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Plasma and Laser enabled metallurgy of Nanoparticles: Reshape the microstructure to reshape Plasmons

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Increasing demand in smart, efficient and green Nanotechnology implies continuous progresses in the synthesis of always more complex Nanomaterials. Tremendous progress in the synthesis of complex Nanoparticles (core-shell, Janus etc…) has been achieved within the last decade so that shape and composition of Nanoparticles (NPs) can be tailored in an always more accurate way. However conventional chemical routes enable only the synthesis of stable compounds. Metastable NPs is large and relatively unexplored library of NPs that is not reachable by conventional routes. High-density energy processes in liquids (plasmas, lasers, ultrasounds etc…) provide strongly non-equilibrium that enable the formation of metastable compounds. For example, dielectric discharges in liquids may locally generate high temperature (up to 3300K) and high pressure (30 bars) with high gradients (10^5 – 10^6 $K.s^{-1}$). Within these conditions, a new metastable crystallographic phase of lead oxide PbO_2 has been discovered by Hamdan *et al.*The present communication will focus on the formation of metastable alloys, and to a larger extent to the microstructure control of NPs. The combination of a plasma and a laser treatment, both conducted in liquids is shown to be beneficial high rate synthesis of metastable NPs, thanks to high cooling rates. The relationship between the microstructure, and mechanical properties has been well studies even at nanoscale. However, this relationship is less obvious for sub-wavelength light matter interaction. In this contribution we investigate, with a model system (Cu-Ag), the influence of different microstructure on the scattering of Nanoparticles. The microsctructure of nanoparticles, in terms of phase composition, grain size within the sub-wavelength NPs is shown to be a potential way to reshape plasmon resonances.

Keywords
Nanoparticles
Discharges in liquids
Laser process