Extensional and Shear Rheology of Oriented Block Copolymers / Clay Nanocomposites

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Block copolymers and nanoparticles can be combined to form materials with interesting properties and structures. Pure block copolymers usually form phase-separated structures in the solid state and even in the molten state within a certain temperature range. These nano-sized phases may have different shapes and dictate the rheological properties of the copolymers in the ordered state. When nanoparticles are added, the interactions between each phase and the particles will result in more complex structures. It is possible to align their microstructure using special processing procedures, and the resulting materials will have very anisotropic properties. Extensional rheometry is a suitable technique to study the properties of anisotropic samples. It is sensitive to the morphology of the materials, and the extensional flow aligns further the anisotropic phases and particles. It is also well established that shear flows are able to align block copolymer domains, but there are not many studies concerning the alignment of nanoparticles within the domains and its stability with time. In this study different pure styrenic block copolymers such as SEBS and SBS and their clay nanocomposites were aligned using processing techniques such as tape extrusion. Their extensional rheological properties were analyzed in two perpendicular directions in order to evaluate their anisotropy. The samples were also shear aligned and time sweep tests were carried out in order to evaluate an occasional disorientation with time. The materials were then studied by small angle x-ray scattering and transmission electron microscopy. It was possible to observe that the extensional flow readily realigns samples tested in a direction perpendicular to the original flow direction, and the clay particles affect the rheological behavior when they are also realigned by the extension. The effects of different block copolymer morphologies, clay dispersion, time and temperature were also evaluated.