STRUCTURE AND DYNAMICS OF MODEL POLYMER NANOCOMPOSITES

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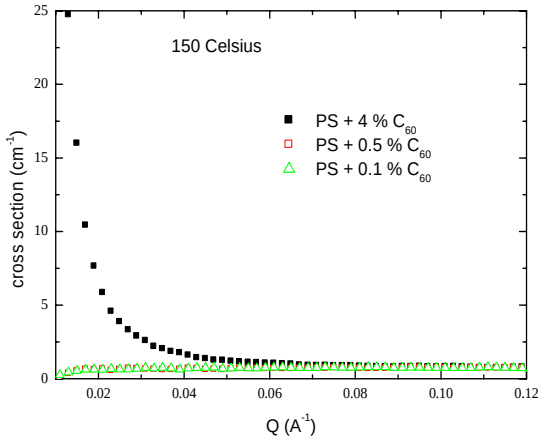
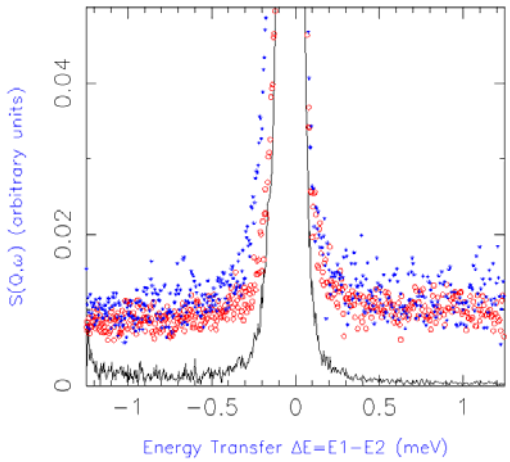
Confined polymers at a nanometre scale exhibit a fascinating structural and dynamic behaviour which has attracted much attention in recent years. Inelastic incoherent neutron scattering (INS) provides a direct measurement of local mobility and has been recently employed to study thin film dynamics, albeit limited by signal-to-noise ratio and therefore limiting the analysis to the Debye-Waller factor. Instead of polymer thin film confinement (2D), we study 3D confinement of polymers in truly dispersed nanocomposites. Polymer conformation and nanoparticle dispersion are evaluated by small angle neutron scattering (SANS), optical and electron microscopies. Polymer local dynamics is investigated by time-of-flight and backscattering inelastic neutron scattering (INS) and the glass transition by differential scanning calorimetry. The model systems chosen are mixtures of styrene-based polymers and Buckminster fullerenes (C_{60}), which given the size mismatch of particles and polymer Rg, have been shown to be thermodynamically miscible below a finite (few %) threshold. Buckyball dispersion in polymer matrices and polymer single chain conformation are measured by SANS using contrast variation. Figure 1 depicts forward scattering at varying fullerene concentration indicating homogeneous dispersion below 4 %, beyond which excess forward or low angle indicates particle agglomeration within the polymer matrix.





Dynamics experiments on the influence of dispersed nanoparticles on local polymer motion are focused on fast proton delocalisation, measured by the Debye-Waller and side-group rotation. Figure 2 compares the QENS spectra of poly(styrene) with 0.1 % of C_{60} (stars) with neat poly(styrene) (circles)at 150 K. Results indicate an enhancement of the dynamics for the nanocomposite as compared to the neat polymer at this temperature. These measurements open new opportunities to elucidate the dynamic consequences of 3D nanoconfinement.