Hyperspectral imaging of gold dimers

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We report on the first realization of a hyperspectral imaging (HSI) technique of surface plasmon polaritons excited in metallic nanostructures by a scanning electron beam. The HSI image is formed by scanning a plasmonic structure with a focused electron beam, simultaneously recording the spectra of light emission from decoupled plasmons by a spectrum analyzer. By scanning the sample in this manner, one obtains a data cube consisting of the spatial coordinates of the position of the injected electron beam and the corresponding plasmon emission spectra.

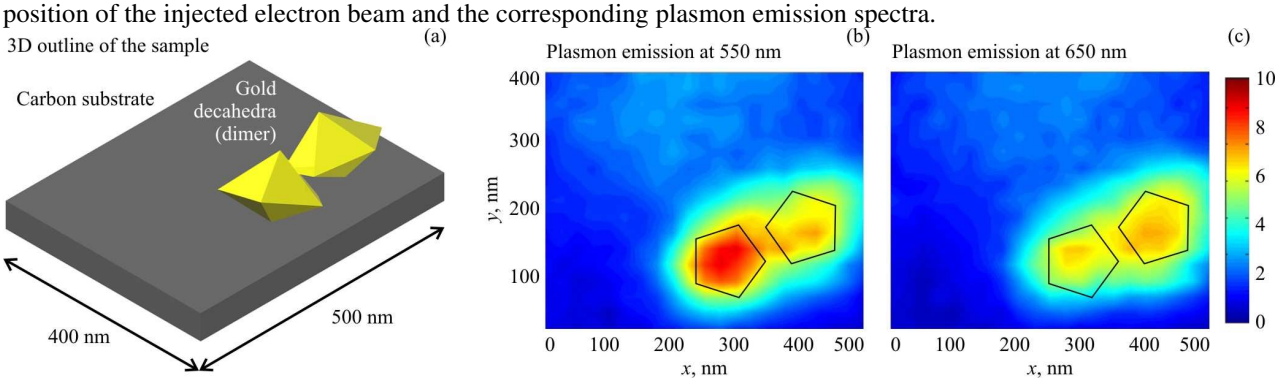

Fig. 1. Electron beam excitation of plasmons in the dimer (a), consisting of two 100 nm gold decahedra separated by a 20 nm gap. An asymmetric mode of excitation is found at 550 nm (b) while a symmetric mode is found at 650 nm (c).

We performed plasmonic HSI on a dimer [1] consisting of two gold 100 nm decahedra on a carbon substrate (Fig. 1). For the dimer nanostructure we demonstrate its imaging as a plasmonic nanostructure, visualizing its plasmonic modes, and we identify the electron beam excitation of symmetric, asymmetric and hybridization modes (Fig. 2).

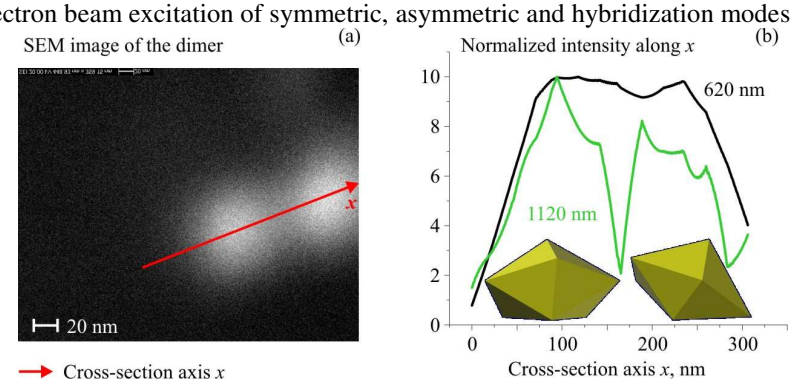

Fig. 2. Intensity distribution along the axis of the dimer (a), illustrating the hybridization mode at 620 nm, at which the nanoparticles collectively act as a dipole, and the separated mode at 1120 nm, in which they act as separate entities (b).

In conclusion, the demonstrated technique can be used in quick examination of plasmonic nanostructures with the resolution of the scanning electron microscope in a single scan. It has all the advantages of plasmon generation by injection of a free electron beam [2,3], such as fast repositioning on the nanostructure and a high localization and intensity of the plasmon source.

References

1. I. Romero, J. Aizpurua, G. W. Bryant, F. J. García de Abajo, "Plasmons in nearly touching metallic nanoparticles: singular response in the limit of touching dimers," Optics Express **14**, 9988 (2006).
2. M. V. Bashevoy, F. Jonsson, A. V. Krasavin, N. I. Zheludev, Y. Chen, and M. I. Stockman, "Generation of Traveling Surface Plasmon Waves by Free-Electron Impact," Nano Letters **6**, 1113 (2006).
3. J. T. van Wijngaarden, E. Verhagen, A. Polman, C. E. Ross, H. J. Lezec, and H. A. Atwater, "Direct imaging of propagation and damping of near-resonance surface plasmon polaritons using cathodoluminescence spectroscopy," Appl. Phys. Lett. **88**, 221111 (2006).