Investigating dark degradation in PTB7-Th:PC71BM organic solar cells: Insights from stability studies and characterization techniques

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Organic solar cell (OSC) devices have increased their power conversion efficiency (PCE) in recent years. PCE has reached 19% in single-junction cells. However, the degradation of OSCs poses a significant challenge that affects efficiency, stability, and production costs. Performance degradation is a key obstacle limiting the commercial use of OSCs. Various factors influence the stability of these devices, including light, humidity, oxygen, heat, and device structure. The active layer materials, which are the most crucial functional layer in these devices, are heavily impacted by these factors in terms of efficiency and stability. In this study, we investigate the dark degradation of PTB7-Th:PC71BM organic solar cells. Stability studies were conducted following the ISOS-D1 (shelf storage) protocol for devices tested in air, in the dark with no load, and without encapsulation. These studies provide information on the tolerance of the solar cells to oxygen, moisture, and other components naturally present in air. Photovoltaic optimization and characterization were performed through current-voltage (J-V) measurements. This experiment provides information on charge extraction in organic solar cells and parameters indicating alterations during dark degradation. The interaction with ambient species can promote the formation of traps or barriers to charge carriers. Additionally, changes in the parameters Voc, Jsc, FF, efficiency, resistances were observed with exposure, and the T80 of the devices was calculated. Optical spectroscopy provides insights into chemical processes that lead to significant absorption loss under ambient conditions. Infrared measurements highlight the sensitivity of the conjugated polymer backbone to oxidation. Atomic force microscopy (AFM) measurements provide information on chemical degradation at the nanoscale due to moisture. Through infrared measurements in combination with other experimental techniques, it is possible to confirm chemical degradation and possible changes in materials due to exposure to oxygen and humidity at the nanoscale.

References:

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