Photochemical Stability of Materials for Organic Photovoltaics

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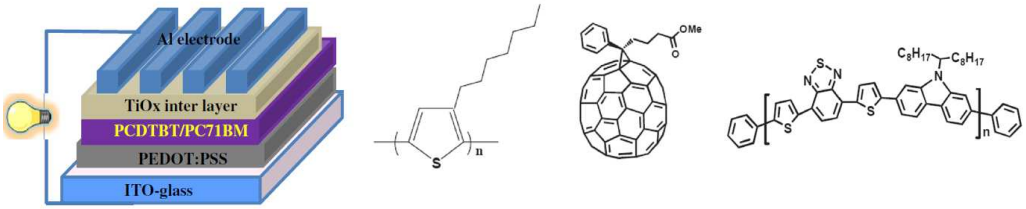
Polymer-fullerene-based donor–acceptor blended bulk hetero- junction (BHJ) solar cells have specific major advantages; for instance, they can be embedded in large-area devices through an efficient, low-cost manufacturing process that involves roll-to-roll methods. Polymer solar cells are now expected to have an innovative impact on developments in the electronics industry, particularly on account of flexibility, light weight, and easy processibility. Moreover, the efficiency of the device has been significantly improved and studied in many ways for several decades through extensive research.

Although the reported device efficiencies are already close to fulfilling some of the requirements of commercial applications, the short life span of polymer- based solar cells is still an obstacle to their commercialization. Because the polymer-based electronic device is seriously vulnerable to UV-visible light, high temperatures, air, water vapor, the photo-thermal stability of semiconducting polymer is essential for investigating the degradation mechanism of a BHJ active layer.



(left) A schematic of a polymer solar cell with a PCDTBT/$PC_{70}BM$ BHJ; (right) Molecular structures of photovoltaic materials (P3HT, PCDTBT, and $PC_{70}BM$).

In this communication, we report the physical and chemical degradation behaviors of active layers based on the current state of the art P3HT (poly(3-hexylthiophene)):$PC_{60}BM$ ([6,6]-phenyl-C_{60}-butyric acid methyl ester).

A new class of push-pull polymers combined with a fullerene derivative have enabled organic photovoltaic efficiencies approaching 10%. One such polymer is PCDTBT (poly[*N*-9”-hepta-decanyl-2,7-carbazole-alt-5,5-(4′,7′-di-2-thienyl-2′,1′,3′-benzothiadiazole). We present the long-term stability of PCDTBT, and PCDTBT in BHJ composites with the $PC_{70}BM$ fullerene derivative ([6,6]-phenyl C_{70}-butyric acid methyl ester).

The last part of the presentation reports part of an inter-laboratory collaboration to study the stability of seven distinct sets of state-of-the-art polymer solar cells. We present the stability data and detailed characterization of devices submitted to accelerated full sun simulation. Cells were submitted for destructive testing to analyze the BHJs. New insights in the variety of mechanisms by which polymer solar cells degrade are presented.