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X-ray Mapping of the Structural Development of Layered-Silicates in Twin-Screw Mixing Regimes during Melt Blending of Polymer Nanocomposites. Effects of Extrusion Temperature Configurations.

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Thermoplastic urethane-ester block copolymer (TPU) and high density polyethylene (HDPE) was melt blended with an organically modified layered-silicate system in a twin-screw extruder and a single-screw extruder respectively to produce nanocomposite polymer hybrids. Mixing was performed using different extrusion temperatures and temperature gradients to investigate the effects of these parameters on the structural evolution of layered-silicate during the extrusion process. The polymer/organoclay melts were collected from the various sections of the twin-screw, from the feed to the die exit, and quenched pressed into specimens for X-ray diffraction (XRD) analysis of the structural transformation of this layered-silicate in the extruder. The XRD spectra showed that the stepwise structural evolution of the layered-silicate differed for blends extruded at different temperature configurations. In general, intercalation of the layered-silicate was more intense when a linear low temperature profile or reverse temperature gradient configuration was adopted during single-screw extrusion. In contrast, for the twin-screw extrusion, a conventional ramp -up temperature profile appeared to be more effective in promoting intercalation of the layered-silicate. The backmixing in twin-screw can lead to a decrease in the interlayer spacing of layered-silicate, while quenching of the resultant extrudate melt may further improve the intercalation level. This alteration in the layered-silicate structure by the extrusion temperature configuration was attributed primarily, but not solely, to the change in the rheological behaviour of the polymer melt.