Spring 4-13-2020

Deposition of Drug-delivering Bandages via a Combined Electrostatic and Air-Driven Electrospinning Device

Lane Huston
Montana Tech of the University of Montana

Emily A. Kooistra-Manning
Montana Tech of the University of Montana

Jessica Andriolo
University of Montana - Missoula

Jack L. Skinner
Montana Tech of the University of Montana

Deposition of drug-delivering bandages via a combined electrostatic and air driven electrospinning device

Lane G. Huston, Emily A. Kooistra-Manning, Dr. Jessica M. Andriolo, & Dr. Jack L. Skinner

Montana Tech Nanotechnology Laboratory

DEVCOM ARMY RESEARCH LABORATORY

Introduction

- Electrospinning (ES) is an affordable manufacturing process to produce nanoscale, polymer fibers.
- During ES, a high voltage differential is required to draw out polymer fibers from a polymer solution at a charged spinneret.
- Fibers produced are then deposited onto an oppositely charged electrode.
- ES typically requires large, immovable equipment and conductive surfaces for deposition of fibers.
- Portability and on-demand ES of fiber mats onto non-conductive surfaces would enable use in remote locations with limited access to medicine.

Methods & Materials

- A portable ES device with the ability to deposit fiber mats onto non-conductive surfaces, including skin, was used to fabricate fiber bandages.
- Fiber bandages were made using biocompatible polymer and solvents.
- Bandages were manufactured by either transitional or direct deposition.
    - Transitional deposition uses conventional ES methods to deposit onto conductive surfaces.
    - Direct deposition allows the user to deposit onto any type of surface.
- The antibiotic vancomycin was used to measure effective drug-delivery to *Staphylococcus aureus* (S. *aureus*) bacterial lawns.
- Gold nanoparticles were dispersed within polymer solution to measure release of encapsulated materials using ultraviolet-visible spectroscopy (UV-Vis).

Figure 1: (A) Direct deposition onto a gloved hand and (B) Transitional deposition of a fiber mat removed from a conductive, collection surface.

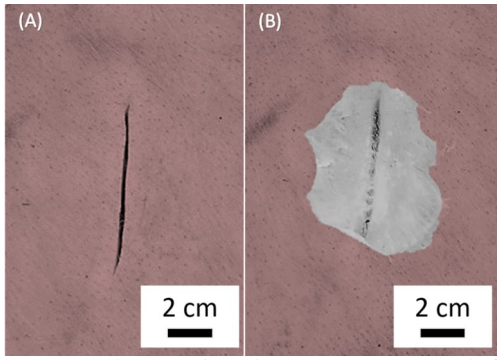

Figure 2: . Porcine skin sample with a 6.5 cm incision (A) before deposition of bandage and (B) after direct deposition of bandage.

Results

- Drug-delivering bandages were deposited onto bacterial lawns using both direct and transitional deposition methods.
- Vancomycin was released after bandage degradation and killed surrounding bacteria areas.
- Gold nanoparticles were released from fabricated bandages via UV-Vis performed on a dissolved bandage.
- The portable ES device successfully demonstrated fabrication of several biomedically relevant electrospun materials that can be deposited directly or fabricated and stored for later use.

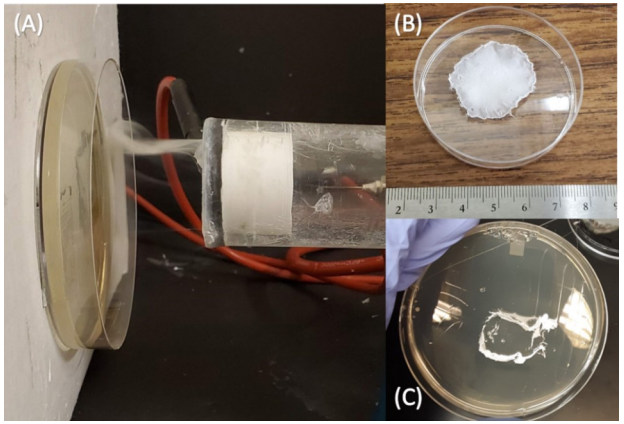

Figure 3: (A) Direct deposition onto *S. aureus* bacterial lawn from portable ES device. (B) Manufactured bandage made using transitional deposition after removal from nonconductive collection surface and (C) deposition of bandage onto bacterial lawn.

Figure 4: Bacteria death zones on S. aureus lawns caused by drug delivering bandages. (Left) Death zone from direct deposition of a bandage onto the bacterial lawn and (Right) death zone from transitional deposition of a bandage.

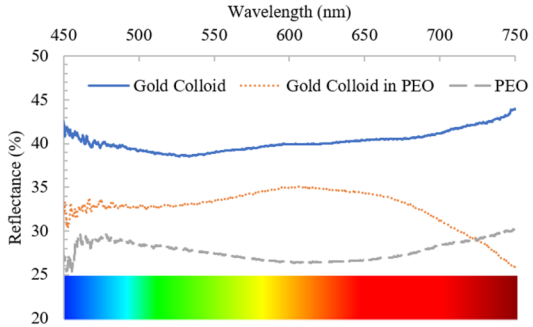

Figure 5: Reflectivity of water solutions containing gold nanoparticles-only (Gold Colloid), dissolved polymer+gold nanoparticles fibers (Gold Colloid in PEO), and fibers only (PEO). The reflectance of the fibers-only solution was clearly shifted due to the incorporation and release of gold nanoparticles during dissolution.

Acknowledgements

Thank you to Dr. Jessica M. Andriolo, Dr. Jack L. Skinner, Slater Family Research Trust, MTNL, & ARL for their support throughout this entire project. Research was sponsored by the Army Research Laboratory and was accomplished under Cooperative Agreement No. W911NF-15-2-0020. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.

Student Profile

Lane Huston

I am a graduate student in the General Engineering—Mechanical Option program originally from Missoula, MT. I am graduating this upcoming summer and hope to continue working in nanotechnology and related fields in the near future.