

Abstract

Over the past three decades, tremendous amount of research has been devoted to the field of renewable energy in order to reduce our dependence on fossil fuels. Among them, organic (OSC) and perovskite (PSC) solar cells have gained enormous attention as they offer unique advantages compared to the traditional silicon solar cells, such as low fabrication cost, mechanical flexibility, light-weight modules and semi-transparency. These unique properties offer a wide range of applications and integration schemes, which make this field of research even more exciting. OSC and PSC have recently achieved power conversion efficiencies (PCE) of around 15% and 22%, respectively, emphasizing the great potential of the technologies. However, both of these devices suffer from low stability and short lifetime (degradation). Therefore, understanding the degradation mechanisms of these devices, paves the way for viable commercialization of this appealing technology in the market.

This work is dedicated to investigate governing degradation mechanisms and pathways taking place inside organic and perovskite solar cell devices. First part of the work focuses on the performance and stability of DBP-C₇₀ based organic solar cells in standard and inverted device configurations. We study their device stabilities by aging them under ISOS-D-3 (darkness, 85°C and 85% RH-humidity) and ISOS-T-3 (darkness, -40°C and room humidity) conditions. The results show that despite a change in the performance upon aging, there is a pronounced morphological stability at the DBP-C₇₀ interface. Possible effects from the electron transport layer (ETL) on the device stability were investigated, demonstrating that this layer contributes significantly to the degradation of the inverted devices.

The second part of this work focuses on understanding the degradation mechanisms taking place inside perovskite solar cells under real operational conditions. Results for indoor (ISOS-L-1, illumination, 60 °C and ambient humidity) and outdoor (ISOS-O-1, sunlight, ambient) degradation test conditions are conducted, showing reversible and irreversible degradation mechanisms under light-darkness cycles, which reveal interesting degradation pathways and emphasize on the importance of including these cycles in experimental protocols for the assessment of long-term stability of the PSCs.