Optical simulation of hemispherical silicon nanostructure for silicon solar cells

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Abstract

Silicon, being an indirect band gap material, has low optical absorption coefficient especially at the energies near the band gap. Hence, the efficient light management scheme is needed to trap the light inside the active region of the solar cell until it get absorbed. Silicon nanostructures, with feature size and periodicity in the order of the wavelength of light, exhibit excellent anti-reflection and light trapping properties for broad wavelengths and incident angles [1]. These nanostructures significantly enhance the light absorption by multiple internal reflection and also reduce the front surface light reflection by gradually increases the refractive index from air to substrate. The reflectivity of these structures mainly depends on the periodicity, height, duty cycle, and shape of the nanostructures [2]. In this work, the optical simulation for the reflectivity of dome-like hemispherical silicon nanostructure was carried out using Lumerical FDTD commercial software. The minimum reflectivity of the optimized hemisphere structure was 0.8% whereas the reflectivity of 39% for planner silicon at 460 nm wavelength.

Keywords: Light trapping; Sub-wavelength texturing; FDTD; Anti-reflection; Silicon solar cells

References

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