A Mechanically Robust and Conductive Fiber Material Based on Chitin

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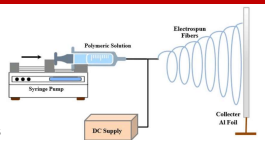
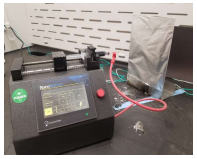
Background

- Current electroconductive flexible matting technology has many downfalls and has yet to be widely successful.
- Using chitin, along with electrospinning technology, allows for a more desirable product to be formed.
- Chitin, extracted from cicada sloughs, is used to increase the tensile strength of the material.
- Cicada sloughs are locally easy to collect.
- Chitin is also biodegradable and non-toxic reducing any waste material.
- Electrospinning is a process for making nanofibers from a polymer solution.
- A high voltage supply is introduced to molecules of the polymer solution in a syringe which allows for a controlled flow rate of nanofibers to be collected on a collection plate.

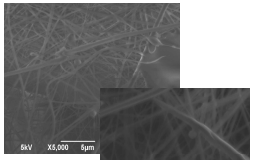


Schematic View of Electrospinning Process[1]

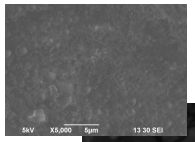


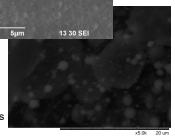
Electrospinner and Collection Plate

Experimental



Scanning Electron Microscope images of the collected fibers





Scanning Electron Microscope images of no collected fibers

- The solution is made up of chitin, Polyethylenedioxythiophene (PEDOT), Polystyrene sulfonic acid sodium salt (PSS), and acetic acid.
- The polymers of the solution are varied experimentally to increase different properties of the end nanofibers.
- The PEDOT is the electroconductive polymer of the solution, varying this varies conductivity.
- The chitin adds tensile strength.
- Some exterior variables affect the process including sonication, material used for collection and others.
- The fibers must be able to be separated from the collection plate, however, the nanofibers still need to be able to attach to this surface to be able to form the matting.
- Once the nanofibers are collected then a scanning electron microscope can be used to give quantitative values to the nanofibers obtained during the electrospinning process.

Results

- Much of the results for this research is based on trial and error derived from educated guesses on how the polymers are affecting the solutions.
- Tracking the data from repeated experimental trials allows us to find trends.
- Portions of that data is displayed in the table to the right.
- Unfortunately with the current national crisis our research was cut short and we were unable to present at the American Chemical Society Meeting. Our intention is to resume experiments in August and present at the meeting next spring.

References

1. Asmatulu, R. "Schematic View of Electrospinning Process." *Research Gate. https://www.researchgate.net/figure/Schematic-view-of-electrospinning-process_fig9_305662363* Accessed 3 Apr. 2020.
2. Greiner, A. and Wendorff, J. "Electrospinning: A Fascinating Method for the Preparation of Ultrathin Fibers." *Angew. Chem. Int. Ed.* Vol. 46, pp. 5670 – 5703. Accessed 27 Aug. 2019.
3. Ifuku, Shinsuke. "Chitin and Chitosan Nanofibers: Preparation and Chemical Modifications." *Molecules.* Vol. 19, www.mdpi.com/journal/molecules. Accessed 27 Aug. 2019.
4. Kiristi, M, Oksuz, L., Ulusoy, S., and Uygun Oksuz, A. "Electrospun chitosan/PEDOT nanofibers." *Materials Science and Engineering C. www.elsevier.com/locate/msec.* Accessed 27 Aug. 2019.

The molecular weight and amount of PSS, along with the PEDOT content, have significant effects on electrospun mats.

Solution Components (all 10 mL)		Fallout	Collection
% PSS*	MW*** of PSS	Quantity	Quantity
15	70,000	significant	none
20	70,000	significant	none
20	70,000	significant	minimal
25	70,000	significant	some
40	70,000	significant	some
35	75,000	significant	little
30	75,000	significant	none
30	75,000	significant	layered
45	75,000	significant	strands
30	200,000	significant	strands
25	200,000	significant	minimal
10	1,000,000	significant	none
15	1,000,000	significant	some
8	1,000,000	less	some
30	200,000	very little	some
20	1,000,000	less	some
5	1,000,000	significant	some
7	1,000,000	significant	minimal
15	200,000	significant	minimal
25	200,000	little	some
30	200,000	little	more
30	200,000	significant	none
30	200,000	significant	minimal
25	200,000	significant	more
25	200,000	less	more
25	200,000	less	more

*Polystyrene sulfonic acid sodium salt (PSS)
**Polyethylenedioxythiophene (PEDOT)
***Molecular Weight (MW)