical reaction on aluminium foil leading to the formation of colloidal aluminium nanoparticles. Right, SEM images of nanoparticles sampled at different reaction time and a graph of the diameter of the nanoparticles depending on the solvo chemistry time.

Upcoming experiments will focus on the modification of the shape and the synthesis of other metallic nanoparticle with this method. Moreover, we are now using these nanoparticles through functionalization experiments in order to do metal enhanced fluorescence in UV.

References

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