Nanotopographical Control of Dental Pulp Stem Cell Fate Using Phase Segregated PLA/PS Thin Films

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Dental pulp stem cells (DPSCs) hold tremendous potential in regard to tissue and bone regeneration. This study evaluated the effects of nanoscale surface topography and cell-plating density on DPSC proliferation and differentiation. While bi-polymer blends have been studied in previous experiments, our technique in the creation of polymer thin film surfaces is novel; Polylactic acid (PLA), a highly biocompatible polymer, and polystyrene (PS) were spun-cast onto silicon wafers. Subsequently, PS was removed through dissolution to construct varying surface topographies, before DPSCs were plated onto the substrates to study cell behavior. Based on early stage proliferation results, higher cell-plating densities were found to correspond with higher plating efficiencies. However, cell-plating density had minimal effect on cell count in the long-run. Atomic force microscopy was used to characterize the surfaces and confocal microscopy revealed favorable spreading of actin filaments over porous surfaces. Scanning electron microscopy verified the biomineralization of the cells, and real-time polymerase chain reaction analysis identified the various differentiation markers of the DPSCs. All surfaces were able to induce biomineralization. Interestingly, when compared to both rough and flat surfaces, porous surfaces induced the greatest osteogenic differentiation, likely due to its similarity to dentin. The implications of our findings are promising in the field of regenerative medicine.

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