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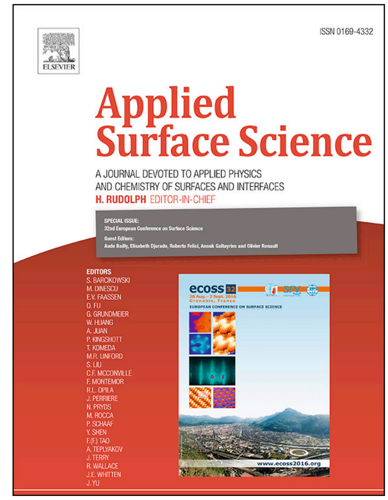

Full Length Article

Multiscale array antireflective coatings for improving efficiencies of solar cells

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Multiscale array antireflective coatings for improving efficiencies of solar cells

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ABSTRACT Multiscale array (MSA) structures are present to reduce the front-side surface reflection loss of solar cells, which consists of nanostructure patterns spanned across the curved surface of micrometer-sized plano-concave cylindrical arrays. The MSAs are fabricated using flexible polydimethylsiloxane (PDMS) polymer by simple template replication together with surface modification technique and characterized by atomic force microscopy (AFM) and scanning electron microscopy (SEM). Optical characterization shows the MSA structure can reduce 3.85% integrated reflectivity of multicrystalline silicon solar cell encapsulated by the flat epoxy resin polymer (ERP) coating. Importantly, the MSA antireflective coating can improve the photovoltaic conversion efficiency of the ERP-encapsulated solar cell from 17.50% to 18.34% and can increase the contact angle of a 2 μL water droplet on the solar cell surface from 110.5° to 153.1°. These improvements have great significance for commercial Si solar cell devices.

Keywords: multiscale array structure, antireflective coating, photovoltaic conversion efficiency, nanowrinkle

1. Introduction

Suppressing the front-side surface reflection is crucial in developing high-performance solar cells. According to optical mechanism, reducing the front-side surface reflection losses can be divided into two methods: antireflective (AR) flat dielectric film and texturized surface [1]. A single- or multi-layer flat dielectric films can effectively suppress the front-side surface reflection. However, the fabrication processes of these flat films were typically involves costly vacuum deposition equipment which leads to high cost for preparation [2-5]. Compared with these flat dielectric films, texturized surface exhibits better durability and mechanical stability due to its monolithic structure and homogeneous material. More importantly, the texturized surface can provide broadband and wide-angle AR properties. A variety of surface texturing micro/nanostructures, such as nanowires [6, 7], nanopillars [8, 9], binary nanogratings [10, 11], spherical and cylindrical microlenses [12, 13], micro/nanocones [14, 15], biomimetic moth-eyes

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