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Hyperspectral imaging of plasmons with nanoscale resolution

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We report on the development of a new technique for the visualization of plasmon excitations in metal nanostructures. The technique uses a nanoscale source of plasmon waves, a "plasmon nano-torch," created by the impact of a focused electron beam [1, 2] and images the sample using light across a broad range of wavelengths generated from the scattering of plasmons by the structure into the free space. By scanning the sample with the "plasmon nano-torch" the technique allows imaging with nanoscale spatial resolution and imaging at hundreds of wavelengths simultaneously.

We illustrate applications of the new imaging technique including the study of spectral dependences of plasmon decay rates on metal surfaces, the visualization of plasmon modes in isolated metal nanoparticles and nanoparticle dimers, the study of plasmon localization and interference in complex meta-material structures, and the investigation of structural phase transition in metallic nano-particles.

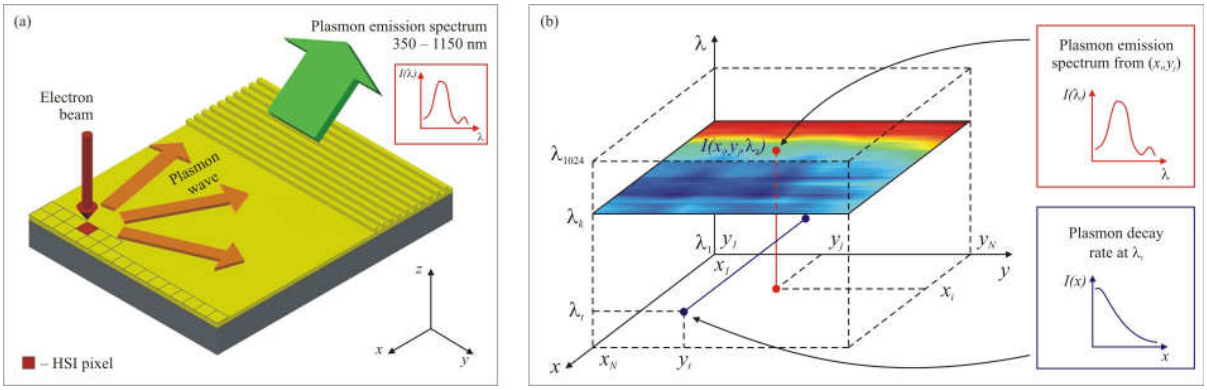

Fig. 1: Hyperspectral plasmon imaging illustrated for the case of a metal film with a grating: at each electron injection point (x_i,y_j) the entire spectrum of the light emission from surface plasmon polaritons decoupled into the free space by the grating is collected at hundreds of discrete wavelengths λ_k, creating a cube of data which may by analyzed to retrieve SPP emission spectra and decay lengths.

[1] M. Bashevoy, F. Jonsson, A. Krasavin, N. Zheludev, Y. Chen, and M. Stockman, *Nano Letters* **6**, 1113 (2006).
[2] J. van Wijngaarden, E. Verhagen, A. Polman, C. Ross, H. Lezec, and H. Atwater, *Appl. Phys. Lett.* **88**, 221111 (2006).