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Tesis: "ANALYSIS OF ORGANIC SOLAR CELLS FILMS THROUGH SCANNING PROBE MICROSCOPIES"

Resumen:

In this Ph. D. dissertation Scanning Probe Microscopies (SPM) are used for the analysis of semiconducting organic compounds widely used in organic solar cells (OSCs). Scanning Tunneling Microscopy (STM) images of PEDOT:PSS film show an ellipsoidal shape of PEDOT surrounded by PSS with 4 nm size. Meanwhile, P3HT films form well-defined crystalline domains with an average interchain distance around 1.41 nm and a chain length ~41 nm. PTB7 chains show a worm-like pattern with a distance of ~2 nm between backbone chains and a chain length of ~90 nm. Besides, by using STM and Scanning Tunneling Spectroscopy (STS), morphology evolution process and energetic level alignment of the low molecular weight molecule DRCN5T and DRCN5T:[70]PCBM blend are analyzed after applying thermal annealing at different temperatures. These films exhibit a worm-like pattern without thermal annealing (amorphous shape); however, after applying thermal annealing at 120°C, the small molecule film domains crystallize. Furthermore, energy band diagrams of the semiconductor bulk heterojunction (blended film) at the donor-acceptor interface are determined by STS. Here is also reported the possible application of carbo-benzenes derivatives as Self-Assembled Hole Transport Monolayer (SA-HTM) to replace the most common p-type contact, PEDOT:PSS. STM images of PBDB-T shows chain-to-chain distance of 950 pm. Meanwhile, STM images of PBDB-T:ITIC blend suggest why PBDB-T domains could facilitate charge dissociation, further, a strong inter-chain π-π interaction of the ITIC molecules could form the electron transport pathways. Moreover, when correlating Electrostatic Force Microscopy and photoconductive Atomic Force Microscopy, the blend morphology and its electrical/electronic properties are determined; the ideal domain size of PBDB-T:ITIC for maximizing the generated photocurrent is 15-35 nm. Therefore, morphology and energy characteristics can be correlated with the OSC performance. The power conversion efficiencies for OSCs based on P3HT was 3.4%, for PTB7 = 8.3%, DRCN5T = 9.0% and for PBDB-T:ITIC = 9.2%.