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Numerical analysis on size dependency of spherical silver nanoparticles in response to an electric field

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Noble metal nanoparticles such as Silver, Gold, and Platinum nanoparticles are used in a broad range of optical applications due to their unique absorption, reflection, and transmittance properties. Such applications include biosensing, improving performances of electronic devices, and nano-optics. In this study, an ambient electric field enhancement around spherical silver nanoparticles in the range of 1 nm to 100 nm diameters was numerically analyzed using COMSOL Multiphysics software. Nanometer scale geometry was designed, and material properties were appropriately set. Using the electromagnetic wave module, a transverse electric input port of 1 W was created, and the output port was set to be parallel to the input port. The study was conducted by simulating an incident electromagnetic wave with 500 nm wavelength in the geometry built. Results showed that electric field enhancement in the vicinity of the nanoparticles (~10 nm) was over 2000-fold relative to the background electric field. The electric field enhancement showed a positive relationship related to nanoparticle size, with a maximum electric field enhancement at 100 nm for the considered diameter range. The simulations illustrated that the spherical nanoparticles enhance the electric field in the vicinity, which consequently enhance the optical properties in the ambient environment, and it is dependent on the diameter of the nanoparticle. The findings emphasize the importance of a thorough understanding of size-dependent phenomena in nanoparticles, and its need of precision in nanoparticle design and manipulation for tailored functionalities and applications.

Keywords: Nanoparticle, Numerical Analysis, Electric fields

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