Solution processable inorganic/organic photonic structures of low loss and tunable refractive index for use in photovoltaic devices

Natalie Stingelin, Imperial College London

An ever increasing interest in the development and application of innovative optical and optoelectronic devices places greater emphasis for the advancement of new smart and functional materials that are readily processable. Significant progress has already been realised in the fields of organic light-emitting diodes (OLEDs) and photovoltaic cells (OPVs) through development of novel semiconducting materials. Further developments in these areas are turning to the deployment of photonic structures to aid and improve light management in these systems, e.g. input-/output-coupling, enhanced absorption and waveguiding. In this work, results from a novel class of hybrid material systems that offer an outstanding set of optical and material properties, including tunable refractive index, low optical losses and solution process ability, are presented. We show that the attributes of these novel hybrid material systems can be controlled and manipulated by a range of means that include 'alloying' or suitable post-deposition treatments, such as thermal annealing and/or irradiation with UV-light. As a consequence, these hybrid materials can exhibit refractive indices of up to 2.1 while also being highly transparent over the entire visible, near- and mid- infrared (N-IR, M-IR) wavelength regime [1]. Furthermore, the processing properties allow the realisation of solution-based, optically low-loss photonic structures that are straightforward to implement in structures, such as OPVs. The readily achievable nature of high quality optical properties and the exceptionally low loss from a single high-index up to several microns thick will be demonstrated. Moreover, we illustrate how one can further exploit the versatile properties of these organic:inorganic hybrid systems to produce high-refractive index conducting layers and in a fluid form for the production of unusual solar fuels.