Effect of Nanoscale Surface Roughness of Polymeric Biomaterials on Cell Function

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Surface roughness can affect cell adhesion, morphology, proliferation and differentiation. Since polymeric biomaterials can inherently exhibit nanometer-scale surface roughness, we have investigated the influence of polymeric nanotopology on cell function. We have used two approaches to tune polymer surface roughness: thermal processing and polymer blending.

Thermal processing can affect the surface roughness of crystalline biomedical polymers. Thus, we have used a gradient technology to explore the effects of processing on cell behavior. Solutions of the biodegradable polymer, poly(L-lactic acid) (PLLA), were spread into smooth, thin films. The films were placed on a temperature gradient stage such that one end was held at room temperature and the other end was heated above the glass transition temperature to 100° C. Atomic force microscopy (AFM) showed that the room temperature-ends remained smooth while the 100° C-ends became more crystalline and roughened. Cell adhesion was not influenced by the gradient while cell proliferation was enhanced on the smooth ends of the gradient.

Since polymer blending can affect the surface topology of polymeric biomaterials, we have also used a gradient technology to explore the effects of polymer blending on cell behavior. A polymer blend gradient library in the form of a thin film was made from two common biodegradable polymers, PLLA and poly(D,L-lactic acid) (PDLLA), using a three-syringe pump system and a translation stage. AFM and FTIR microspectroscopy showed that the annealed gradients were PLLA-rich and roughened on one end and PDLLA-rich and smooth on the opposite end. Cell studies showed that proliferation was enhanced on the smooth, PDLLA-rich end of the gradients. Collectively, these results suggest that the nanoscale surface topology of polymeric biomaterials can influence the performance of tissue engineered medical products.