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Non-fullerene acceptors: A universal answer towards addressing the "burn-in" stability challenge of solution processed organic solar cells

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Fullerene-based organic photovoltaics (OPV) tend to exhibit a rapid initial phase of performance loss under 1 sun illumination in nitrogen, dropping by 25–50 % over tens of hours, before entering a slower phase of degradation. This initial rapid phase of degradation is widely referred to as "burn-in" and has had a number of origins suggested, including: photoinduced fullerene dimerization and spinodal demixing. Non-fullerene acceptors (NFA) are a new class of electron accepting materials with reportedly high efficiencies (over 13 %) and promising stability. One such NFA, Eh-IDTBR, was shown to form burn-in free devices when utilized with PCE11. There was a stark contrast in stability when compared with fullerene-based PCE11:PC71BM devices, attributed to the trap-assisted recombination through increased photoinduced trap states in the fullerene-based devices. In this study, we systematically tested the two highest performing families of NFA:IDTBR (>12%) and ITIC (>13%) with a range of polymers. In every case, NFA's outperform fullerene acceptors, exhibiting devices with both higher efficiency and reduced burn-in. We utilized advanced characterization; including transient photovoltage measurements, to provide some insight on the origins of the burn-in effect. We demonstrate a universal superiority of NFA's device stability over fullerenes, indicating that the answer for high performance stable OPV which may lie with NFA development.

Recent Publications

1. Lee H (2018) The role of fullerenes in the environmental stability of polymer: fullerene solar cells. Energy & Environmental Science 11:417–428.
2. Cha H (2017) An efficient, "burn in" free organic solar cell employing a nonfullerene electron acceptor. Adv. Mater. 29:1701156.
3. Li Z (2015) Towards improved lifetimes of organic solar cells under thermal stress: substrate-dependent morphological stability of PCDTBT: PCBM films and devices. Scientific Reports 5:15149.
4. Schroeder B (2014) Enhancing fullerene-based solar cell lifetimes by addition of a fullerene dumbbell. Angewandte Chemie International Edition 53(47):12870–12875.
5. Li Z (2013) Performance enhancement of fullerene-based solar cells by light processing. Nature Communications 4:2227.

Biography

Zhe Li has completed his PhD in 2012 from the University of Cambridge and Post-doctoral studies from the Imperial College London in 2014. Later on he joined Swansea University as a Research Fellow (2014–2016) and Senior Research Fellow (2016-2017). He is now a Lecturer of Energy Materials at the School of Engineering, Cardiff University. He has published more than 30 papers in reputed journals and holder of one industrial patent.

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