Physico-Chemical and Biological Characterization of Blends of L-tyrosine based Polyurethanes and Polyphosphate for Biomedical Applications

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Statement of Purpose

Novel L-tyrosine based 'pseudo' poly (amino acids) such as polyurethanes and polyphosphates have been developed to counter problems associated with synthesis and processing of poly (amino acids). Despite being synthesized using a common monomer, DTH; these polymers have dramatically different properties. We hypothesize that a step wise transition in the material properties may be obtained by blending polyphosphate and polyurethanes in different ratios. A wider spectrum of material properties obtained in this way will help expand the application base of these biomaterials. Physico-chemical characterization of these materials was carried out to determine the dependence of various properties such as surface morphology and composition, relative surface hydrophilicity, water uptake properties, *in vitro* degradation properties and thermal properties on the polyphosphate concentration within the blends. Finally, cytotoxicity of these polymeric blends was evaluated using a live dead cell assay and the results showed high cell viability for both the blends and their degradation products.

Materials, Methods and Analytical Procedures

L-tyrosine, n-hexanol, thionyl chloride, diethyl ether, phloretic acid (desaminotyrosine or DAT), 1-ethyl-1'-dimethylaminopropylcarbodiimidehydrochloride (EDC.HCl), N, N-dimethylformamide, polycaproloctone diol, poly (ethylene glycol), stannous octanoate, 4,4'-methylenebis (cyclohexyl isocyanate), phosphate buffer saline (PBS), human dermal fibroblasts, DMEM feeding media, Live/Dead cell assay, DMSO, chloroform.

Blends Fabrication

L-tyrosine based polyphosphate and polyurethanes were synthesized as described in literature[1]. PEG and PCL based polyurethanes were used for this study. The polymers were dissolved in chloroform at a concentration of 10% (w/v) and blends were created by mixing polyphosphate and polyurethane solutions in various ratios and solvent casting onto Teflon plates followed by solvent evaporation.

Physico-Chemical Characterization of Blends

The physico-chemical, thermal and microscopic characterization of polyphosphate and polyurethane blends was done to establish the composition dependence of various properties. Physico-chemical characterization includes FTIR, ^{1}H-NMR and XPS spectroscopy, investigation of surface and bulk hydrophilicity and *in vitro* biodegradation, thermal study includes DSC and TGA and microscopic characterization includes polarized optical microscopy and scanning electron microscopy of the blends.

Biological Characterization of Blends

Cytotoxicity of blends of L-tyrosine based polyphosphate and polyurethanes was performed using a live dead cell assay. Human dermal fibroblasts at passages between 4 -10 were used for these studies. Exposure to UV radiation (265nm) was used for sterilization of these films. Similar studies were also performed using degradation products of blends. Inflammatory studies will be performed using porcine monocyte cells and the results evaluated using an ELISA based assay for detection of IL-1β.

Results

The spectrometric studies of the blends showed the presence of peaks corresponding to both the polyphosphate and the polyurethane polymers within the blend. FTIR spectra of blends showed the presence of peaks corresponding to the stretching of phosphate bonds of poly (DTH-EP) at 1160 and 1190 cm^{-1} and the urethane bond stretching within the polyurethane polymer at 1720-1740 cm^{-1}. Scanning electron microscopy shows a defect free surface for the blends. Optical microscopy results show an increasing dispersion of polyphosphate within the films with an increasing concentration of polyphosphate within the blends. This is suggestive of a degree of phase segregation within the blends. The thermal characterization results show the presence of a single glass transition for polyphosphate between 30-40°C and two thermal transitions for polyurethanes around -50°C and -5°C respectively. However, in case of polyurethane and polyphosphate blends, showed the presence of two thermal transitions around -35°C and between 30-40°C suggesting the occurrence of phase segregation within the blends. Swelling studies show an increasing degree of water uptake with an increase in polyphosphate concentration for PCL-CHMDI-DTH and polyphosphate blends. The degradation results show an increasing rate of degradation with an increase in polyphosphate concentration. Finally live/dead cell assay results for blends and their degradation products show no significant degree of cytotoxicity.

Conclusion

The characterization results show that the blends have intermediate properties between the two parent polymers: polyurethanes and polyphosphates. Thermal, degradation and water uptake properties were found to be susceptible to significant modification by varying the polyphosphate concentration within the blends. Biologically, the polymeric blends were found to be non-cytotoxic to human dermal fibroblast cells.

References

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