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MODELING AND SIMULATION OF OPTICAL CHARACTERISTICS IN A TEXTURED A-SI THIN FILM SOLAR CELL USING THE TRANSFER MATRIX METHOD

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Abstract. *A simulation of a thin film hydrogenated amorphous silicon cell was developed, in order to demonstrate the use of the transfer matrix method, TMM , with diffusive interfaces to model a textured a-Si solar cell. A quantum efficiency comparison between experiment and simulation of thin film a-Si:H solar cell was performed. We have implemented a self-consistent optoelectronic model for simulation of solar cells with rough textured interfaces.*

Key words: thin film solar cells, transfer matrix, quantum efficiency

1. Introduction

Worldwide growth of photovoltaics has been fitting an exponential curve for more than two decades [1-3]. During this period of time, photovoltaics (PV), also known as solar PV, has evolved from a pure niche market of small scale applications towards becoming a mainstream electricity source [4]. There that is being made a rapid progress with inorganic thin-film photovoltaic (PV) technologies, both in the laboratory and in industry. While amorphous silicon based PV modules have been around for almost 30 years, recent industrial developments include the first polycrystalline silicon thin-film solar cells on glass and the first tandem solar cells based on stacks of amorphous and microcrystalline silicon films [5-7]. Optical modeling has become a powerful tool for analyzing the optical properties of the thin-film solar cells. To model the complex optical behavior in the multi-layer optical systems with rough interfaces, such as a-Si solar cells, accurately, there should be taken into account both the interference effects and light scattering [8]. To optimize the performance of the solar cells by taking advantage of the enhanced light absorption, one needs to understand the influence of light scattering on the absorption profile in the solar cell. We would expect that the light is completely scattered, or in other words, diffused in the solar cell after passing through several rough interfaces. However, in wavelength-dependent spectral response and total reflection measurements on the solar cells, a moderately pronounced interference pattern can be observed. This indicates that besides the scattered light, which propagates incoherently in different directions, there is still a significant amount of specular light in the structure that propagates coherently.

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