Electrospinning of thermoplastic polyurethane(urea) elastomers for vascular grafts

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Cardiovascular diseases are among the most fatal worldwide and difficult to address. While preventive strategies can be taken, treatment often requires surgical intervention such as the implantation of vascular bypass grafts. Ideally, the material for such grafts is taken from the patient themselves, but this is not always possible, resulting in a growing focus on synthetic alternatives.

Such synthetic bypass grafts are already used for large-diameter blood vessels, but insufficient biocompatibility makes available materials unsuitable for small-diameter bypass grafts (< 6 mm). A promising solution may be thermoplastic polyurethane(urea) elastomers (TPU(U)s) which demonstrate suitable biocompatibility and mechanical properties as well as a high processibility. The latter being particularly important to shape the chosen material into structures mimicking natural tissue.

The most common method to fabricate such structures is electrospinning: It uses a strong electric field to draw a sufficiently viscous macromolecular fiber precursor into micrometer thin jets, which are then solidified by physical means such as the evaporation of solvent. The subsequently formed fibers are then collected into nonwoven structures resembling the extracellular matrix of blood vessels. The success of the procedure is dependent on used solvent, polymer size and concentration, precursor feed rate, electric field strength, and jet travel distance.

In this work, we were able to establish an electrospinning procedure for both commercially available and self-synthesized TPU(U)s on our specially constructed electrospinning device. Through parameters variation, we further determined an operating range regarding polymer concentrations, precursor feed rate, electric field strength and jet travel distance for future applications. Additionally, methods to characterize nonwoven graft thickness and tensile properties were established.