50e Functionalizable Biomaterials Based on Dihydroxyacetone

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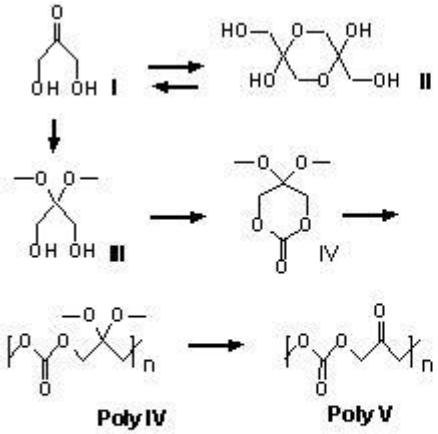
Dihydroxyacetone (DHA) is a metabolic intermediate of glucose, and is FDA-approved as the active ingredient in sunless tanning lotions. Polymers based on DHA were synthesized with the goal of creating new biomaterials with non-toxic degradation products. Our working hypothesis is that the toxicity profiles of new polymeric biomaterials will be reduced if the polymer degradation products can be eliminated from the body via their natural metabolic pathways, akin to the development of polyesters based on lactic and glycolic acid. The propensity of DHA (I) to dimerize (II) makes its polymerization challenging. In addition, the C2 carbonyl is susceptible to nucleophilic attack forming a Schiff base. Therefore, we devised a synthetic route to lock DHA in its monomeric form via acetalization of the C2 carbonyl functionality (III). Ring closure with triphosgene or ethyl chloroformate allowed the formation of cyclic 2,2-dimethoxypropylene carbonate (IV) which readily undergoes ring opening polymerization with stannous octanoate as an initiator, with the molecular weight of the polymer being a function of the monomer to initiator ratio (scheme 1). Three polymer samples with their Mw ranging from 5,000 to 40,000 were successively obtained by this approach. Acid catalyzed deprotection of the C2 carbonyl afforded the target poly(2-oxypropylene carbonate), poly V. Uniaxial compression of pressed pellets of poly V revealed a compressive yield stress of ~50 MPa, i.e. approaching the compressive strength of bone, and a Young's modulus of 0.56 GPa. These polymers also possess a unique characteristic in that they can be functionalized by nucleophilic addition at the C2 carbonyl. Reductive amination was performed on a low molecular weight analogue of poly V, thus providing the means for surface modification and patterning with amine containing reagents and other nucleophiles. Thin films of poly V reacted rapidly with the primary amines of fluorescently labeled proteins in the presence of excess water, suggesting that these materials may be useful as bioadhesives (Figure 1).



Scheme 1: Synthetic route to poly(2-oxypropylene carbonate) (poly V) from DHA.

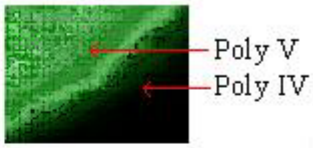


Figure 1: Micrograph of poly(2-oxypropylene carbonate) modified with fluorescently labeled protein (bright field).