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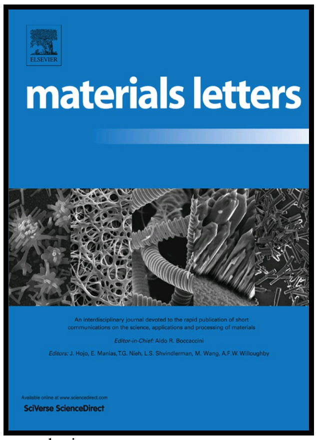

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Application of a Dual Functional Luminescent Layer to Enhance the Light Harvesting Efficiency of Dye Sensitized Solar Cell

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Abstract

A luminescent coating of $CaAlSiN_3:Eu^{2+}$ particles applied on photoanode (TiO_2) layer of SQ1 sensitized solar cell by doctor blading the paste of phosphor particles. The luminescent layer acted as a dual functional layer and enhanced the short circuit current density (J_{SC}) by 64% via both scattering effect and downshifting of the photons in 400-600 nm spectral range to photons in 600-800 nm spectral range. Considerable relative enhancement in incident photon to current conversion efficiency (IPCE) up to 350% in 400-600 nm spectral range proves the down shifting effect as the dominant factor for the improved performance of dye sensitized solar cell (DSSC).

Keywords: Luminescence; Phosphors; Solar energy materials

1. Introduction

Since the breakthrough work conducted by O'Regan and Gratzel in 1991[1], dye sensitized solar cells have garnered much attention owing to relatively good efficiency and low fabrication cost [1,2]. The critical problems that limit the photon conversion efficiencies of a DSSC are low absorption cross-section and insensitivity of the dye molecule to the full solar spectrum. Therefore, the most straightforward way to increase the short circuit photocurrent of DSSC is to both intensify and broaden the absorption of incident light [3,4]. Light scattering is commonly applied in a DSSC to enhance the light harvesting (LH) by increasing the sunlight optical path length in photoanode [5]. Moreover, optical methods such as photon conversion by luminescent materials have been used to broaden LH by transforming un-absorbed photons into the absorption band by upconversion/downconversion/down shifting processes [6-10].

In our earlier report [11] we successfully demonstrated the potential of luminescent down shifting (LDS) technique by using NIR absorbing squaraine (SQ1) as a dye and visible light absorbing inorganic phosphor $CaAlSiN_3:Eu^{2+}$ as LDS material. The LDS layer was applied outside the DSSC in a reflective configuration, and it showed more than 50% increase in short circuit photocurrent of the device. Also, we made a detailed assessment of LDS layer outside DSSC [12]