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Fullerene oxidation – A key degradation pathway of organic photovoltaic cells

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Environmental stability is a common challenge for the commercialisation of low cost, encapsulation-free organic opto-electronic devices. Understanding the role of materials degradation is the key to address this challenge, but most such studies have been limited to conjugated polymers. Here, we quantitatively study the role of the common fullerene derivative PCBM in limiting the stability of benchmark organic solar cells, showing that a minor fraction (<1%) of photo-oxidised PCBM, induced by short exposure to either solar or ambient laboratory lighting conditions in air, relevant to typical processing and operating conditions, is sufficient to compromise device performance severely. We identify the effects of photo-oxidation of PCBM on its chemical structure and connect this to specific changes in its electronic structure, which significantly alter the electron transport and recombination kinetics. The effect of photo-oxidation on device current-voltage characteristics, electron mobility and density of states could all be explained with the same model of photoinduced defects acting as trap states. Our results demonstrate that the photochemical instability of PCBM and chemically similar fullerenes remains a barrier for the commercialisation of organic opto-electronic devices.

Biography

Zhe Li has completed his PhD from University of Cambridge and Post-doctoral studies from Imperial College of London. Later on, he joined Swansea University as a Research Fellow (2014-2016) and Senior Research Fellow (2016-2017). He is currently working as a Lecturer in Energy Materials at School of Engineering, Cardiff University. He has published more than 30 papers in reputed journals and holder of 1 industrial patent.

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