

Effect of carbon black on the preferred orientation of organoclays dispersed in polymer nanocomposites.

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Organoclays are organically modified layered silicates, which are widely used as nanofillers, which can be intercalated or exfoliated by the polymer. The polymer nanocomposite thus formed shows a notable enhancement in the modulus, the gas permeability, and flame retardation¹⁻³. Another filler carbon black, which when dispersed in the polymer matrix, can form a strong percolating network of nanostructures, resulting in an enhancement of various polymer properties⁴. In this study we present synergistic effects of organoclay and carbon black dispersed together in a polymer matrix on the gas permeability of polymer. Two frequently used characterization techniques for the determination of nanoclay morphology (i.e., exfoliation vs. intercalation, stacking sequence statistics) are transmission electron microscopy (TEM) and small-angle X-ray scattering (SAXS). However, extracting information on clay dispersion and orientation using these techniques requires a certain degree of careful data analysis, not well practiced in the community. Quantitative analysis of TEM has been shown to be capable of evaluating the extent of silicate exfoliation in polymer matrices⁵. It was shown that the permeation properties of nanocomposites strongly depend on the extent of clay exfoliation as well as the orientation of organoclays. The process of clay dispersion often results in the disintegration of large silicate stacks and formation of primary tactoids, which can be further disintegrated into single platelets, thus increasing the effective specific surface area.

The clay tactoids and single platelets are often aligned in the plane of the polymer film. 3D-TEM and directional X-ray diffraction techniques have been used to obtain structural information on clay orientation in polymer nanocomposites with and without carbon black as additional filler. 3D TEM showed that the clay particles were mostly intercalated having a preferred orientation as sketched in Figure 1.

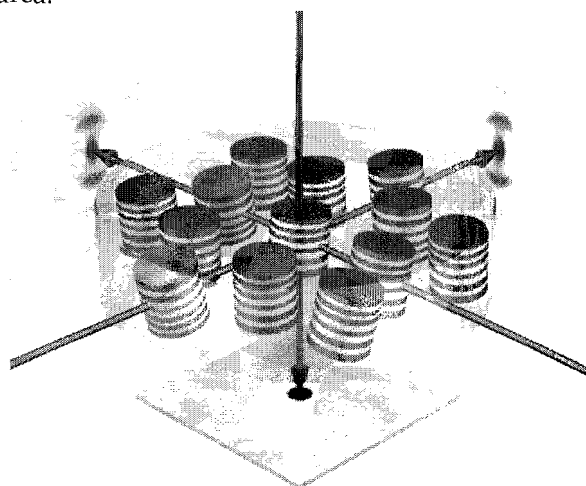


Figure 1: Directional SAXS simulation from nanoclays with cylindrical symmetry and preferred orientations.

In this study we present the characterization of the morphology and the preferred orientation of organoclays in a series of nanocomposites, containing ethyl vinyl acetate (EVA) copolymers (as a model system) or butyl polymers with and without carbon black. The effect of carbon black on the orientation can be accounted to availability of less free volume for organoclays hence leading to decrease in preferred orientation of the particles.

References:

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