CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

S0618

Project Title

Nanowire Sensing of Iron (III) in Millimolar Concentrations

Abstract

Objectives/Goals

The goal of the prototype was to test the detection of a metal ion, specifically of iron (III), using a nanowire array in millimolar concentrations, instead of standard expensive and comparatively time-intensive equipment, such as spectroscopy tests. The ultimate aim is to apply this technology to medical or environment testing involving iron (III) and to even apply it to other chemicals, such as glucose sensing by changing the chelator.

Methods/Materials

The seven-step LPNE process was followed, involving nochromix-sulfuric acid solution, chromium, gold, nickel, a potentiostat with a three electrode-system, positive photoresist and developer, gold and chromium etchants, a contact mask, nickel and gold evaporators, a UV lamp and aligner stage, and PEDOT-deferoxamine solution to pattern and etch the nanowire trenches and to grow the nanowires. Then using the potentiostat, and various concentrations of zinc and iron (III) solutions and a sodium background, the change in electrical resistance was measured.

Results

The results of the zinc and iron concentrations against the sodium background proved to show increases in resistance across the nanowire array. And as expected, the tests run in iron (III) showed a much larger drop in the resistance measurements than in the zinc solutions, which some changes are expected as charges may be carried across the gap by the ions. The measurable differences shown after 20 minutes to equilibrate indicate that the design has the ability to relay a reading much quicker than most modern commercial processes at a millimolar scale.

Conclusions/Discussion

The goal of the prototype was to test the detection of a metal ion, specifically of iron (III), using a nanowire array in millimolar concentrations. The nanowire array and the 20 minute equilibrium time, which may be shortened with further testing, showed distinct responses, allowing for much faster, more inexpensive, and greater efficiency as opposed to various spectroscopy tests and testing from nanowire arrays doped with ethylenediaminetetraacetic acid, which requires a 200 to 400 minute wait to attain a response to low millimolar concentrations. The detection and results confirm that the nanowire array design has the capability for effective testing and lasting durability as it underwent over five hours in various solutions, suggesting that the nanowire array design and method is viable for practical applications.

Summary Statement

PEDOT-DFA nanowire arrays in millimolar solutions, ranging from 10^-5 to 10^-9 concentration of iron (III), were tested to examine the efficiency and capabilities of this technology.

Help Received

I fabricated all of the nanowire arrays and conducted all the testing, but relied on the training and guidance from Rajen Dutta and Mya Le-Thai. I used the faculty and equipment provided in Professor Penner's Laboratory at the University of Irvine: California and the consulted previous research from