# CALIFORNIA STATE SCIENCE FAIR
# 2014 PROJECT SUMMARY

**Name(s)**

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**Project Number**

34767

**Project Title**

## The Development of a Electrode Based Biosensor for Cardiac Health Diagnostics

**Abstract**

**Objectives/Goals**

Acute myocardial infarction (AMI), or cardiac arrest, accounts for one-third of the deaths in the world. When the heart muscle begins to degenerate, three main proteins are released: Troponin, Myoglobin, and C-reactive protein. Currently, the concentrations of these proteins are determined through a series of multi-step, low sensitivity, time intensive and costly procedures. Electrochemical based biosensors have potential for quick, sensitive, portable, accurate, cost effective detection of a variety of proteins and other biomolecules.

**Methods/Materials**

A standard silica wafer electrode etched with lithography is used as a substrate for the biosensor. CNFs are grown using plasma enhanced chemical vapor deposition. A series of surface modification procedures are conducted, including nitric acid soaking, couple linker binding, antibody binding, and antigen binding. At each step of the process, electrochemical characteristics (CV and DPV curves) using the electrochemical workstation are taken. Vertically aligned carbon nanofibers (CNFs) are extremely sensitive detection mechanisms because of their conductivity, biocompatibility, and ease of surface modification. Electrochemical biosensors are 25 times more sensitive than current laboratory techniques, and the CNFs allow for the synthesis of an accurate device with reduced risk of false positive results.

**Results**

The change in concentration of Troponin and Myoglobin was mapped using the change in electrical current in the CNF sensor, measured by EIS. Conventional methods can only measure protein concentrations to 5ng/mL sensitivity, and uses laboratory grade equipment with multi-stage processing. The developed biosensor has a sensitivity of .02ng/mL and would only need a very small sample for testing.

**Conclusions/Discussion**

By measuring the difference in current between the antibody and antigen curves for each sample, a scale between concentration and current (hence resistance) was calibrated, effectively creating a biosensor for cardiac arrest.

This solution provides a cost effective, efficient, highly sensitive, portable, and reliable diagnostic tool for cardiac arrest. It is expected to save the lives of hundreds of thousands of people across the globe, and revolutionize the way we approach cardiac health diagnostics.

**Summary Statement**

A highly sensitive, cost effective, reliable electrode based biosensor for cardiac arrest diagnostics was developed using plasma enhanced chemically vapor deposited carbon nanofibers.

**Help Received**

Lab equipment used at NASA Ames Research Center under the supervision of Dr. Jessica Koehne