Pushing the high-energy limit of plasmonics

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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 of metal nanoparticles allows confining the electromagnetic field in nanosized volumes, creating high-field “hot spots”, most useful for enhanced nonlinear optical spectroscopies. However, Au and Ag, the materials that conjugate high-quality LSPR with low reactivity, cannot exhibit plasmon resonances at photon energies above the visible-light regime. Stretching upward, this energy limit becomes however possible with one of the cheapest and most abundant materials available: aluminium. Al exhibits indeed a LSPR theoretically extending up to the deep-ultraviolet. However, complex nanofabrication issues and the unavoidable Al oxidation have so far prevented the achievement of this ultimate high-energy response. We overcame these hurdles by means of a bottom-up nanofabrication technique based on template-driven metal deposition, producing ultrafine and purely metallic Al nanoparticles. Under these conditions, we successfully pushed the plasmon resonance to a record value of 6.8 eV photon energy (λ≈ 180 nm), observing an experimental LSPR energy matching theoretical predictions and broadening the spectral range of plasmonics' numerous applications.

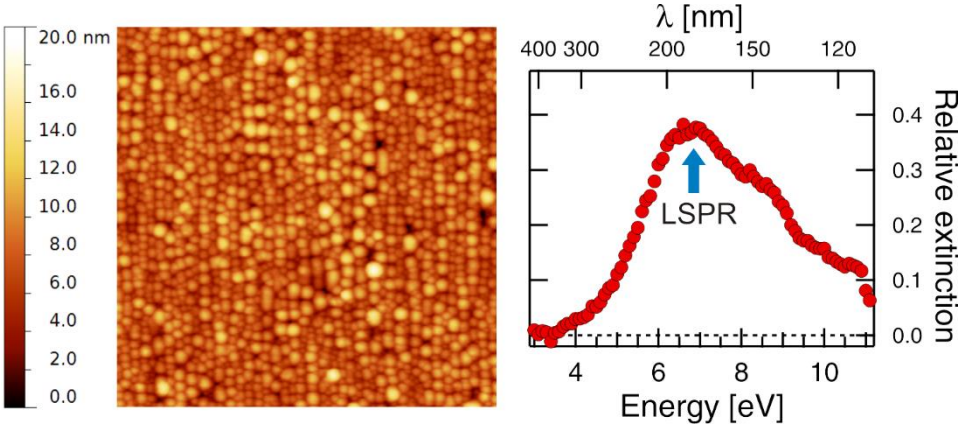

Figure 1: left: Al-particles nanoarray (image size 1×1μm^2); right: extinction spectrum of Al nanoparticles. The prominent peak is the fingerprint of the LSPR.