Dynamics of Polymers at Interfaces

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Structure and dynamics of interfacial species are very important to the physical properties of systems, such as composites, but the latter is seldom studied. We have focused our research efforts on the molecular motion of polymers at or near solid surfaces. These studies have used nuclear magnetic resonance (NMR) plus other techniques, such as modulated differential scanning calorimetry (MDSC) and Fourier Transform Infra-red (FTIR) spectroscopy to probe the mobility (and structure) of polymers near solid surfaces.

We have found that polymers, from the acrylate, methacrylate and related families, are well suited for interfacial studies. Polymers from these families have been adsorbed on silica and studied on silica surfaces. With those specifically labeled, such as poly(methyl acrylate)-d_3 (PMA-d_3), we found that segmental dynamics of the bulk polymer could be classified as "homogeneous", while the surface-adsorbed polymer could be characterized as "heterogeneous" with respect to different regions of the sample. Segments at the polymer-air interface were more mobile and those at the polymer-solid interface were less mobile than those in bulk. More mobile segments could be eliminated through over-layering with an unlabeled polymer compression molded on top of the surface polymer. The effects of molecular mass and the interaction with the surface were also probed. In contrast to bulk polymers, the surface adsorbed polymers show more complicated molecular mass behavior. We confirmed these effects through the use of MDSC of poly(methyl methacrylate) (PMMA) on silica. MDSC showed increases in the temperatures and breadth of the glass transition region for the surface polymer.

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