CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35257

Project Title

Carbands: Flexible High-Strain Biometric Sensors from Carbon Infused Elastic Bands

Abstract

Objectives/Goals

My goal is to prove that infusing carbon black particles and graphene into common elastic natural rubber bands can create flexible, high sensitivity strain sensors useful for a variety of biometric applications. A secondary objective is to demonstrate that carbon black will work as effectively as graphene as a conductive medium. Finally, I hypothesize that it is possible to accurately measure a variety of biomedical metrics such as respiration, pulse, weight, or joint movement using such sensors. These sensors are cheap to manufacture and have properties that distinguish them from more traditional strain sensors including light weight, compliance and flexibility, high strain capability, and fast response times.

Methods/Materials

My project of consisted of two phases: fabrication of the 'carbands' using solvents (Toluene) and solutions of NMP and either carbon black or graphene nanoparticles, and testing the properties of the carbands via experiments and demonstrations. I used an ultrasonic bath to mix my solutions thoroughly, and used a multimeter and Arduino based data collection system to capture my data.

Results

I was able produce both graphene and carbon black carbands which possessed the hypothesized capabilities. During the preparation of the bands, I tested a variety of recipes to optimize their uniformity and electrical characteristics. Changing the soak time by several hours could drastically alter the bands performance. Also, the bands were very sensitive to situations where they would stick together in the solution and prevent uptake of the carbon particles. After a few tests, it became evident that the graphene bands were much more variable in their characteristics than the carbon black bands. The graphene bands resistance was 13 to 20 times higher than the carbon black bands. When measuring strain, I observed that both bands resistance changed exponentially with high strains, but stayed mostly linear with small strains.

Conclusions/Discussion

Both bands demonstrated potential when testing biometric measurements such as muscle movement, respiration, weight, and pulse. These test prove that carbands are practical as sensitive biometric sensors with many potential applications. The next experiments I will perform could include testing pulse in other regions in the body, measuring vocal chord vibrations (speech), and logging complex movements of the hand in real time.

Summary Statement

My project is about developing lightweight, high strain biometric sensors by infusing carbon particles into natural rubber bands.

Help Received

Father bought materials and helped debug control program; Used high power sonication probe under the supervision of Dr. Jeffery Tok at Stanford