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Interfacial degradation in organic thin films for optoelectronic and photovoltaic applications: challenges and opportunities

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After efficiency, lifetime is the second most important parameter for molecular photovoltaic devices. In organic solar cells (OPVs), heterojunctions play a defining in device stability. They also control the major processes: charge separation relies on effective organic/organic interfaces; charge transport is critically determined by the structure of the thin film, controlled by the organic/inorganic interfaces with substrates; and charge extraction can only occur at high quality inorganic/organic interfaces at the electrodes.

This contribution reviews the current state of the art with regards to interfacial stability of electrode/active layer interfaces to understand the performance of OPVs. From examples relating to interfacial chemical reactions, interfacial morphological changes, and interfacial electronic level modification, a comprehensive picture of the role of the organic-electrode interfaces in device stability can be formed. Beginning with a brief overview of general degradation in organic devices, including definitions and measurement approaches, this contribution then focuses on two key interfaces within the device architecture. The first is the bottom contact (substrate) interface, where chemical reactions and dewetting are the two main mechanisms of device degradation. The second is the top contact interface, which is prone to oxidation, interdiffusion, blistering and delamination, and inhomogeneous loss of performance (dark spots). For both bottom and top contact interface degradation, various approaches to overcoming device instabilities are given, with special attention to the various interlayers that have been introduced for improved stability. Examples are given where degradation mechanisms are used advantageously to produce novel devices and surprising solutions to device degradation.

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