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Applicability of polyisobutylene-based polyurethane structures in biomedical disciplines: some calcification and protein adsorption studies

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In recent years, polyurethane structures are paving the way for elastomer usage in biology, human medicine and biomedical application areas. Polyurethanes having a combination of high oxidative and hydrolytic stability and excellent mechanical properties are focused due to enhancing the usage of PUs especially for implantable medical device application such as cardiac-assist. Currently, unique polyurethanes consisting of polyisobutylenes as soft segments and conventional hard segments, named as PIB-based PUs, are developed with precise NCO/OH stoichiometry (~1.05) for obtaining PIB-based PUs with enhanced properties (i.e., tensile stress increased from ~11 to ~26 MPa and elongation from ~350 to ~500%). Static and dynamic mechanical properties were optimized by examining stress-strain graphs, self-organization and crystallinity (XRD) traces, rheological (DMA,creep) profiles and thermal (TGA,DSC) responses. Annealing procedure was applied for PIB-based PUs. Annealed PIB-based PU shows ~26 MPa tensile strength, ~500% elongation, and ~77 Microshore hardness with excellent hydrolytic and oxidative stability. The surface characters of them were examined with AFM and contact angle measurements. Annealed PIB-based PU exhibits the higher segregation of individual segments and surface hydrophobicity thus annealing significantly enhances hydrolytic and oxidative stability by shielding carbamate bonds by inert PIB chains. According to improved surface and microstructure characters, greatly efforts are focused on analyzing protein adsorption and calcification profiles. In biomedical applications especially for cardiological implantations, protein adsorption inclination on polymeric heart valves is undesirable hence protein adsorption from blood serum is followed by platelet adhesion and subsequent thrombus formation. The protein adsorption character of PIB-based PU examines by applying Bradford assay in fibrinogen and bovin serum albumin solutions. Like protein adsorption, calcium deposition on heart valves is very harmful because vascular calcification have been proposed activation of osteogenic mechanism in the vascular wall, loss of inhibitory factors, enhance bone turnover and irregularities in mineral metabolism. The calcium deposition on films is characterized by incubating samples in simulated body fluid solution and examining SEM images and XPS profiles. PIB-based PUs are significantly more resistant to hydrolytic-oxidative degradation, protein adsorption and calcium deposition than ElastEonTM E2A, a commercially available PDMS-based PU, widely used for biomedical applications.

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