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Meeting-report

Tuning of Plasmonic Response in High Aspect-Ratio Au Nanowires through Laser Irradiation: A TEM-EELS Study

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For the past couple of decades, plasmonics [1] has been on the spotlight of research, mainly for its varied applications [2,3]. Within this field, the study and tuning of localized surface plasmon resonances (LSPRs) in metallic nanowires has been of importance due to their application versatility; ranging from photonics to electronics, sensors [4], or even chemical analysis through surface-enhanced light spectroscopies [5]. Additionally, recent works have shown it is possible modify the morphology of these nanowires by means of laser irradiation, hence providing a new realm of high aspect-ratio nanostructures with potential new properties [6].

Low-loss electron energy loss spectroscopy (EELS) is a very fitting technique regarding the study of plasmonic resonances in these novel nanostructures, combining a nanometric spatial resolution and a very accurate spectral resolution [7]. In this way, the EELS studies shown in this work, combined with discrete dipole approximation modelling, show how the plasmonic response of high aspect ratio gold 1D nanostructures can be tuned by means of coupled and non-coupled nanoparticles attached to the tips of gold nanowires, as well as a proof of concept as to how this technique can be used to understand coupling in these nanostructures [8]. Specifically, these studies have been carried out on gold nanowires and nanostructures consisting of nanoparticles of various sizes joint to them, producing high aspect-ratio half-dumbbells and dumbbells. The investigation of the surface plasmon resonances has been developed through a non-negative matrix (NMF) decomposition of EELS spectrum images. In addition, discrete dipole approximation (DDA) calculations have been performed for the analysis of these experimental results, see Figs. 1 and 2.

We evidence that the modification of the extremities of a high aspect ratio metallic NW allow the control the resonance energy for small wavelength Fabry-Perot plasmon modes where longer wavelength modes stay almost unperturbed. Furthermore, an unexpected robustness of the dielectric response of the NW against the modification of the extremities reinforce their potential interest as nanophotonic waveguides and low energy resonators.

All these analyses serve as experimental proof of the tuning (or robustness) of the plasmonic modes, which is of interest regarding applications for sensing devices as well as other optical remote control devices [9].

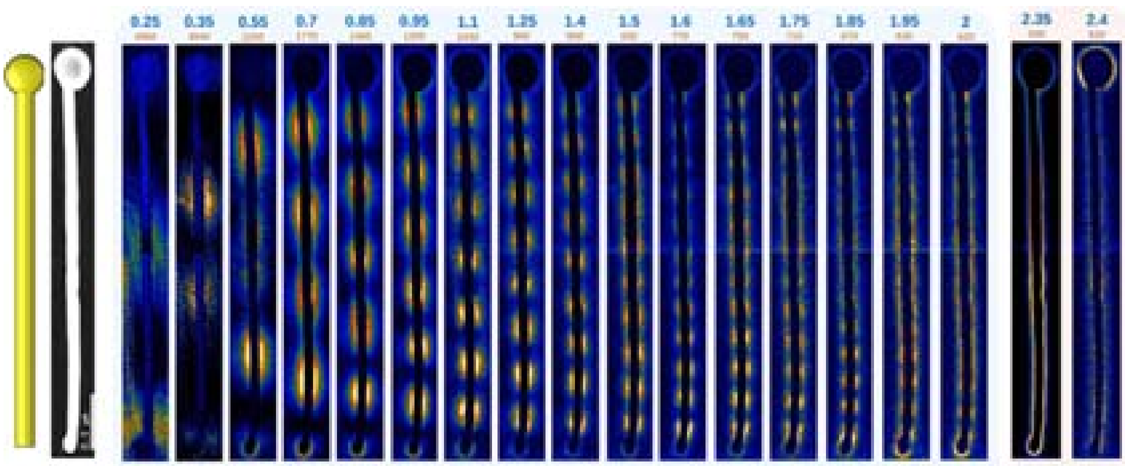

Fig. 1. From left to right: STEM HAADF image and NMF components corresponding to Fabry-Perot modes and to the surface modes of the Au NW and the Au NP in an Au half-dumbbell nanostructure.

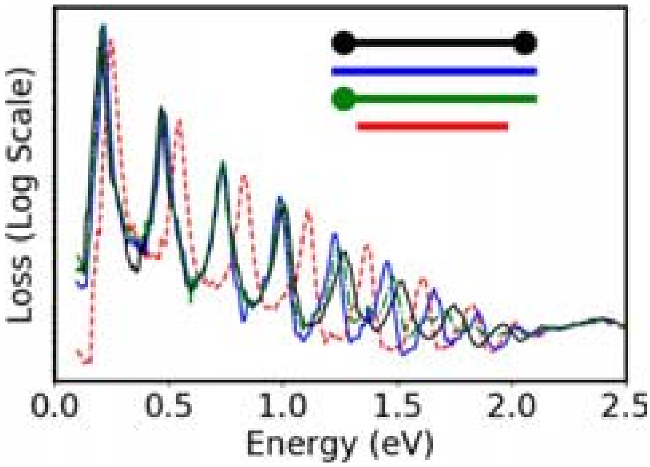

Fig. 2. DDA modelled low-loss EEL spectra for a dumbbell and half-dumbbell nanostructures and an Au NW of the same dimensions as well as a shorter Au NW.

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