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ABSTRACT

In this study, the substantial performance enhancement of crystalline silicon (C-Si) solar cells through the combined utilization of two luminescent down-shifting europium (Eu)-doped phosphor species in the silicate (SiO_2) layer was experimentally demonstrated. The combination of emission wavelengths of 512 nm and 550 nm, of 512 nm and 610 nm, and of 550 nm and 610 nm from the two Eu-doped phosphor species, respectively, was proposed to achieve a broad band luminescent emission as well as a higher conversion efficiency. The surface morphologies and optical properties of the 3-wt% Eu-doped phosphor species mixed with SiO_2 solution coated on C-Si solar cells via a spin-on film technique were characterized by scanning electron microscopy, photoluminescence, optical reflectance, external quantum efficiency, and photovoltaic current density-voltage measurements under one sun AM 1.5G illumination. The short-circuit current density enhancement (ΔJ_{sc}) of the Si solar cells with Eu-doped phosphor particles on a SiO_2 layer was 4-9% higher than that of cells with only a SiO_2 layer. A ΔJ_{sc} of 19.85% and a conversion efficiency enhancement of 15.97% for the cells with the combination of two Eu-doped phosphor species with emission wavelengths of 512 nm and 610 nm were obtained due to broad band luminescent emission and forward light scattering.

Keywords: Luminescent down-shifting; Eu-doped phosphors; Light scattering; Silicon-based solar cells