Fabrication of Nylon-6/Multi-Walled Carbon Nanotube Composite for Sodium Ion Quantification

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Abstract

Multi-walled carbon nanotubes (MWCNT) are a material being integrated into a wide variety of fields due to their high tensile strength and high electrical and thermal conductivity. Implementing MWCNT into an electrochemical sensing platform has allowed for improved electrical performance by increasing sensor sensitivity. Through this work, fabrication of a nanocomposite used in a sensor that is able to measure the sodium ion concentrations found in sweat in real-time was studied to analyze the effects of incorporating MWCNT in the solution used in the production of the sensor. 0.5, 1, 2, and 5 weight percentages of MWCNT were incorporated into the solution. The solutions were then electrospun into a mat and cut into 1.2 cm by 1.2 cm sensor samples. The samples were then analyzed electrochemically using a potentiostat, to run direct current through two micro-alligator clips placed on the edges of the nanocomposite to ultimately measure the resistance at known concentrations of sodium solutions. The average resistance was then plotted against the sodium solutions to then observe the R^2 value of the best fit line to evaluate the performance of the sensors. Electrochemical analysis indicates that the sensor performance was optimized at 1 weight percent. The performance of these sensors at 1 weight percent also had the least variability in the regression model parameters considered . Future work that includes at least two more runs to be tested in a triplicate would determine if incorporating MWCNT into solution is a viable option to reduce the fabrication time.

Introduction

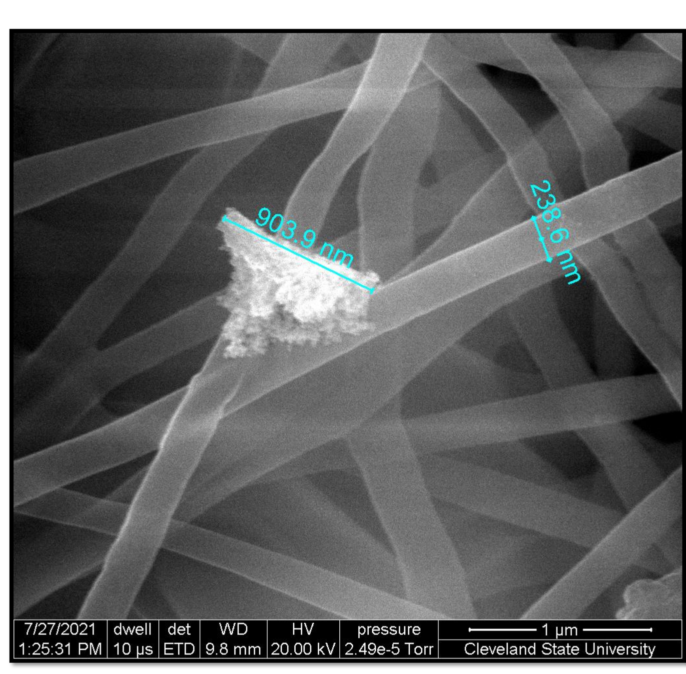

Figure 1. Scanning Electron Microscope Image. Shows the morphology of the 2 wt % nylon-6/MWCNT/calix[4]arene nanocomposite after being tested on.

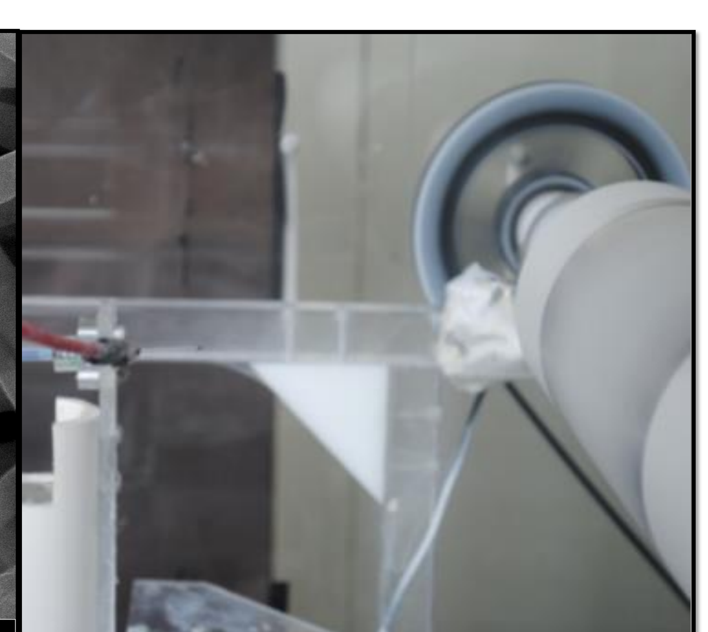

Figure 2. Electrospinning. Shows the homemade cabinet electrospinning a solution onto a mat. It uses an electrical force to thread the solution onto the collector as it spins on the rotating drum.

Methods

The electrospinning solution was made by combining Formic Acid, Acetic Acid, 0.3% Triton-X, MWCNT, and Nylon-6 to be mixed overnight at 45ºC

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The solution was then electrospun for 10 hours at a voltage of 20 kV and flow rate of 0.5 µL/min and left overnight to dry

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The mat was then cut into 1.2 cm by 1.2 cm pieces and functionalized in a toluene/calixarene solution overnight to react

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The functionalized nanocomposites were then taken out of the solution and left under a fume hood to dry overnight

Figure 3. New Fabrication Procedure. The arrows indicate the order in which the new fabrication procedure was followed.

Results

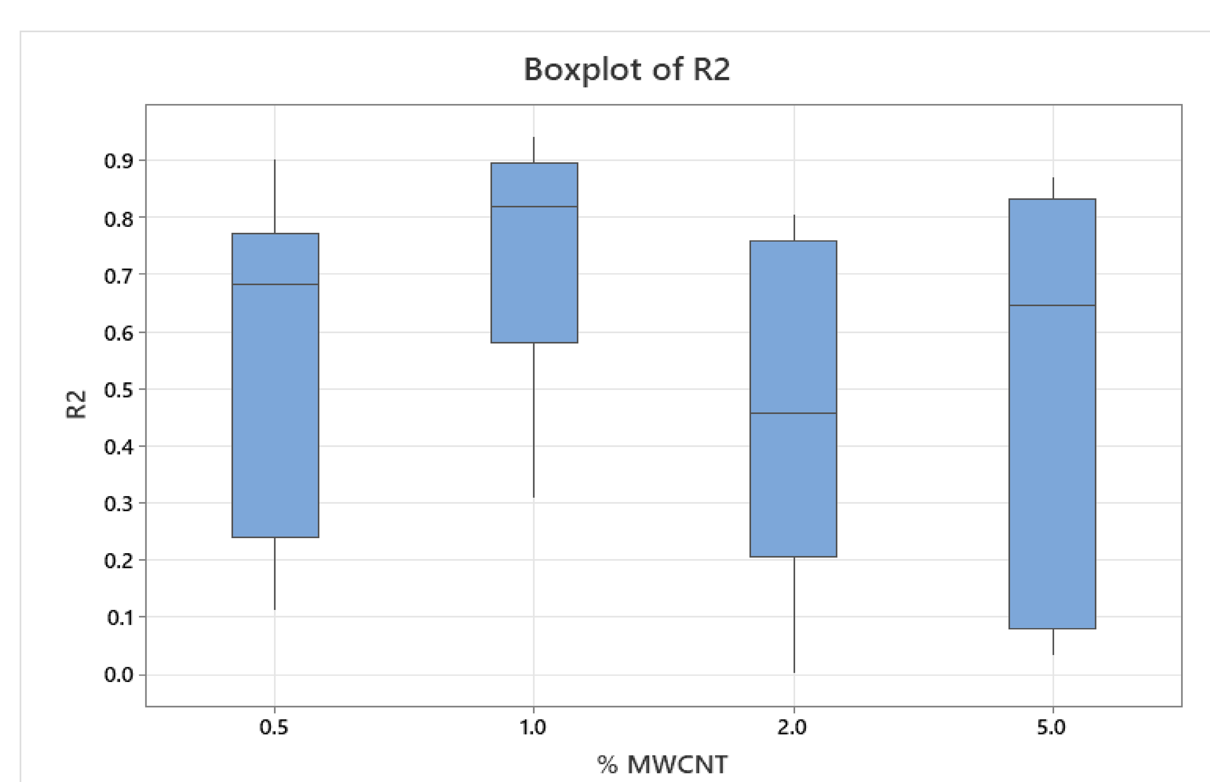

Figure 4. R^2 vs MWCNT Loading Levels. This plot shows the variability of the R^2 values at different loading levels. The R^2 value was used to indicate how well the empirical model considered variations from the best fit line on the Resistance vs Concentration graphs.

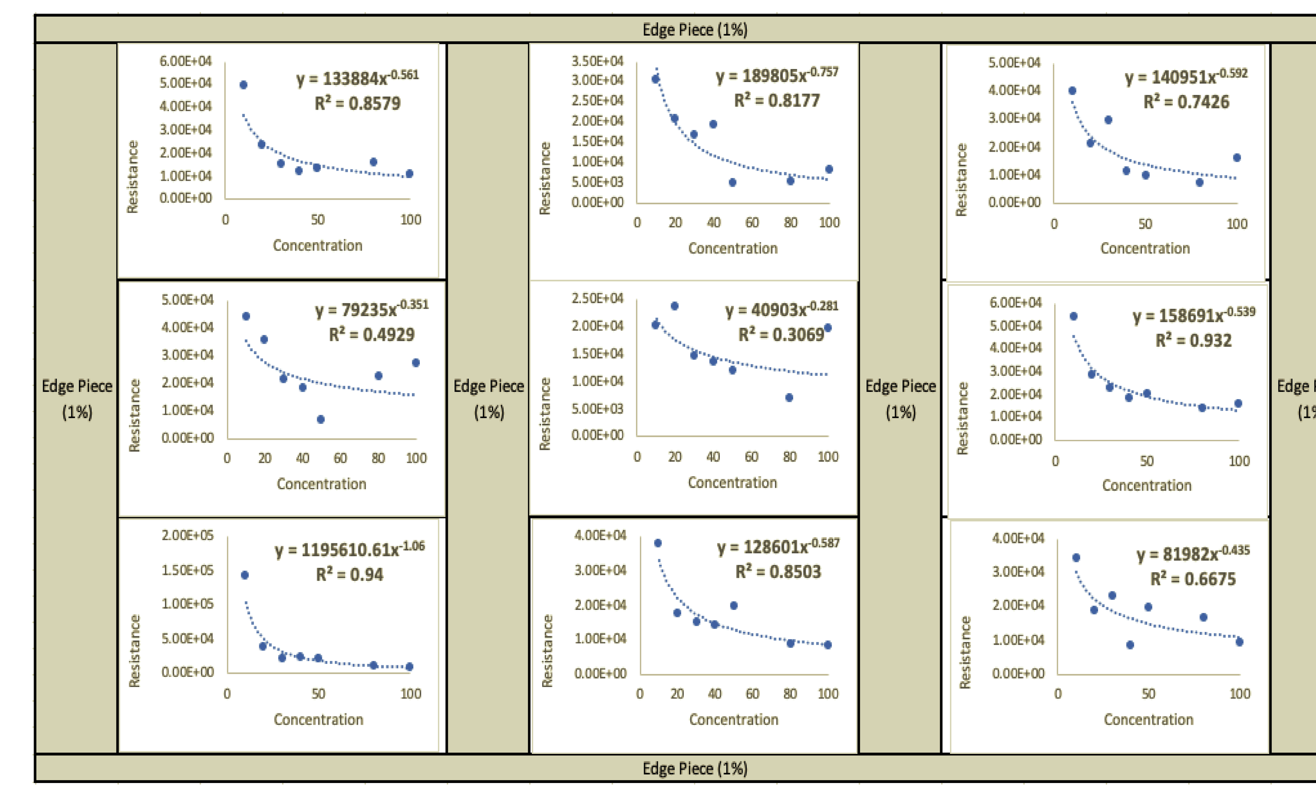

Figure 5. Resistance vs Concentration Graphs. These graphs show the average resistances of the 1 wt % nanocomposites plotted against the sodium ion concentration levels. Each graph corresponds to the location at which the nanocomposite was taken and tested.

Summary/Conclusion

- 1 wt % loading of MWNCT in solution had the optimal performance compared to the other levels considered.
- As shown by Figure 4., 1 wt % loading of MWCNT produced nanocomposites with the least variability. It also had the highest average R^2 value of 0.7344.
- This new fabrication method shows similar behavior to the current method, more replicates will validate whether this new technique is just as good or better than the current fabrication procedure.

Acknowledgements

I would like to thank Dr.Monty-Bromer for allowing me the opportunity to carry out research and to Mary Pat for showing me the ropes inside the lab. I would also like to thank Dr. Ángel L. Reyes-Rodríguez for his patience and help throughout my summer research experience.

Funding: McNair Scholars Program

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Department, Institution, City, Two letter state abbreviation

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University Logo

Abstract

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Introduction

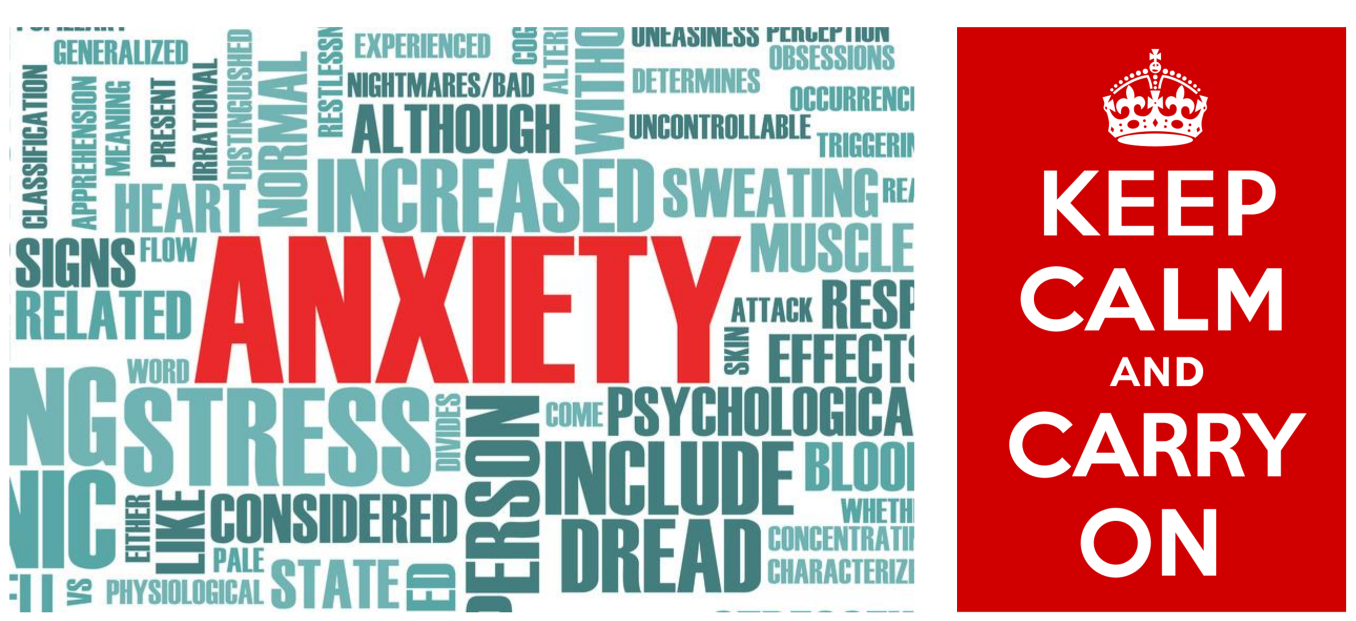

Figure 1. Name of the figure. The first figures of your posters can be used as an introduction to help the audience understand the topic you are researching. Your figure legend should be concise and allow the reader reach their own understanding. Figure legends offer observations, not conclusions. You can use diagrams, tables, etc. You can also use figures from published papers but provide references.

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Methods

The Scientific Method as an Ongoing Process

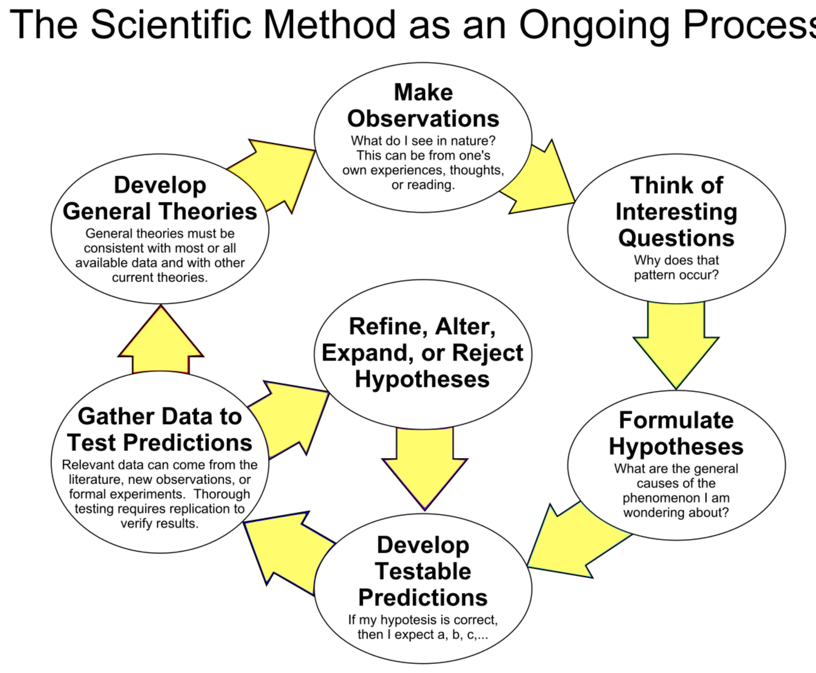

Figure x. Methods. Use a schematic or an image that best describes your methodology. Your figure legend should be concise and allow the reader reach their own understanding. Figure legends offer observations, not conclusions. You can use diagrams, tables, etc. You can also use figures from published papers but provide references.

Results

Characteristic	ReDO group (n=42)	CAU group (n=42)	P-value
Age; mean (SD)	45 (19)[a]	46 (9)	0.628
Living with a partner; n (%)	30 (71%)	27 (64%)	0.320
Number of children; mean (SD)	2.4 (1.4)	2 (1)	0.085
Having a university degree; n (%)	16 (40%)	21 (51%)	0.284
First diagnosis (%)			0.662
Depression; F32	19 (45%)	23 (54%)	
Stress/exhaustion; F43	20 (48%)	17 (41%)	
Physical diagnosis; M54	3 (7%)	2 (5%)	
Sick leave (months) before baseline; mean (SD)	13 (20)	10 (10)	0.414

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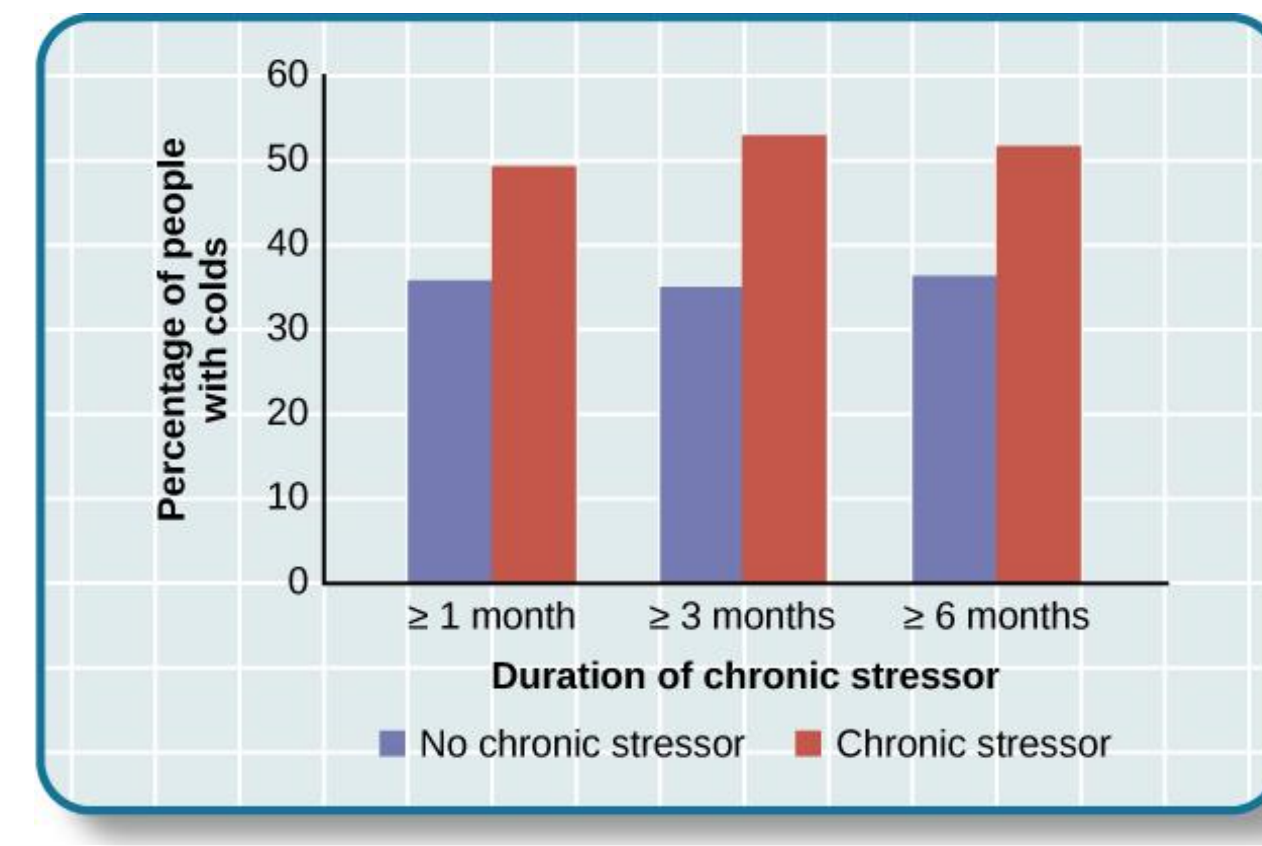

Figure x. Name of the figure. Your figure legend should be concise and allow the reader reach their own understanding. Figure legends offer observations, not conclusions. You can use diagrams, tables, graphs, pictures, etc. This should be your data.

Summary

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Conclusions

Bullets with Key Conclusions

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Acknowledgements

List the people who help you with the research (including other team members, lab members, librarians, office personnel, etc. You don't necessarily have to Acknowledge the mentor since they are authors (akin to thanking yourself) but you can do it.

Funding: McNair Scholars Program