Thermophysical Properties of Hybrid Organic-Inorganic Thermoplastic Polymers

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The design of new materials with enhanced properties continues to be a driver for the investigation of hybrid materials. As hybrid materials are copolymers based on inorganic and organic comonomers, they display enhanced properties by bridging the properties space between two dissimilar types of materials. Recently, we have taken an unique approach to the synthesis of hybrid materials by designing polymerizable inorganic oligomers with specific reactive sites. Polymerization at the single reactive site results in a linear polymer containing monodisperse, nano-size inorganic cluster pendent to an organic polymer main chain. A series of random copolymers were synthesized with different mole fraction of these inorganic nano-clusters. Mole fraction was determined using ^{1}H NMR. The molecular weight of copolymers were characterized with a gel permeation chromatography and a combination of refractive index and multi-angle light scattering measurements. The thermal properties such as glass transitions and thermal expansion were characterized as a function of mole fraction of inorganic clusters. Although, the inorganic clusters phase separated from the organic polymers as observed with a transmission electron microscopy. However, only a glass transition was observed using modulated differential scanning calorimetry (MDSC). The glass transition temperature increases with the content of inorganic material. This type of observation in DSC is often associated with "single phase" material. Therefore, these copolymers provide a unique approach to study the molecular length scale of glass transition. The detail local dynamics was also investigated with Positron Lifetime Spectroscopy as a function of temperature. In which, free volume expansion associated with the inorganic and organic phase can be easily separated and compared with the bulk expansion as observed in the dilatometry. Results of mechanical properties as a function of temperature will also be presented.