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Influence of particle shape on the efficacy of plasmonic metal nanoparticles to enhance the energy conversion efficiency of thin-film solar cells

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The energy conversion efficiency of solar cells can be enhanced significantly due to the effect of coupling the solar cells with plasmonic nanostructures. However, while the advantage of using plasmonic nanostructures has already been established, the physical parameters of the structures at which the efficiency is optimized has not yet been thoroughly analyzed. Of all the possible parameters, this study analyzes, via rigorous simulations, the impact of plasmonic nanoparticle shapes in enhancing the energy conversion efficiency of solar cells. The different shapes that were taken in to account in this study were cubes, cylinders, pyramids, spheres and spheroids, respectively. Through this study, it was found that spherical silver nanostructures, of radius 50nm, showed the most significant improvement in optical absorption and electrical current generation enhancement from thin-film solar cells. The study also presents results that suggest the reasons for which the more spherical nanostructures are showing the greater improvement. The conclusion reached in this study has been made through established analytical techniques, namely extinction spectra analysis, optical absorption enhancement studies, short circuit current density simulations, 3-dimensional angular scattering analysis and near field imaging studies.