Optical simulation of one-dimensional silicon gratings for silicon solar cells

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Abstract

Minimizing the optical losses is very crucial in achieving higher efficiencies is silicon solar cells. More than 30% of the incident light is lost via reflection in planner silicon solar cells and this is more pronounced in short wavelength range [1]. One of the techniques that addresses this issue is the front surface texturing. Silicon nanostructures, with feature size and periodicity in the order of wavelength of light, exhibit excellent anti-reflection behavior for broader wavelengths and incident angles. These nanostructures significantly reduce the Fresnel reflection by gradual increase in the refractive index from air to substrate. The reflectivity of these structures mainly depends on periodicity, height, duty cycle and shape of the nanostructures [2]. In this work, the reflectivity of one-dimensional silicon gratings was studied using Lumerical FDTD commercial software. The minimum reflectivity of the optimized square grating and triangular grating were 13% and 10% respectively, whereas the reflectivity of 33% and 35% for planner silicon at 900 nm and 700nm wavelength.

Keywords: Light trapping; sub-wavelength grating; FDTD; anti-reflection; silicon solar cells

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