# Probing nanostructures using neutrons

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## Abstract

Neutrons, like X-rays, can be used to probe structures at the nanoscale. Some advantages of long-wavelength neutrons compared to X-rays include: a higher contrast for lighter elements relative to heavier ones; an absence of beam damage, and a much greater penetration capability. In this talk it will be demonstrated, using specific examples drawn from our own work, how neutron scattering techniques such as Small-Angle Neutron Scattering (SANS) and Neutron Reflectivity (NR), can be used to probe buried nano-structures in soft matter and materials in general.

In the field of organic photovoltaics [1] we show, using SANS, that in PffBT4T-2OD/$PC_{71}BM$ devices the additive 1,8-diiodooctane (DIO) promotes domain coarsening of the bulk-heterojunction, an effect which is assisted by thermal annealing and which is responsible for the ~20% increase in the corresponding power conversion efficiency (PCE) from 7.2% to above 8.7%. However, importantly, NR does not show any vertical segregation of the $PC_{71}BM$ in these devices which could be responsible for that improvement.

In the field of melt processing of polymer nanocomposites [2] we show how SANS provided invaluable information in an investigation of the effect of the feeding formulation (pre-mixed powders of pure components versus a solvent-blended mixture) of polystyrene-$C_{60}$ composites on the dispersion and re-agglomeration phenomena that developed along the barrel of a twin screw extruder. Our results show that the two different feeding formulations, with widely different morphologies, converge along the extruder, through opposite morphological pathways, into a similar final nanomorphology which is dictated by the interplay between the thermodynamics of the system and the flow.

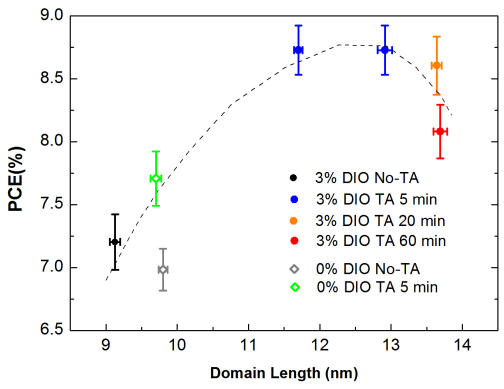
## References

[1] Y. Zhang, A. J. Parnell, J. F. K. Cooper, R. L. Thompson, R. A. L. Jones, S. M. King, D. G. Lidzey, G. Bernardo, *Understanding and controlling morphology evolution via DIO plasticization in PffBT4T-2OD/$PC_{71}BM$ devices*, Scientific Reports (2016) accepted

[2] H. Gaspar, P. Teixeira, R. Santos, L. Fernandes, L. Hilliou, M. P. Weir, A. J. Parnell, W. G. Bouwman, S. R. Parnell, S. M. King, N. Clarke, J. A. Covas, G. Bernardo, *A Journey Along the Extruder with Polystyrene:$C_{60}$ Nanocomposites: Convergence of Feeding Formulations into a Similar Nano-Morphology*, submitted

## Figures

**Organic Photovoltaics**




**Melt processing polymer nanocomposites**