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Microstructured Polymers: Fundamental Studies and Applications in Renewable Materials

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Polymers are pervasive in everyday life, from electronics to disposable products to medical equipment. These applications require control over various polymer properties such as mechanical properties, chemical compatibility, transport (or prevention of transport) of small molecules, adhesion, conductivity, and biocompatibility. For a specific application, a single polymer is unlikely to have all of the properties that are required. Rather, combinations of more than one type of polymer are often used to take advantage of the diversity of polymer attributes. Various strategies can be employed to create polymer mixtures: binary blending, synthesis of copolymers, and designing polymeric surfactants to compatibilize immiscible polymers. This talk will be divided into two sections: fundamental studies on designing block copolymer surfactants and applications of polymer mixtures derived from renewable resources.

In the first study, microstructured polymer mixtures were created by the addition of a block copolymer to two immiscible polymers. The block copolymer exhibited both repulsive and attractive interactions with the immiscible polymers. These interactions were manipulated in order to improve the efficacy of the surfactant and control the blend morphology. Thermodynamically stable microstructured materials were prepared with as little as 1 vol. % of the block copolymer added to the mixture.

Presently, the majority of polymers are synthesized from petroleum-derived feedstocks. The world supply of petroleum is finite, and in the future it will be necessary to turn to sustainable alternative resources for plastics raw materials. In the second study, blends were prepared from two renewable materials: polylactide, a biodegradable polymer derived from starch sources such as corn, and triglyceride oils, which are abundant and inexpensive. Polylactide is a commonly studied polymer derived from a renewable resource. However, the brittleness of the polymer is one of the main impediments to its use in many traditional petroleum-based polymer applications. One well-established method of toughening a brittle polymer is to blend it with a rubbery material, creating rubber particles in the brittle polymer matrix. In this case, triglyceride oil droplets were incorporated into the polylactide matrix, resulting in a ten-fold increase in the toughness and allowing for broadened applicability of the material.

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