INNOVATIVE TEXTILE-BASED FUNCTIONAL NANOCOMPOSITES FOR FINGER MOTION RECOGNITION

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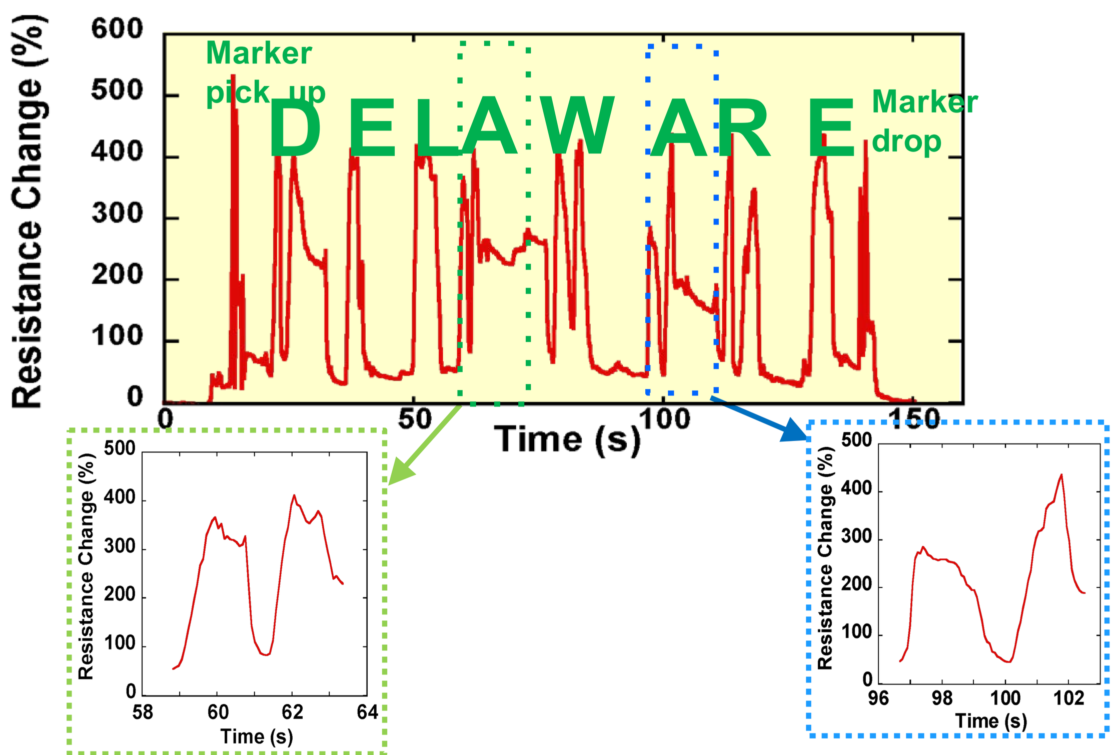
Introduction

- Carbon nanotube (CNT) composites have been shown to increase tensile strength, improve heat deflection temperatures and enhance conductivity.
- Recent studies show that CNT composites also have piezoresistive properties, making them an excellent candidate for a variety of sensors



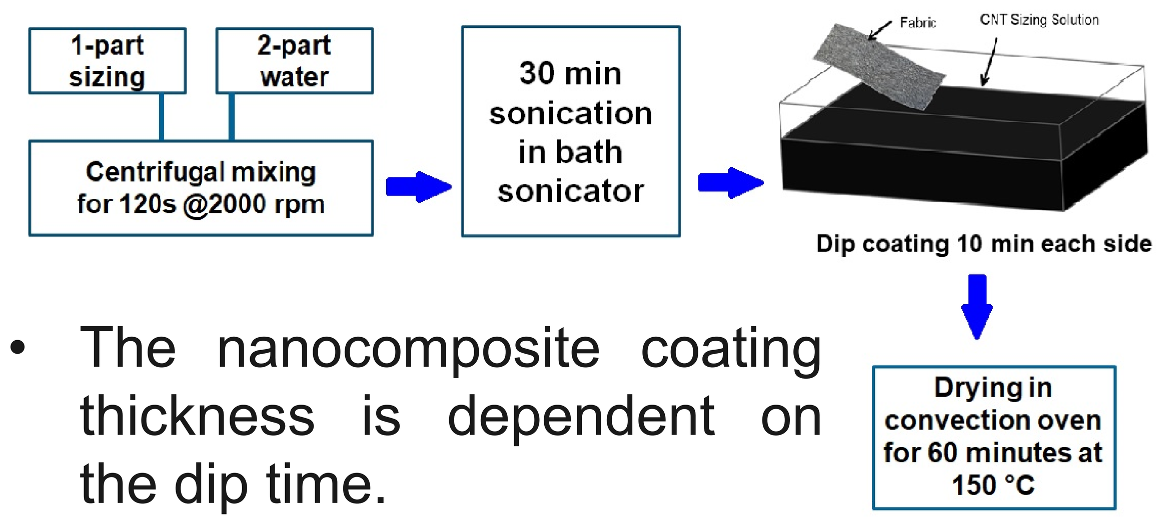
- Our prior studies have shown that garment-based nanocomposite sensors can detect delicate finger motion, such as writing the word Delaware.
- Hand gestures can be utilized in virtual reality and human/machine interactions, but many of the interactive glove systems are expensive, bulky, and inaccurate.

Objectives

- Manufacture textile-based sensors by coating a knitted fabric with functionalized carbon nanotubes.
- Integrate the sensor into a glove and examine the electrical response due to finger motion.
- Interface the sensors with a prosthetic hand to examine sensor repeatability.

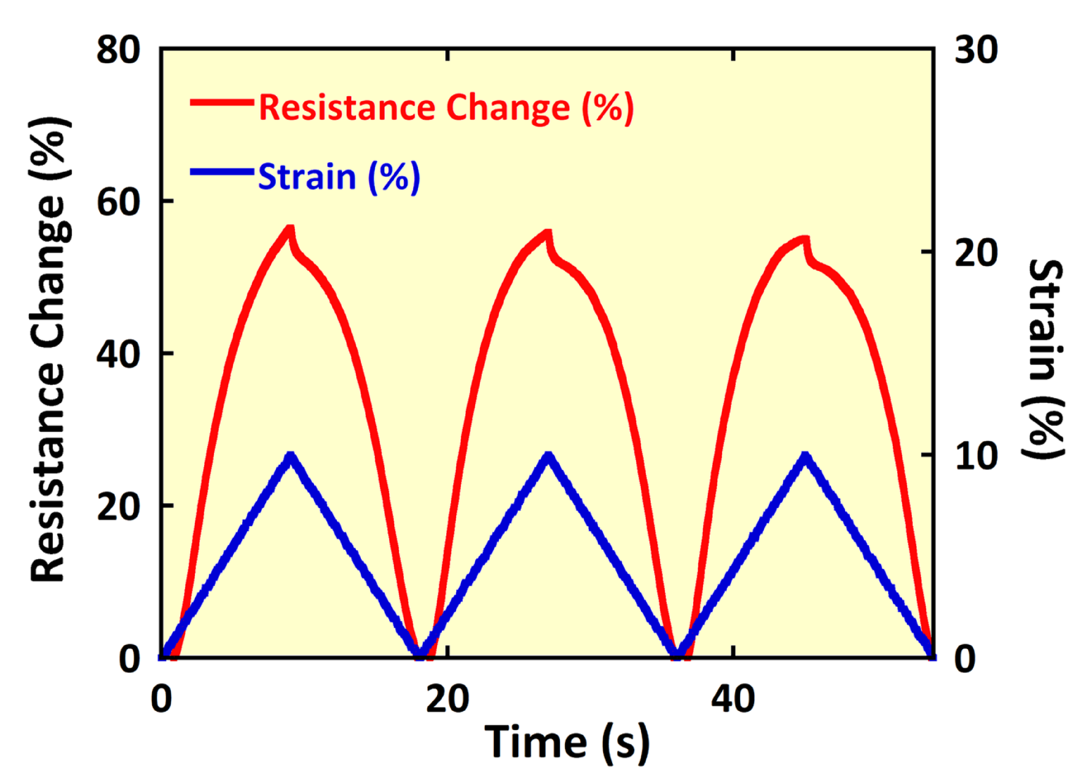
Sensor Manufacturing

- **Dip coating** was utilized to create a nanocomposite coating on the fabric.

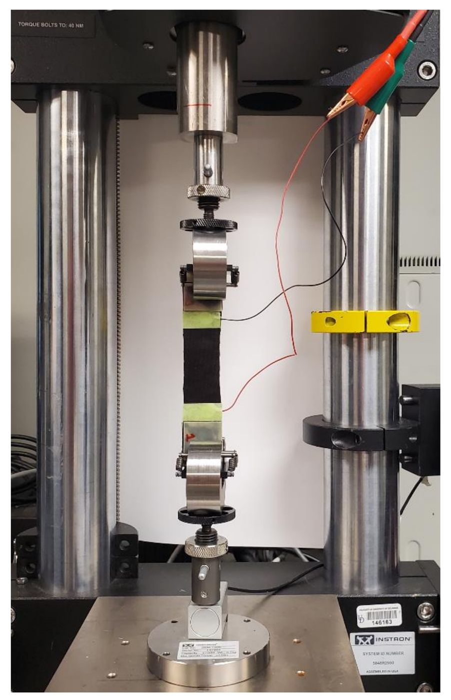


- The nanocomposite coating thickness is dependent on the dip time.
- **Electrophoretic deposition (EPD)** was also used to create nanocomposite coatings. The coating thickness was controlled by applying varying electric fields from 5-50 volts in an aqueous dispersion of CNTs.

Electromechanical Characterization

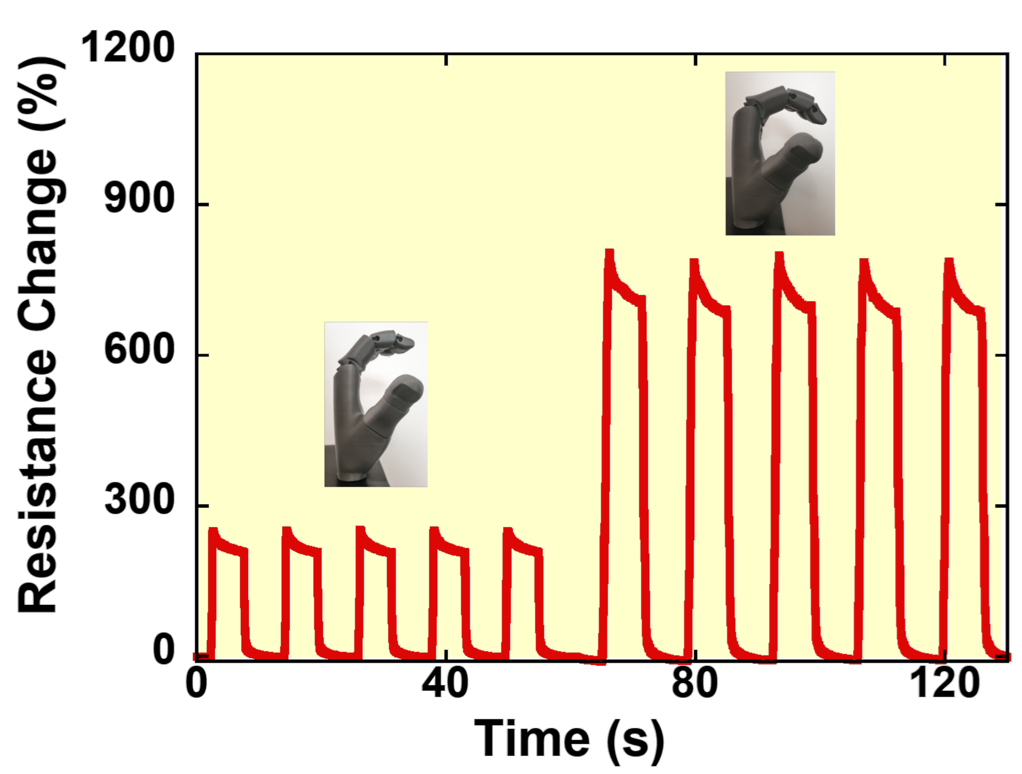


- Multiple fabrics were tested by dip-coating 1" x 4" samples and measuring the electrical resistance change of the sensor under controlled displacement.
- Based on the results, fabric was down-selected for use in the finger sleeve sensors.



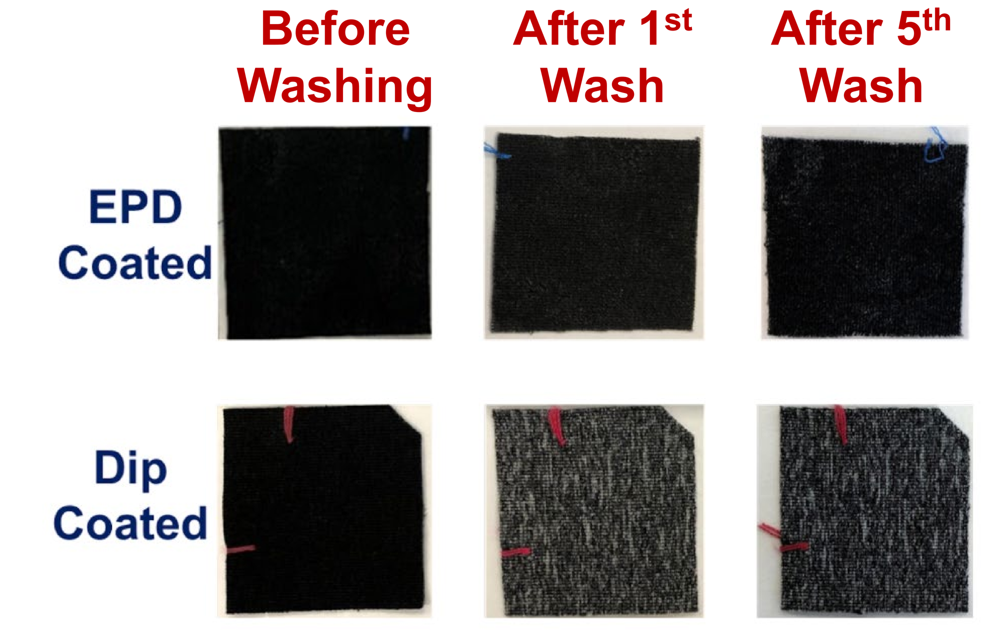
Finger Sleeve Sensors

- In order to and overall obtain repeatable results a 3-D printed prosthetic hand was developed for testing
- The prosthetic hand was actuated using four servo motors attached by a cable through each finger and controlled with an Arduino Nano.
- Individual finger sleeves were manufactured and tested on the hand at varying range of motion.



- Sensors showed extremely high sensitivity and repeatability under finger flexion.
- Finger sleeves were also used to control the hand remotely. Use the QR code or visit https://youtu.be/NPUckgsGjMY.

Sensor Durability



- After testing, the fabric sensors coated in went thru a washing machine to examine the sensor durability
- The EPD-coated sensors showed high durability, with no visible change after five washing cycles.

Conclusions and Future Work

- CNT nanocomposite coatings were used to create highly sensitive sensors for finger motion detection.
- The sensors can be seamlessly integrated into a glove and be used for motion detection and also robotic control.
- The sensors are created with low-cost CNTs and offer the potential for creation of inexpensive controller gloves while also being lightweight and breathable.
- Future work will focus on the development of a wireless Bluetooth controller and interaction with virtual reality systems for physical rehabilitation.

Acknowledgments

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