Exploring the Fano resonance of dolmen structures in near field by PEEM

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Fano resonance arises due to the interaction of a dipolar surface plasmon mode with a dark plasmon mode in some plasmonic nanostructures, in particular unsymmetrical structures with a nanometer-width gap. The dolmen-type metallic slab that includes a slab monomer and a slab dimer as shown in the insert of Figure 1(a) is a typical plasmonic nanostructure that exhibits Fano resonance.[1,2] So far, the far-field spectra of dolmen structures have been investigated and a clear Fano dip in the spectrum has been observed when the polarization of the incident light was perpendicular to the symmetry axis of the dolmen structure.[1,2] In this study, we elucidated the near-field properties of the dolmen structures using photoemission electron microscopy (PEEM), which has been demonstrated as a powerful tool for investigating the near field of plasmonic nanostructures.[3] The near field spectra of the dolmen structures were obtained by PEEM measurements with the wavelength-tunable femtosecond laser source. Surprisingly, we found that the maximum near field enhancement was not induced at the Fano dip wavelength, instead it coincided with extinction peak at longer wavelength as shown in Figure 1(a). This experimental observation could be reproduced well by finite-difference time-domain (FDTD) simulations (Fig. 1(b)), although the simulation gives another near field enhancement peak at the shorter-wavelength extinction peak. We also studied the near-field mapping of the dolmen structures at several particular wavelengths to get insight into the mechanism of the Fano resonance on the structures.

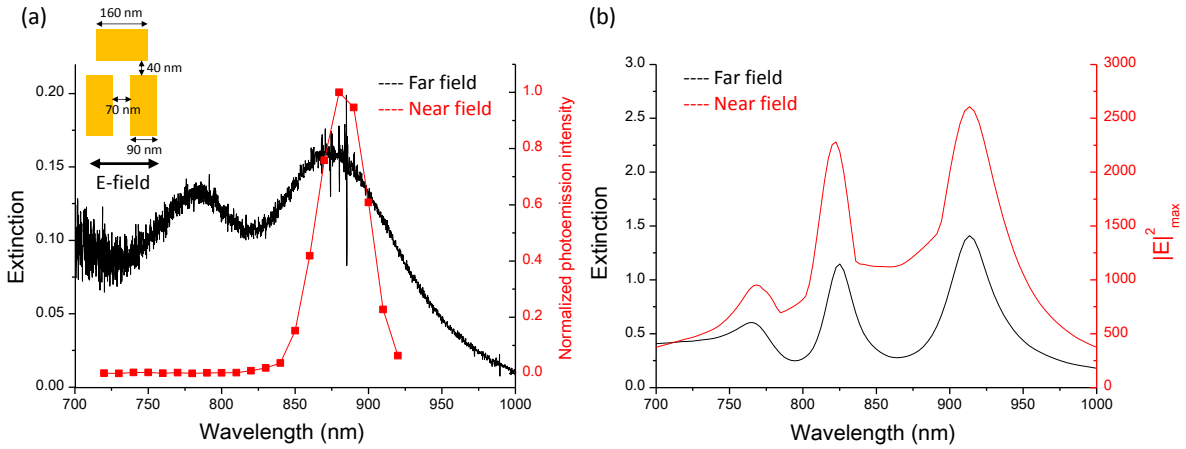

Figure 1 (a) Far field extinction spectra and near field spectra (wavelength dependence of photoemission (PE) intensity) of the dolmen structure whose structural design was schematically illustrated in the insert figure. (b) FDTD simulation results of far field extinction spectrum and near field enhancement spectrum.

References

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