

50d Degradable Segmented Polyurethanes for Bone Tissue Engineering

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Tissue engineering is an attractive approach to address the growing need for clinically effective materials that requires the creation of constructs capable of stimulating integration, vascular infiltration, and remodeling. We postulate that the mechanical properties of the biomaterial scaffold are an important design criterion and must be tuned to the requirements of the target tissue. For the goal of regenerating bone, we have undertaken the synthesis of a family of novel degradable, biocompatible, high-modulus segmented polyurethanes. Our polyurethanes consist of a poly(ϵ -caprolactone) (PCL) macrodiol soft segment and a hard segment comprising 1,4-diisocyanatobutane (BDI) and a tyramine-BDI-tyramine (TyA.BDI.TyA) chain extender. Differences in polarity between the hard and soft segments promote microphase separation. Hydrogen bonding between urea groups in the hard segments of adjacent polymer chains promotes hard segment ordering, thereby increasing the modulus of the material. By systematically varying the PCL macrodiol molecular weight and the polymer stoichiometry, we can achieve a family of polymers with similar chemistries but with different mechanical properties due to differences in hard segment content and the degree of microphase separation and percolation.

We present initial chemical, physical, and biologic analyses of our polyurethanes. Polymers were analyzed by proton NMR and GPC to determine hard segment content and molecular weight, respectively. The materials were processed into porous foams by compression molding/particulate leaching and the porosity and compressive modulus were measured. Finally, proliferation and osteoblastic differentiation of bone marrow stromal cells were measured on polyurethane films. Our results demonstrate that polymers support osteoblastic differentiation and porous foams have compressive moduli of 0.1 to 3 MPa.