Stability of Organic Solar Cells

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Organic solar cells can be manufactured in efficient and low cost roll-to-roll processes and have reached power conversion efficiencies above 20%. Especially the development of non-fullerene acceptors has led to remarkable improvements of the OPV efficiencies. The last essential issue to be solved before the technology can be commercialized on a GW scale, is the still moderate stability of OPV limiting the lifetime to a few years. Thus, within this work, we summarize our investigations on polymer/non-fullerene acceptor organic solar cells (OSCs).
OSCs consists of a combination of two organic semiconductors, an electron-donating semiconductor (donor) and an electron-accepting semiconductor (acceptor) with shifted HOMO-LUMO values, arranged either in a bilayer heterojunction or in a bulk heterojunction (inter-penetrating network). The active layer is thereby contacted by selective transport layers and subsequent electrodes. Upon absorption of a photon, excitons (electron-hole pairs) are formed, separated into free charge carriers at the interface via electron transfer (redox-reaction) and the free charge carriers are extracted via the transport layers and electrodes.
Stability issues may arise from the intrinsic (photo and photoelectrical) stability of the materials, the interactions between the materials as well as impurities.

In this contribution, we summarize the current status of organic solar cells and discuss our investigations on different aspects on the OSC´s stability.
The first issue is the photostability of the organic semiconductor as well as the charge transport layers, which can be improved by a careful design of the materials. Secondly, we will discuss the incompatibilty of several materials combinations, e.g. fluorinaated aryl compounds with aluminium electrodes, as this can lead to a dehalogenation reaction and enrichment of fluoride at the interface to the electrode.
Finally we will discuss the purity of organic semiconductors. Whereas purity is of utmost importance in inorganic semiconductor industry, the type and amount of impurities are often not known at all in solution processed OSCs. Thus we carried out a pyrolysis-gas chromatography - mass spectrometric (GC-MS) study on one of the most investigated OSC system PM6-Y6.