Tuning the Aggregation of Metal Nanoparticles prepared by Laser Ablation with Halide Salt solutions

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The localized surface plasmon resonance (LSPR) properties in metal nanoparticles (NPs) are greatly influenced by different geometrical and environmental factors, as well as their aggregation phenomena. This phenomenon is used across a wide spectrum of applications. Our research is focused on the LSPR behavior of gold (Au) NPs generated through laser ablation in liquid, and their subsequent aggregation induced by halides. We investigated the aggregation dynamics across different parameters such as bromide concentration, temperature variations and different halide salts. Through absorption spectroscopy and electron microscopy, we demonstrated that increasing bromide concentrations result in elongated and more intricate aggregates, consequently leading to a red-shift and broadening of the LSPR. Finite-Difference Time-Domain simulation data compared with the experimental ones (refer to Figure 1) show that a redshift in the LSPR is the result of the increase of the chain length. Real-time absorption spectroscopy revealed immediate NPs growth upon salt addition. Additionally, we observed that higher temperatures tend to inhibit the aggregation process, whereas lower temperatures facilitate it. Lastly, we have demonstrated the disruption of aggregates through re-irradiation of the colloid. These findings significantly enhance our comprehension of the factors governing aggregation phenomena, consequently promoting advancements in existing applications and inspiring novel ones. [1]

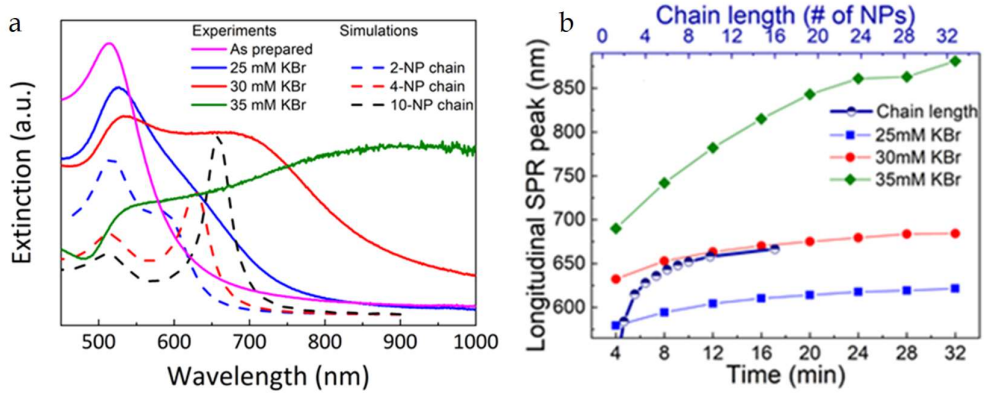

Figure 1: Comparison a) between experimental extinction spectra obtained from the addition of KBr at different concentrations and simulated spectra of Au NP chains of different lengths and (b) between the evolution in time of the experimental longitudinal LSPR peak and of longitudinal SPR value of simulated linear chains (from 2 to 16NPs).

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Reference: [1] L. Catanzaro, V. Scardaci, M. Scuderi, M. Condorelli, L. D'Urso et al., Mat. Chem. and Phys. Vol. 308, 128245 (2023).