

SAXS FROM POLYMER-CLAY COMPOSITES AND OTHER LAYERED SYSTEMS

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Layer silicates like clay are important fillers for polymer composites, improving their mechanical properties as well as gas permeation or flame retardation behavior, all at a comparatively low cost.

Silicate layers can be decorated with surfactants and intercalated with polymers. If the mixing with the polymer leads to a complete exfoliation of the lamellar stacks into isolated silicate lamellae embedded in a polymer matrix, the resulting systems could be described as dilute (or, at higher concentrations, diskotic) systems of platelet-shaped particles. However, in the present work we focus on intercalated but not exfoliated polymer-clay composites.

Compared to many other layered systems like semi-crystalline polymers or lamellar block copolymers, the rigid nature of the silicate layers in these lamellar stacks composed of inorganic and organic layers results in a much higher validity of analytical approaches based on one-dimensional density profiles or, more generally, linear chains of lamellar stacking correlations that may also allow for lateral displacements if the lamellae are decorated with a regular pattern.

Analytical descriptions of the stacking statistics of such lamellar stacks can go well beyond classical approaches of infinite chains of independent events and can incorporate correlated stacking statistics, finite stack heights, stack height polydispersities, in all cases with arbitrary and possibly multimodal distance distributions, and still result in close form analytical expressions for the scattering intensities.

The approach is applied to experimental small-angle x-ray scattering data from various intercalated polymer-clay composites and surfactant-intercalated clays, showing the presence of multi-modal distance distributions or of Peierls' distortion like breaking of translational symmetry.

Applications to other layered systems will be discussed, including graphite and non-graphitic carbons; stacking faults in close-packed spherical systems ranging from packings of atoms to micellar macrocrystals; stacking statistics of perforated layer phases as found in some block copolymers.