Morphological and Photochemical Stability of PCBM in Organic Solar Cells

Introduction

Materials

A model system of PS:PCBM with device representative substrate of PEDOT:PSS. This enabled focusing on PCBM stability.

Experimental Methods

Morphological stability under illumination and thermal stress

AFM analysis:
- After annealing at 85°C and 100°C, with and without light, topographical relaxation observed at 100°C in the dark only. Light constrains reduction in surface roughness.
- AFM Fourier transforms (FT) while annealing at 120°C.
- Annealing at 120°C in the dark, with and without prior light soaking.

Morphological studies
- Neutron reflectivity (NR) probes the stratification of the film to angstrom resolution, normal to the substrate. (below left)
- Atomic for microscopy (AFM) probes the surface stability. This gives roughness and surface periodicity from Fourier transform. (below right)

Photochemical studies
- Absorption spectroscopy (UV-vis) can monitor PCBM dimerisation and de-dimerisation due to a feature change at ~120 nm. (below)

Results and Discussions

1. The first detailed study examining competitive effects of light and thermal stress, simultaneously.
2. Significant morphological instability observed at 100°C with PCBM concentrations from 20-65%.
3. Topographical relaxation of the top interface and PCBM enrichment on the bottom PEDOT:PSS interface observed for non-light soaked samples.
4. Modelling of the PCBM enrichment suggests PCBM dimers are fully immobilised, significantly inhibiting both surface relaxation and PCBM stratification of the film.
5. PCBM dimerisation activation energy found with in-operando modelling of monomer concentration.

Conclusions

References & Affiliations