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The Study of Local and Higher Order Structure in Soft-Matter Systems by Contrast-Variation Simultaneous SANS & WANS

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Materials based on semi-crystalline polymers are used in different fields of applications, from high temperature to plastics, elastomers and fibers, from biomedicine to aerospace, from oil industry to fuel cells. Such materials exhibit a phase separation in crystalline and amorphous regions. The crystalline domains are characterised by a complex morphology spanning a broad length scale from Å to hundreds of micrometres and consisting of hierarchically organised, multiple structural planes such as crystalline unit cells, lamellar crystals, fibrils or boards and fibres or spherulites. Furthermore, the amorphous regions in the bulk and between the lamellae can be functionalised, leading to even more complex morphologies when external stimuli such as humidity (RH), temperature (T) or uni-axial deformation (UD) are applied to the sample. For the structural characterisation of such complex morphologies, a large length scale has to be covered, which usually requires a combination of different experimental methods in structural analysis. Due to the advantage of contrast variation and the large Q-range that can be covered, small angle (SANS) and wide angle (WANS) neutron scattering techniques are particularly suitable for the detailed study of natural and synthetic polymeric materials. However, when working with different instruments to collect scattering data in wide and small scattering ranges, it is difficult to ensure perfect reproducibility of sample composition and quality as well as external field conditions so that a global analysis of data collected in different experimental geometries and at different times can be reliably performed. The simultaneous use of wide and small neutron scattering methods in the same experiment is therefore necessary for sensitive or expensive samples when special care must be taken with sample preparation (composition, quality, quantity, etc.) or treatment (temperature, humidity, etc.) during the experimental investigation.
Here I report on the experimental investigation of various semi-crystalline polymer and soft-matter systems under different RH, T and UD conditions using neutrons on pinhole SANS or TOF SANS/WANS diffractometers, with emphasis on the Q range and experimental resolution involved in structural studies. The use of complementary methods (SAXS, FTIR, etc.) to better understand the local or long-range structures will also be discussed.

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