Broadband high efficiency silicon nanowire arrays with radial diversity within diamond-like geometrical distribution for photovoltaic applications

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ABSTRACT In this study we report novel silicon nanowire (SiNW) array structures that have near-unity absorption spectrum. The design of the new SiNW arrays is based on radial diversity of nanowires with periodic diamond-like array (DLA) structures. Different array structures are studied with a focus on two array structures: limited and broad diversity DLA structures. Numerical electromagnetic modeling is used to study the light array interaction and to compute the optical properties of SiNW arrays. The proposed arrays show superior performance over other types of SiNW arrays. Significant enhancement of the array absorption is achieved over the entire solar spectrum of interest with significant reduction of the amount of material. The arrays show performance independent of angle of incidence up to 70 degrees, and polarization. The proposed arrays achieved ultimate efficiency as high as 39% with filling fraction as low as 19%.

KEYWORDS Guided waves; Sub-wavelength structures, Nano structures; Thin films, Optical properties; Solar energy; Nano materials; Optical engineering.

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