Hybrid polymer/quantum dot materials for optoelectronic applications

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Indium phosphide (InP) is a III-V semiconductor whose electronic properties are suitable for optoelectronic applications. Moreover, the less toxicity of InP compared to Cd-based materials make it an alternative material for optoelectronic devices. In this work InP quantum dots (InP QDs) were synthesised and surface-modified to enhance compatibility with polymers. For photovoltaic applications, a light harvesting layer was obtained by blending InP QDs (as electron acceptors) with a well-known electron donor polymer, poly-3-hexylthiophene (P3HT). Charge transfer between the polymer and the QDs was investigated by photoluminescence spectroscopy (PL) and Transient absorption spectroscopy (TAS). The TAS decay (Figure 1, left) indicates increasing charge carrier generation with increasing the QD concentration. This emphasises the potential of using InP QDs as electron acceptors in hybrid photovoltaic devices. In addition to the photovoltaic applications, InP QDs were investigated as a light emitter in hybrid light emitting devices with poly(9,9-dioctylfluorenyl-2,7-diyl) (PFO) as a host polymer. The improvement of InP emission with increasing InP loading in the electroluminescence spectra (Figure 1, right) suggests the possibility of using InP QDs as emitters in light emitting applications. Better understanding on relative band offsets of these materials will help designing efficient hybrid systems. Therefore, further studies will focus on photoemission spectroscopy (PES) measurement for energy band determination.

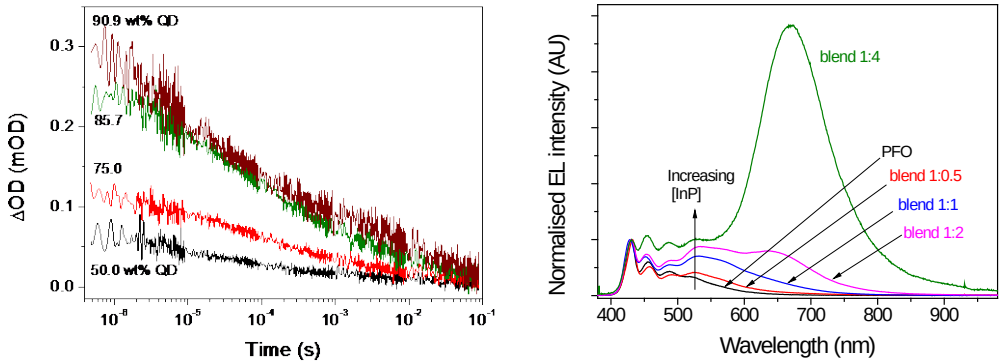

Figure 1. Left: transient absorption decays of P3HT$^+$ polaron in the P3HT:InP blends. Right: electroluminescence spectra showing the InP QD emission in the PFO:InP QD blends. [1]

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[1] T. Boonkoom, InP Quantum Dots for Hybrid Photovoltaic Devices, Ph.D. thesis, Department of Chemistry, Imperial College London, London, 2013