Abstract – Workshop for Multi-Functional Materials: From Synthesis to Applications

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Scientific thematic domain: Materials and chemistry – Synthesis and characterizations

Title: "Sputtering of silver onto silicone oils: nanoparticle formation and mass transfer into the bulk solution"

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Abstract:

Nanoparticles (NPs) synthesis by low-pressure plasma-base sputtering onto liquid offers many advantages. However, the NP formation mechanism using this method is not well known. Moreover, the viscosity effect on the formation and the diffusion of these NP are not well understood. Here, an operando absorption spectrophotometry has been setup and used to record, during the plasma treatment but also afterward, time- and space-resolved spectra of the liquid into which the sputtered metal atoms are incorporated.

In this work, silver atoms are deposited onto a still silicone oil with different viscosity (20, 50 and 100 cSt). Analyses were carried out during sputtering (Plasma ON time). A first absorption signal, related to the detection of the NP inside the liquid, appears after 2min04 for the 20 cst liquid, while it is delayed to 3min38 for 50 cSt oil. For the 100 cSt oil, the signal appears much later, around 12min26 after the start of sputtering. Moreover, the increase of absorbance is different for each viscosity: the absorbance increases faster for oil characterized by a lower viscosity than for oil with high viscosity. After the sputtering (Plasma OFF time), the time at which the first signal is detected for the different fiber position follow the same trend as for the plasma ON time. Indeed, the detection time increases with the oil viscosity. The time evolution of spectra is also different for each viscosity and each position.

These results show that the detection time, of the first signal, at each position increases linearly with the oil viscosity. Hence, the diffusion of the nanoparticles towards the bulk of the solution is dependent on the viscosity and is slower as viscosity increases. These results are in agreement with the Stokes-Einstein diffusion coefficient equation ($D = \frac{k_b T}{6\pi\eta R_h}$) where we can see that the diffusion coefficient D is inversely proportional to the viscosity.

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