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Deep Ultraviolet Plasmon Resonance in Aluminum Nanoparticle Arrays

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The localized surface plasmon resonance (LSPR) is a resonant oscillation of the free-electron gas within a metallic nanoparticle (NP), induced by an external electromagnetic (EM) field. The LSPR is instrumental in fabricating devices for sub-wavelength light routing or ultra sensitive molecuar detectors. So far, however, most of the research on plasmonics has been performed employing Au or Ag-based systems, thus limiting the LSPR range to the visible regime.

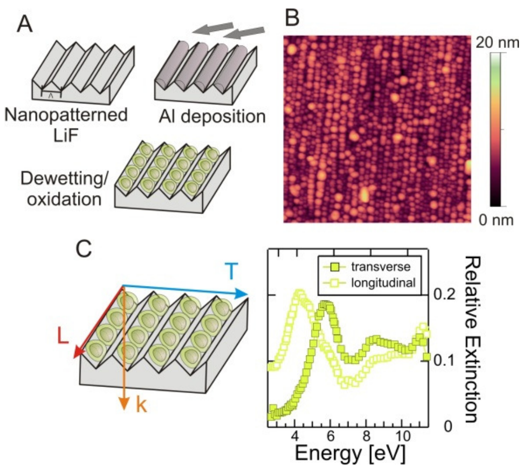

Fig.1: A: schematic representation of the Al NP array fabrication procedure. B: AFM image of an ultradense array of Al NPs. C: optical geometry for extinction measurements. Extinction spectra measured in longitudinal and transverse optical geometry.

In our work, we demonstrate a new upper energy limit for DUV plasmonics in ultradense (>10^{11} particles/cm^2) arrays of Al/Al_2O_3 core-shell NPs. The Al NPs were produced by bottom-up approaches (Fig.1A) depositing Al on a self-organized insulating surface and dewetting it to form arrays of disconnected Al/Al_2O_3 core/shell NPs (Fig.1B).

The optical extinction of the Al NP arrays as a function of photon energy, measured with the electric-field either parallel (longitudinal) or perpendicular (transverse) to the Al-NP "chains" (Fig. 2C) shows peaks corresponding to the excitation of LSPR that reach the strikingly-high energy of 5.8 eV, the highest ever observed in optically-excited metallic NPs.

The achievement of a high-energy plasmonic response in Al NPs, and the ease of fabrication of these NPS in ultradense arrays is a milestone for DUV plasmonics, and a promising achievement for future applications in plasmon-enhanced DUV optical spectroscopy.