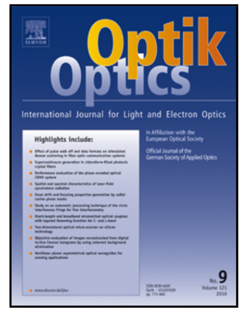

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Simulation analysis of inverted organic solar cells with grating structure: undesirable effects of high absorption near grating anode

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Abstract

An inverted organic solar cell (IOSC) with nanograting array as anode of the cell has been simulated and analyzed using a combined electrical and optical approach. We have used finite difference time domain (FDTD) method for optimizing device structure. We have compared the characteristics of the IOSC with grating structure with a reference IOSC without grating structure. As a result, an improvement of 11% and 26% in power conversion efficiency (PCE) and short circuit current (J_{SC}) compared to the reference structure was achieved. An analysis is provided on the origin of reduced fill factor (FF) in the IOSC with grating structure. We also have discussed about disadvantage of using optical approaches for optimization of the device structure and the need for coupled electrical-optical approaches to achieve more accurate results.

Keywords: organic solar cell, inverted structure, grating, fill factor

I. INTRODUCTION

By utilizing plasmonic effects in thin-film photovoltaic devices, optical properties can be improved due to ability of plasmonics in strong light scattering and extreme subwavelength confinement. By introducing metallic nanostructures, light absorption at the active layer of devices will be enhanced, which results in short-circuit current (J_{SC}) and power conversion efficiency (PCE) enhancement. Plasmonic effects can particularly improve power conversion efficiency in organic solar cells. In organic materials, short carrier (especially hole) diffusion length restricts the active layer thickness. Light-trapping strategies utilizing plasmonic metallic nanostructures as light concentrators offer a highly attractive solution to this problem [1-3].

In this work, we have used inverted structure and Ag nanograting arrays as the anode of inverted cell. Ameri *et al*. [4] have demonstrated that the inverted architecture allows more photons to be absorbed in the active layer because of more favorable electromagnetic field distribution inside the active layer and reduced absorption losses in the PEDOT:PSS layer. By using periodic metallic gratings as subwavelength antennas and scattering centers, we can enhance the absorption in the active layer and consequently the device performance [3]. Majority of previous works, rely on optimization of the structure based on optical properties of the cell and don't consider electrical effects. We have optimized IOSC considering interplay between optical and electrical effects. In