Spatial resolution of coherent cathodoluminescence microscopy

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In coherent cathodoluminescence (CL) imaging of a plasmonic nanoparticle, the time-varying electric field of the electron excites surface plasmon modes. The spatial map of the plasmonic mode measured by CL is determined by the strength of the coupling between the evanescent field of the electron beam and the mode[1]. The spatial resolution by which this map can be measured is unknown. Here, we present measurements of 10-30 keV CL and secondary electron (SE) distributions for over 200 monocrystalline Ag nanocubes[2] (Figure 1) with dimension of 70 nm and with surface plasmon resonances in the 400-700 nm spectral range. We analyze the data using boundary element method simulations (MNPBEM toolbox[3]) of the electron-plasmon coupling and use Monte Carlo simulations (Casino[4]) of the electron trajectories inside the particle and near the nanoparticle edges. We find excellent agreement between the data and our model and find the spatial resolution of the measurement to be less than 5 nm FWHM.

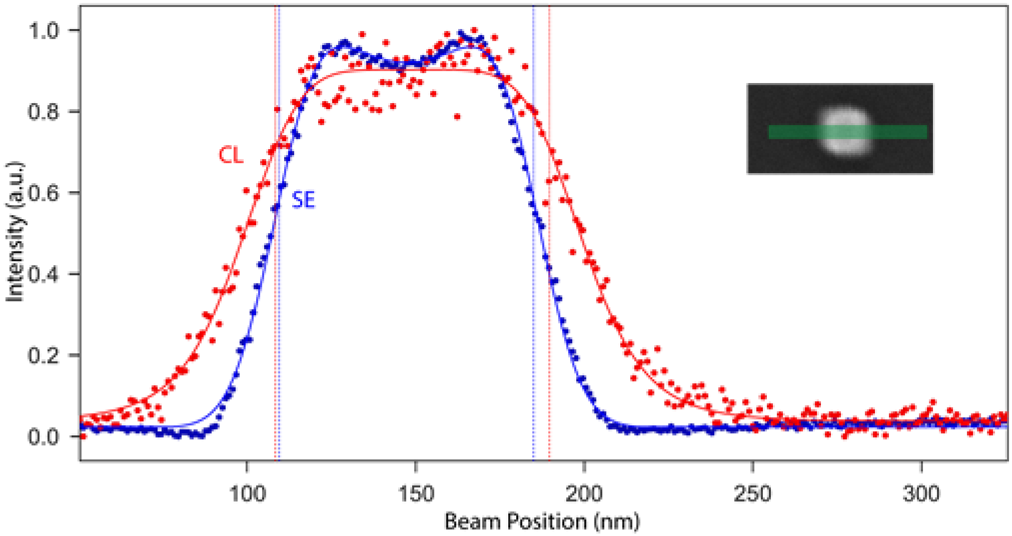

Figure 1 CL intensity (red) and SE contrast (blue) for a line scan across a 70-nm Ag nanocube (inset). The solid lines are the model fits and the vertical dotted lines show nanoparticle edges derived from the CL model (red) and the SE model (blue). The difference between the edge determinations defines the resolution of the CL map.

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(1) García de Abajo, J. *Rev. Mod. Phys.* **2010**, *82*, 209

(2) Sciacca, B.; Berkhout, A.; Brenny, B. J. M.; Oener, S. Z.; van Huis, M. A.; Polman, A.; Garnett, E. C. *Adv. Mater.* **2017**, *29* (26), 1701064

(3) Hohenester, U.; Trügler, A. *MNPBEM - A Matlab toolbox for the simulation of plasmonic nanoparticles*, Elsevier B.V., 2012; Vol. 183.

(4) Demers, H.; Poirier-Demers, N.; Couture, A. R.; Joly, D.; Guilmain, M.; De Jonge, N.; Drouin, D. *Scanning* **2011**, *33* (3), 135 - 146.