Emission hotspots in complex metal nanostructures

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Abstract: We have observed that in complex nanostructures, such as pairs of nanorods, hotspots of optical emission induced by electron-beam excitation exist at their point of closest proximity, where strong local field enhancements are expected.

Individual metallic nanoparticles subjected to highly localized electron-beam excitation show hotspots of optical emission related to their geometry- and composition-dependent surface plasmon modes, as illustrated in Fig. 1a for a gold nano-prism. Here, bright emission at 600 nm is observed for electron injection points at the tips of the triangular particle. We now show that in more complex multi-particle structures, emission hotspots exist at the points of closest proximity between particles.

Spatially resolved measurements of electron-beam-induced light emission were performed in a scanning electron microscope, with light collected in the far field for spectral analysis. Figs. 1b and 1c show emission maps at 570 and 720 nm respectively for paired arrangements of gold nanorods on a carbon substrate. Light emission is found to be substantially stronger for injection points around the junctions between the rods than for any other point on the structures. It is exactly in these regions that strong local field-enhancement effects are expected as a result of the change in local density of states that occurs when the nanorods are brought into close proximity.

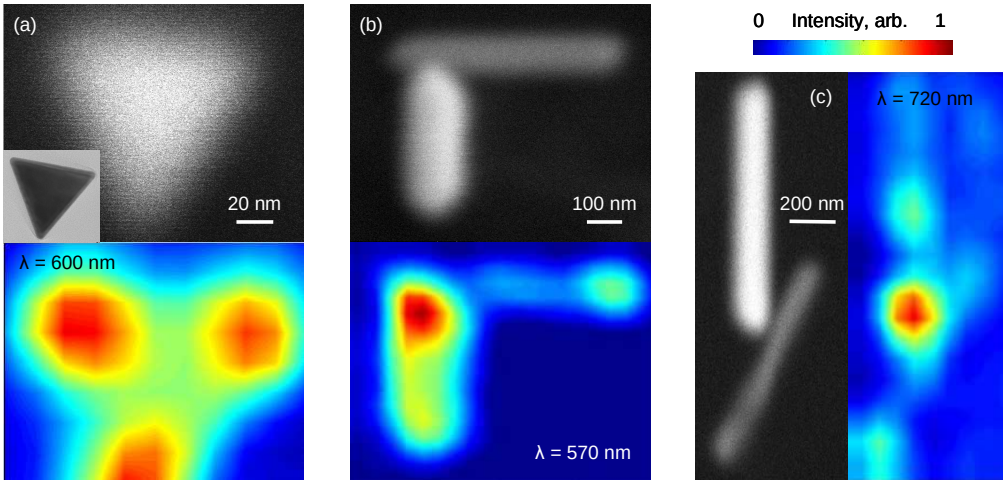

Figure 1: (a) Secondary electron image and corresponding electron-beam-induced radiation emission map at 600 nm for a gold nano-prism. A higher resolution TEM image of such a prism is show inset. (b and c) Secondary electron and light emission images for pairs of gold nano-rods.