Computational Study on the Optimized Random Array of Plasmonic Metal Nanoparticles for Maximum Solar Spectrum Absorber

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Plasmonic nanostructures have been employed for solar energy conversion. In particular, metallic nanoparticles (NPs) can work as broadband solar absorbers due to plasmonic resonances. However, ordered array of the NPs is limited to cover broad solar spectrum. Instead, randomized 2D array with different inter-distances can work for absorption of wide spectrum. Unfortunately, it has not been studied to find the optimized disorder. In this study, we designed the 2D random array of Ag NPs targeting maximum optical path length of incident light in underlying dielectric layer such as hybrid organic perovskite film. Using 3D Monte Carlo ray tracing method, we calculated the extension of the optical path length with different wavelengths and incident angles and found that the optimized disordered array exhibits enhanced optical path length compared to ordered array. The designed random array of metal NPs is expected to work for designing and fabricating a variety of solar energy converters such as solar cells, solar-steam generator, and solar hydrogen generators.