Plasmon resonances in Magnesium nanoparticles

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Nanoparticles (NPs) of some metals (commonly Cu, Ag, and Au) sustain oscillations of their electron cloud called localized surface plasmon resonances (LSPRs). These resonances can occur at optical frequencies and be driven by light, generating enhanced electric fields and spectacular photon scattering, opening applica-tions including photocatalysis, photothermal therapy, and enhanced spectroscopies, to name a few. However, current plasmonic metals, in particular Ag and Au, are rare, expensive, and have a limited resonant frequency range. Recently, much attention has been focused on earth-abundant Al, but Al NPs cannot resonate in the IR. Here we report earth-abundant Mg NPs that surmount this limitation.

Our colloidal synthesis forms 100-300 nm diameter, 30-50 nm thick hexagonal nanoplates, reflecting Mg's simple hexagonal lattice, as shown by SEM and HRSTEM (Figure 1). STEM-EDS and STEM-EELS mapping reveals a ~5nm layer of oxide analogous to that observed in Al NPs, protecting the metallic core. Mg NPs sustain multiple LSPRs with size-dependent frequencies spanning from UV to IR, which we precisely characterize by combining STEM-EELS, optical dark-field scattering, and numerical simulations. Colloidally synthesized Mg thus offers a route to inexpensive NPs with novel shapes and resonances spanning the UV-vis-IR spectrum, making them a flexible addition to the nanoplasmonics toolbox.

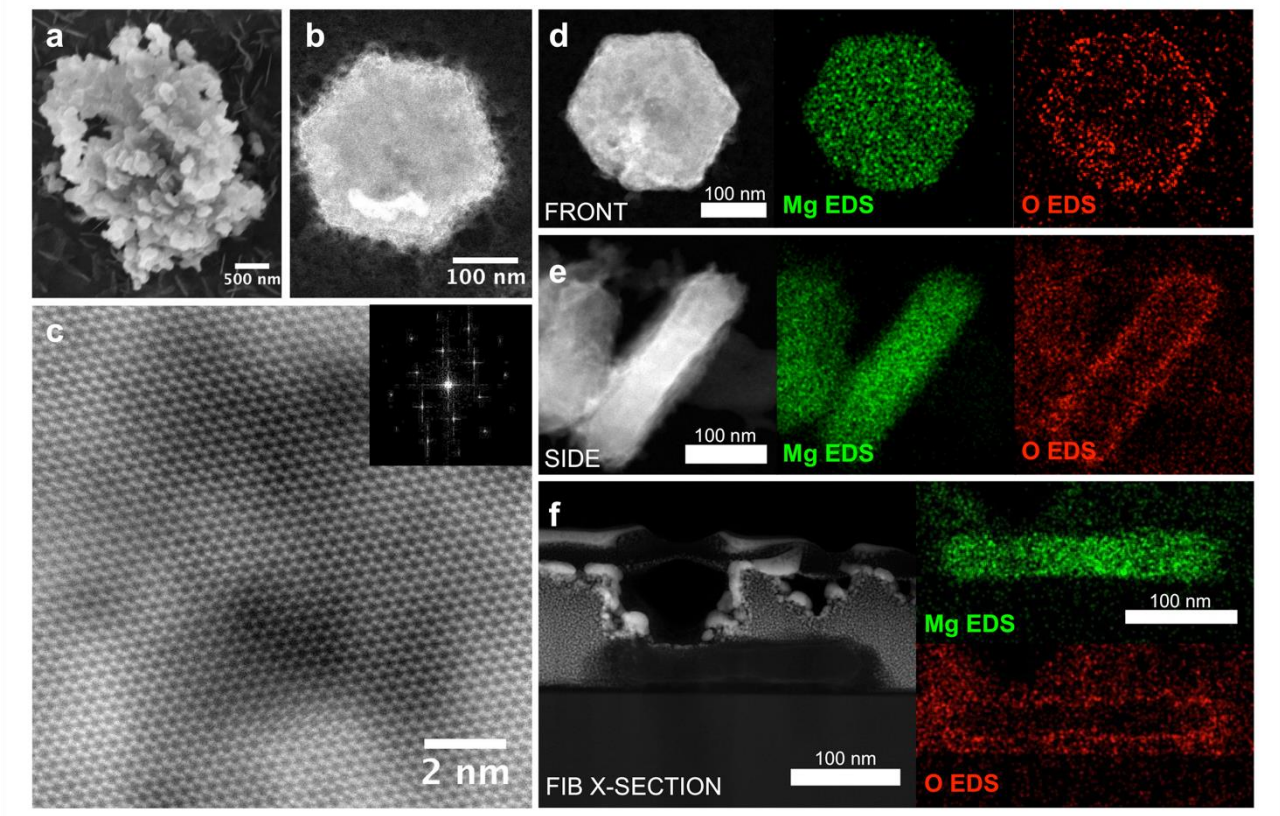

Figure 1. a) SEM image of a large Mg NP aggregate, b) HAADF-STEM image of a single NP, c) HAADF-STEM atomic resolution image (and associated FFT) of the center of the NP in B, showing the simple hexagonal lattice of Mg along the [0001] axis. HAADF-STEM images and associated Mg and O STEM-EDS maps of a nanoplate (d) perpendicular and (e) parallel to the electron beam. f) HAADF-STEM image of a FIB-cut section of a hexagonal NP viewed edge-on, and Mg and O STEM-EDS maps showing the ~5 nm Mg oxide at the NP surface; the thin SiO_2 native oxide on the Si substrate can also be seen below the NP.

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