# Transition radiation in cathodoluminescence spectra of silicon nanoparticles


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Cathodoluminescence (CL) spectroscopy, where signals generated from the excitation of a material by a fast electron beam are harnessed, has been extensively employed for analyzing the optical properties of plasmonic and dielectric nanostructures. Despite its undeniable success, particular care must be taken when interpreting the CL measurements, since the recorded signal can originate from the interplay of different excitation mechanisms. Transition radiation (TR) is a prominent source of coherent radiation emission, generated when the electron beam penetrates the nanoparticle [1]. As the electron approaches the surface of the particle, so does its image charge inside the medium, until, at contact, the two charges collapse. Therefore, two electric dipoles are formed —at the entrance and the exit point of the electron beam— that can interfere constructively or destructively [see Fig. 1(a)], depending on the electron time of flight inside the medium [2].

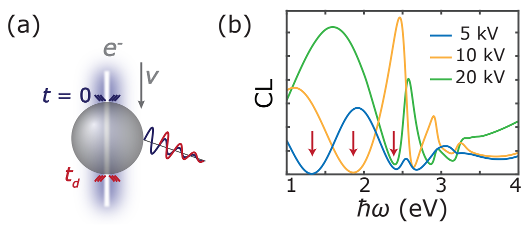


Figure 1: (a) Emergence of TR at the upper and lower surfaces of a nanoparticle crossed by an electron beam through its center. (b) Theoretical CL spectra for a silicon sphere 75 nm in radius, for the different acceleration voltages given in the inset. The arrows indicate the destructive interference minima.

Here we show, experimentally and theoretically, that interfering TR signals can generate distinct spectral features that distort the recorded spectrum and lead to potentially erroneous assignment of modal character to them [see Fig. 1(b)] [3]. We then offer an intuitive analogy that helps distinguish between the particle Mie resonances and the TR contribution.

## References


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

[2] Pogorzelski, R., and Yeh, C., Phys. Rev. A **8**, 137 (1973).

[3] Fiedler, S. et al, Nano Lett. **22**, 2320 (2022).



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