Advances in Thermoplastic Elastomers

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Abstract:
There has been intense academic and commercial interest in block copolymers since the 1960s. To date, the single largest application for block copolymers has been as thermoplastic elastomers (TPEs). TPEs combine the ease of processing and recyclability of thermoplastics with the mechanical properties of crosslinked elastomers. The most important TPEs commercially are ABA triblock copolymers, made anionically and having glassy A blocks of polystyrene (PS) and rubbery B blocks composed of polydienes (PI or PBD). Work in our laboratory over the past two decades has focused on how changing the macromolecular topology from a linear triblock to a branched multigraft copolymer structure can be used to tune and greatly enhance mechanical properties, leading to "designer TPEs". This work will be summarized.

Regardless of macromolecular architecture, the upper use temperature of all styrenic block copolymers is limited due to softening of the PS block (Tg = 100 °C). This prevents the use of styrenic TPEs in tires and other applications where the material is exposed to heat. Benzofulvene is a new monomer for synthesis of TPEs capable of being used at higher temperatures (e.g. in recyclable tires). This monomer undergoes living anionic polymerization, and polybenzofulvene (PBF) has a Tg around 150 °C, which can be tuned by adjusting the microstructure of the PBF. For the development of TPEs having higher upper use temperature, well-defined homopolymers and block copolymers containing PBF blocks were synthesized by living anionic polymerization in benzene at room temperature via high vacuum techniques. PBF-b-PI-b-PBF triblock copolymer was synthesized using a difunctional lithium-based initiator. The molecular weights and polydispersities were characterized by GPC and LS, thermal properties were investigated by DSC and DMA, and chemical composition by was characterized by NMR. Promising new high temperature TPEs were obtained.

Brief Biographical Sketch:
Professor Mays received the B.S. degree in Polymer Science from the University of Southern Mississippi in 1979 and a Ph.D. in Polymer Science from the University of Akron in 1984 under the direction of Professor Lewis Fetters. After graduation he worked for several years at Hercules Research Center, prior to joining the faculty at the University of Alabama at Birmingham. In 2002 he moved to his current position as UT/ORNL Distinguished Scientist at the University of Tennessee, Knoxville, and Oak Ridge National Laboratory. Professor Mays' research is centered on polymer synthesis, especially synthesis of polymers having controlled architectures. He is a Fellow of the American Chemical Society, Fellow of the Royal Society of Chemistry, and Fellow of the American Association for the Advancement of Science. He and his wife, Trish, enjoy reading, walking, traveling, fine wine, and playing with their dogs: Bitz and Taz.