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Modeling the optical response of plasmonic nanoparticles

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Abstract

In this research, the optical response of gold and silver plasmonic nanoparticles to incident plane wave with intensity of 13.3 W/cm^2 has been modeled for two geometrical structures of a whole sphere and a quarter sphere in the radial range 1 to 500 nm. The Helmholtz equation was solved by the FEM method and by applying the PEC and PMC boundary conditions with the appropriate mesh selection, for each of the geometrical structures independently, and the corresponding absorption and scattering spectra were obtained. The scattering pattern for gold nanoparticles at selected radii of 20, 50, 80, 100 and 500 nm shows that the minimum scattering intensity for the first three radii occurs at angles of 90, 85 and 65 degrees, respectively. As the radius increases, the minima are observed far away from the 90- degree angle, and the number of them also increases. Modeling at radii greater than 100 nm leads to the production of plasmonic nanojets while dipolar behavior occurs below 30 nm radius. We have determined the radial range of the maximum surface enhancement of the electric field for silver nanoparticles. The tunability of the SPR location with the dielectric constant of the medium and the radius of the nanoparticles has been investigated. We have shown that the red shift for 5, 10, 15, 20, 25 and 30 nm nanoparticles equals to 56, 72, 206, 232, 252 and 262 nm, respectively.

Keywords: plasmonic nanoparticles, absorption spectrum, dielectric function, near field enhancement, far field pattern

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