Effects of Interfaces on Adhesion: Stiffness and Glass Transition Temperature in Polymer Films

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Pressure sensitive adhesion (PSA) properties of materials is often considered primarily a function of macroscopic properties of the material like glass transition temperature (Tg), modulus, chemical and mechanical interactions, etc. Prior work has reported however that correlations between PSA properties and bulk properties often break down, suggesting that other factors can be equally important in determining PSA performance. It is well known that adhesion is strongly dependent on the substrate, implying that interfacial properties at the adhesive/substrate will be important. Several reports have suggested that nano-scale interfacial properties of polymers, including acrylic polymers, can deviate significantly from bulk properties.

Here, we will describe recent and ongoing studies in collaboration with Northwestern University, related to interrogating and characterizing how the interface and the details of the substrate to which the polymer is adhered can impact polymer properties such as glass transition temperature (Tg) and stiffness over length scales of tens to hundreds of nanometers from the interface into the polymer film. We will also discuss the implications for the interfacial gradients in properties on adhesion. Recently, we have developed ways to characterize relative stiffness using a fluorescent dye-labeled polymer approach that exploits how stiffness leads to changes in fluorescence spectrum shape. Even in polymers films that exhibit no change in Tg near a substrate interface, large changes can be observed in local stiffness up to several hundred nanometers from the interface if there is major difference in polymer and substrate stiffness. We will also describe how the presence of low molecular weight additives to the polymer and thermal history of the polymer-substrate system can impact Tg and stiffness.

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2 work done as a student at Northwestern University, now with Dow
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