

MARINA MARIANO JUSTE
Advisor: Jordi Martí



PhD Thesis Defense **MARINA MARIANO** 'Light Harvesting in Fiber Array Organic Solar Cells'

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Tuesday October 21, 11:00. ICFO Auditorium

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Organic Nanostructured Photovoltaics

ICFO-The Institute of Photonic Sciences, SPAIN

Considering that the most abundant renewable energy source is the Sun, photovoltaic technology possesses one of the highest potentials to provide environmental benign and sustainable energy worldwide. Currently, most of commercially available modules are fabricated from crystalline silicon because of its high efficiency. To lower fabrication costs and increase the functionality of the solar modules, several thin film technologies are under development. Among them, organic photovoltaics have created large expectations,

providing some intrinsic advantages, such as light weight, flexibility or semi-transparency.

However, the low charge mobility in the majority of the organic semiconductor materials prevents the use of active layers thicker than a few hundred nanometers. This leads to a limited light harvesting capacity and, consequently, a limited conversion efficiency. Different optical approaches have been considered to enhance the absorption of organic solar cells and increase their efficiency. In this thesis, we propose a novel configuration based on the use of fiber arrays to effectively trap light and efficiently couple it into the active layer to enhance absorption.

The thesis work is presented in five chapters. After an introductory chapter, in chapter 2 light absorption of an organic solar cell deposited on the backside of a fiber array is studied theoretically. A strong enhancement in light harvesting is predicted using such configuration. For small diameter fibers the enhancements originated from light coupling to some low quality whispering gallery modes, while for large diameter fibers light seemed to be effectively trapped inside the fiber structure.

In chapter 3 and 4, we consider the dip-coating procedure, a fabrication technique that can be applied to deposit from a precursor solution, layers on a substrate irrespective of its shape. Its viability is demonstrated by applying it to different device architectures. The deposition on such non-flat substrates of the rest of the layers forming an organic solar cell is also examined. For instance, several relevant changes that had to be introduced to the ITO sputtering to obtain transparent electrodes with an optimal quality, both, optically and electrically, are discussed.

Once the layer deposition is optimized to fulfill the electrical and optical requirements of organic solar cells, in chapter 5, we experimentally demonstrate that an enhanced light absorption can be achieved from such organic solar cells when deposited on fiber arrays. Optical fibers of 80 μm in diameter were used to fabricate the arrays to be used as the cell substrate. Such substrates were coated with an organic solar cell of evaporated small molecules. The implemented fiber array configuration is seen to be an effective light trapping

method. Indeed, the photogenerated current from such devices is shown to increase by 26%, which is a considerable percentage when compared to the majority of the optical approaches that were considered in the past to enhance absorption in organic cells.

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