Plasmon spectroscopy and imaging of individual gold nanodecahedra: A combined optical microscopy, cathodoluminescence, and electron energy-loss spectroscopy study

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Imaging localized plasmons in noble-metal nanoparticles is of fundamental importance for applications such as ultrasensitive sensing and detection. Here, we demonstrate the combined use of optical dark-field microscopy (DFM), cathodoluminescence (CL), and electron energy-loss spectroscopy (EELS) to study localized surface plasmons on individual gold nanodecahedra. By exciting surface plasmons with either external light or an electron beam, we experimentally resolve a prominent dipole-active plasmon band in the far-field radiation acquired via DFM and CL, whereas EELS reveals an additional plasmon mode associated with a weak dipole moment. We present measured spectra and intensity maps of plasmon modes in individual nanodecahedra in excellent agreement with boundary-element method simulations, including the effect of the substrate. A simple tight-binding model is formulated to successfully explain the rich plasmon structure in these particles encompasing bright and dark modes, which we predict to be fully observable in less lossy silver decahedra. Our work provides useful insight into the complex nature of plasmon resonances in nanoparticles with pentagonal symmetry.

References

[1] V.Myroshnychenko et al., Nano Lett., 2012, 12 (8), pp 4172–4180.