

Structure-Properties Relationship in Microfibrillar Hybrid Composites by Means of Simultaneous X-ray/Stretching Experiments

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Monitoring of nanostructure evolution during mechanical failure is of both fundamental and practical relevance. The mechanisms revealed in such studies should help to increase the significance of modeling in predicting of the mechanical properties of polymer materials. Understanding the relationship between the structure and mechanical properties can direct the research for new composite materials and the optimization of the already existing ones. To this purpose, generation and analysis of time-resolved structural data obtained during the mechanical tests are necessary. This investigation exemplifies the use of X-rays from synchrotron for studying the nanostructure development and mechanical properties of some new composite hybrids. They comprise an isotropic high-density polyethylene (HDPE) matrix reinforced by polyamide 6 (PA6). For further reinforcement, organically treated montmorillonite (MMT) was dispersed within the PA6 fibrils. Synchrotron small-angle X-ray scattering (SAXS) patterns were collected while subjecting the composite samples to static or cyclic load. The resulting two-dimensional SAXS patterns were reconstructed, calibrated and the structural information extracted from them by means of new image treatment and data evaluation procedures involving the computation of the Chord Distribution Function. True stress-strain curves were obtained in real time for each SAXS data frame. Thus, it was possible to visualize how the processing conditions and nanoclay content could change the structure at nanometer level and to assess the structure-mechanical properties relationship. Wide-angle scattering (WAXS) measurement were also made to estimate the thickness of the transcrystalline HDPE shell and diameter of the PA6 core of the reinforcing fibrils and their relation to the mechanical properties.