Computational Study on the Optimized Random Network of Plasmonic Metal Nanowires for Maximum Solar Spectrum Absorber

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Plasmonic nanostructures have been employed for solar energy conversion. In particular, metallic nanowires (NWs) can work as broadband solar absorbers. This is due to the multi-mode plasmonic resonances. In a 2D network, metal NWs generate linear segments with different lengths, which cover wide range of solar spectrum. The 2D network can also provide advantages for large scale devices with cost-effectiveness. However, it has not been studied to find the optimized random network of NWs for maximum absorption solar spectrum. In this study, we designed the 2D random network of Ag NWs. For design, the primary resonance mode of Ag NWs with different lengths is calculated by numerically solving Maxwell equations. Given the primary mode, we next optimized the overall extinction of the solar spectrum using Monte Carlo simulations. From the calculations, the optimized number density of Ag NWs was determined by the primary mode, NWs' geometry, and the substrate. The computationally designed random network of metal NWs 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.