P.26 Cross-sectional imaging of organic solar cells: Understanding efficiency and lifetime issues

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Organic solar cells offer a potentially cheaper alternative to traditional solar technologies, but presently have low efficiencies and poor lifetimes. The structure of the cell and the morphology of the polymer blend forming the active layer are important in attempts to achieve higher efficiencies, whilst not much is presently known about causes of failure and degradation pathways.

TEM imaging of FIB cross-sections allows such devices to be viewed, both before and after cells have been used – offering advantages over other techniques such as AFM which only examine the surface. This approach has enabled us to study the active layer and also the electrical contact layers in real devices. Phase separation in the active layer has previously been observed by TEM [1] but similar results have not been seen here. The similar atomic composition and densities of the two materials means that very little contrast is observed with TEM. This is made more challenging by the miscibility of PCBM [2], the averaging effect of viewing through a three-dimensional sample and the difficulties in accurately interpreting defocused TEM images [3].

This cross-sectional imaging has also been used to study degradation. Water and oxygen are known causes [4] and by observing what is happening in the cell at various stages in the degradation process, failure mechanisms can be better understood. By exposing cells to high humidity it has been shown that the grain size of the aluminium used in the cathode changes the extent of the degradation observed. The use of calcium in the cathode and choice of material for the hole transport layer also affect the degradation. This knowledge should enable cell design to be improved to increase device lifetime.

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