Enhanced Broadband Absorption of Crystalline-Amorphous Core-Shell Silicon Nanowire Array Via Diverse Geometry Design

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ABSTRACT Nanowires (NWs) solar cells have the potential to outperform the thin-film counterparts in terms of optical absorptance. In this study a novel silicon nanowire (SiNW) array structure that has near-unity absorption spectrum is proposed. The design of the new SiNW array is based on inclusion of diverse radius nanowires with proper geometrical distribution in the array. The distribution of the NWs in a unit cell is inspired from the diamond lattice structure. The optical absorption is studied for a nanowire heterostructure consisting of a crystalline silicon core surrounded by a conformal shell of amorphous silicon. The proposed heterostructure arrays with multiple wire radii are simulated using the Ansoft's HFSS software package and shown to achieve ~38% efficiency enhancement improvement over a uniform periodic array. The new design shows significant enhancement of the absorption spectrum over the entire solar spectrum of interest with significant reduction of the amount of material. The enhanced optical properties of advocated silicon nanowire array indicate potential use in the design of a wide range of nano-scale semiconductor electro-optical devices, including photovoltaic solar cells.

KEYWORDS Heterostructure silicon nanowires, optical properties, broadband absorption spectrum, solar cell efficiency, radii diversity.

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