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Organic Photovoltaic Devices Based on Polythiophene using Thin TiO_2 Films as Intermediate Layer

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Abstract – Organic photovoltaic devices with polythiophene electrochemically synthesized as active layer are presented. The device efficiencies are improved when a sol-gel TiO_2 layer is placed between the transparent electrode (FTO) and the organic active layer (PT) in a sandwich structure FTO/TiO_2/PT/Al or Au. The spectral response (IPCE), with illumination throughout the FTO reached 9% (λ = 610 nm, 1 W/m^2) what is three times the response for devices without TiO_2 and with the same PT thickness. The device conversion efficiency for the fabricated devices was obtained through the J(V) curves.The AFM images and X-ray difractograms are also presented.

Organic photovoltaic devices with active layer produced by electrochemical methods are promising on account of their photovoltaic behavior and the easiness of these fabrication methods. In this work, the influence of thin titanium dioxide (TiO_2) films on the efficiency of photovoltaic devices based on polythiophene (PT) films electrochemically synthesized were investigated. The PT and its derivates are p-type semiconductors which are very stable under environmental conditions and presenting a large absorption coefficient in the visible range of the spectrum. TiO_2 is an n-type semiconductor with a large gap and with a strong stability under environmental and high illumination conditions. The TiO_2/PT interfaces improve the device efficiencies by increasing the dissociation of the exciton generated in PT layer by the radiation absorption, also improving the device lifetime.

The devices were fabricated in a sandwich structure (FTO/TiO_2/PT/Al or Au) using films of fluorine doped tin oxide (FTO) as transparent electrode. The TiO2 film was obtained by the sol-gel method. The PT films were produced in a 3-electrode cell, with Ag/AgCl as reference electrode and Pt as counter electrode [1]. The composition of the TiO_2 films was determined by X-ray diffraction technique. The results shown that the TiO_2 films are predominantly composed by the anatase phase, which is the best phase for photovoltaic purposes. TiO_2 surface morphology was also investigated throughout AFM analysis.

The presented results show that TiO_2 layer improves considerably device efficiency when compared with those obtained from conventional FTO/PT/Al devices [1]. This behavior is discussed in terms of the internal field distribution in devices with TiO_2 layer.

[1] R. Valaski, C. D. Canestraro, L. Micaroni, R. M. Q. Mello, L. S. Roman, *Solar Energy Materials and Solar cells*, v. 91, 684 – 688 (2007).