Solution Blow Spinning of Biodegradable Tissue Adhesives for Applications in Surgery

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Statement of Purpose: Efficacy concerns in widely available clinical materials for surgery are highlighted by poor mechanical properties and difficulty in precise application to topographically complex tissue surfaces *in vivo*. Our previous research has successfully demonstrated an ability to deposit via solution blow spinning (SBS), tissue adherent sealants for intestinal anastomosis and liver laceration with exceptional mechanical properties. Here, we adapt SBS to create adhesive polymer scaffolds for (1) antimicrobial burn wound dressings and (2) pressure sensitive tissue adhesives (PSTAs).

Methods: Deposition of polymer via SBS yields highly conformal, dry fibers adherent to topographically complex tissue surfaces via dissolution of polymer in an organic solvent upon loading and spraying from a commercial airbrush. Polymers investigated include a lend of poly(lactic-co-glycolic acid) (PLGA) and polyethylene glycol (PEG) owing to its unique fiber-to-film transition occurring at body temperature and increasing adherence to porcine and mouse tissue, in addition to blends of poly(lactide-co-caprolactone) (PLCL) due to pressure mediated adhesion facilitated by the composite material's inherent viscoelasticity. *In vitro* characterization of polymer fiber mats is highlighted by mass loss, dynamic mechanical analysis (DMA) and rheological measurements, thermal properties via differential scanning calorimetry (DSC), and antimicrobial efficacy studies of Ag^+ released from polymer scaffolds via inductively coupled plasma atomic emission spectroscopy (ICP-AES). *In vivo* studies are succinctly summarized in both porcine partial thickness wound healing and mouse intraperitoneal space polymer implant model.

Results: *In vitro* release of 1 mg/mL Ag^+ from PLGA/PEG presents a burst phase (~50% at t = 1 day) followed by stabilized release at a concentration sufficiently antimicrobial and non-toxic to critical fibroblasts and keratinocytes over 28 days. While addition of Ag^+ resulted in lower Young's Modulus (12 kPa) and Ultimate Tensile Strength (6 kPa) and an unaffected wound closure adhesion strength (4 kPa), previous research by our group has indicated that soft polymer composites form a better interface with tissue and thereby improved adhesive properties, as indicated by durable polymer-scab hybrid scaffolds in porcine wound healing studies with PLGA/PEG/Ag materials as compared to Tegaderm, a polyurethane-based film often used in clinical settings.[1]

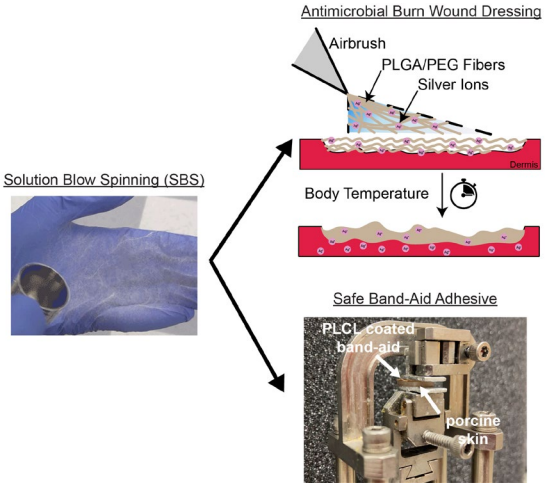

Figure 1: Exemplary applications of solution blow spinning in surgery

Additional applications of SBS explore use molecular weight blends of poly(lactide-co-caprolactone) (PLCL) to produce a viscoelastic material with augmented wet tissue adhesion via pressure-mediated application. Results from this work show that fabricated PSTAs dramatically improved sealant burst pressure (>100 kPa) and pull-apart adhesion strength (20 kPa) on *ex vivo* porcine intestine and skin, while also facilitating total wound healing as a band-aid adhesive in a porcine wound healing model.[2,3]

Conclusions: The combination of a favorable release profile for an antimicrobial agent in Ag^+, thermal properties encouraging improved adherence to tissue, and mechanical properties ensuring long term stability establishes blowspun PLGA/PEG/Ag fibers as a potential burn wound dressing alternative requiring fewer dressing replacements whilst facilitating total healing.

Additional work with molecular weight blends of PLCL yielded a biodegradable wet tissue adhesive with high translatability and biocompatibility, as compared to a band-aid coated adhesive that is frequented with cases of allergic contact dermatitis and cases of healthy tissue removal during wound healing.

Biocompatible adhesive curing via pressure or a body temperature mediated events, whilst facilitating complete wound healing *in vivo*, are presented in both burn wound dressing and PSTA applications of SBS.

References: [1]Daristotle JL. Bio Eng Trans Med. 2020;5(1):e10149
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