Surface Studies on Polyurethane-Silicone Copolymers Using Sum Frequency Generation Spectroscopy and Atomic Force Microscopy

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Abstract

Tailoring bulk properties of polymers such as the glass transition temperature and elastic modulus is important in designing biocompatible materials. As opposed to polymer blends, copolymer bulk properties can be specifically modified while minimizing phase separation. In general, the bulk composition of a polymer governs its mechanical properties, while the surface composition dominates its interaction with biological systems. Polyetherurethanes-silicone copolymers were studied using several surface specific techniques to confirm that increasing the siloxane groups increased the polymer surface biocompatibility, while leaving the bulk mechanical properties relatively unchanged. Sum frequency generation (SFG) spectroscopy, atomic force microscopy (AFM), and contact angle measurements were collected for a set of polyetherurethanes-silicone copolymers with 0% to 60% silicone (by weight). SFG studies on the copolymer/air interface indicate that the surface concentration of silicone increases linearly with the bulk silicone concentration. Additional SFG studies of biopolymers show that low concentrations (~2%) of silicone end groups can completely cover the polymer surface. However, AFM images show that polymer surfaces with silicone end groups exhibit ~0.1 micron holes, making these materials non-ideal for bioapplications. AFM images of the polyetherurethane-silicone copolymers indicate that the surface is relatively flat for samples that contain less than 60% silicone by weight. From contact angle measurements, it was determined that polyetherurethane-silicone copolymers are indeed hydrophilic. Further SFG studies of these copolymers in aqueous environments were performed to monitor the polymer surfaces in vitro conditions. Finally, Fourier transform infrared spectroscopy (FTIR) spectra indicate that the bulk spectra, and therefore bulk mechanical properties, change significantly after silicone is more than 10% of the total polymer weight.