Novel Urethane bond doped polyesters for cardiovascular tissue engineering

Yi Zhang, Jian Yang*
Department of Bioengineering at The University of Texas at Arlington, Arlington, Texas 76019
Joint Biomedical Engineering Program between UTA and UTSW (jianyang@uta.edu)

Statement of Purpose: For the cardiovascular tissue engineering, finding an ideal biomaterial with the proper mechanical properties and biocompatibility has been an intense focus. In the present urethane bond doped polyester (POMCU), a prepolymer (POMC) obtained from three monomers, 1,8-octanediol, citric acid and maleic acid, was reacted with 1, 6-hexane diisocyanate (HDI). By controlling the molar ratio between the diol and diacids, the amount of carbon-carbon double bond from maleic acid, and the ratio between prepolymer and HDI, the mechanical property of the materials can be tuned for a wide range. The carboxylic and hydroxide group can still be used for postpolymerization, which can form a 3D crosslinked structure to provide another way to control the mechanical property.

Methods: The synthesis schematic is shown in Fig 1. The termination of the reaction was determined by FT-IR based on the disappearance of the isocyanate peak.

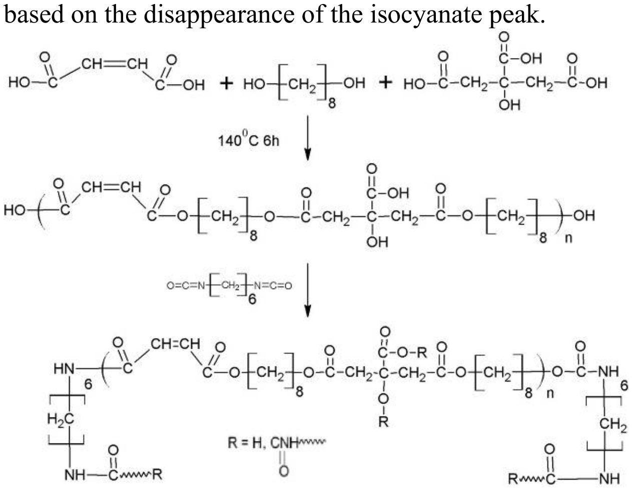
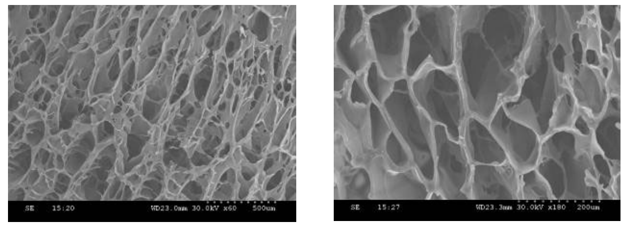


Fig. 1. The synthesis schematic of POMCU

The different chemical structure of the polymers obtained from different feeding ratio was analyzed by FT-IR. The mechanical test on different materials was also conducted with an MTS Insight 2 (Eden Prairie, MN) fitted with a 500 N load cell. The initial modulus was calculated by measuring the gradient at 10% of elongation of the stress–strain curve (n=8). The polymer films were prepared by the solvent evaporation method. POMCU scaffolds were fabricated by the thermal induced phase separation (TIPS) technique. Briefly, the concentration of obtained polymer solution was fixed to 3%. 20ml of polymer solution was added into a Teflon dish, and then frozen at -20°C overnight. The totally frozen solution was then freeze-dried for 2 days. Both the surface and cross section of the resulting scaffold was observed by SEM. 3T3 fibroblast cells were seeded on POMCU thin films to test the cell affinity. The cell morphology was observed by microscope.

Results: The FT-IR spectrum from the different monomer ratios showed a difference in peaks in the range of 1800−1600 cm^{-1}, which belongs to different carbonyl groups. This indicates that the FT-IR spectra can distinguish the chemical structures of the POMCU obtained from different feeding ratios.

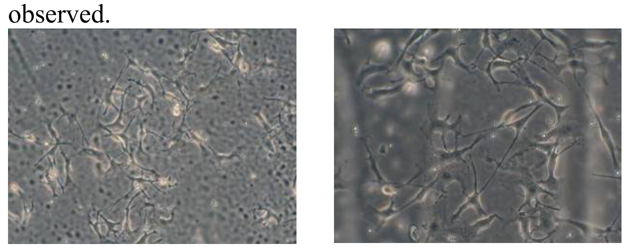
The tensile strength of POMCU was as high as 10.913±0.63 MPa with a corresponding elongation at break of 208.180±17.78%. The initial modulus ranged from 0.460±0.048 MPa to 8.975±0.526 MPa.



(A) (B)

Fig. 2. The surface (A) and cross section (B) of POMCU TIPS scaffolds

The SEM pictures of TIPS scaffold was shown in Fig 2. The picture of surface (A) and cross section (B) both showed a porous structure with an average pore size of 200μm. The interconnected structure can also be observed.



(A) (B)

Fig. 3. Images of 3T3 fibroblast on POMCU films (A) 20x and (B) 32x magnification

The cell morphology on the POMCU film was shown in Fig 3. These images showed that the cells can attach and proliferate on the POMCU films.

Conclusions: The FT-IR indicated the structure of POMCU obtained from different feeding ratios. POMCU exhibited tunable mechanical properties. A material with needed mechanical property within this range can be obtained by different feeding ratio during the synthesis. The POMCU possesses great processability for 2-D and 3-D fabrication. The POMCU also showed excellent cytocompatibility. The development of POCMU should add new choices in selecting suitable biomaterials for tissue engineering applications.

References:

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