CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

S0501

Project Title

Malleable Polymer-Imprinted Porous Silicon Photonic Crystal Composites

Abstract

Objectives/Goals

Porous silicon as a sensor is useful in many applications throughout the real world, from detecting toxins in the environment to monitoring levels of chemicals in the living systems. But while porous silicon possesses assets of reliability and efficiency, it lacks certain practical qualities such as biocompatibility, flexibility, and adaptability to a myriad of environments - qualities offered by polymers. The purpose of the project is to create composite materials comprised of porous silicon nanofilms infiltrated by various polymers.

Methods/Materials

The two polymers used were ethylene vinyl acetate and polydimethylsiloxane. In etching the porous silicon chip, using a HF-ethanol solution under an electric current, numerous current settings were attempted that allowed optimum polymer infiltration. Conditions of polymer application, such as exposure to high temperature, length of time in and out of heat, as well as procedure and method, were adjusted over the course of trial-and-error. After successfully synthesizing the composites, they were placed under a spectrometer in air and ethanol, and various computer programs were used to analyze the spectral shifts to determine the material's sensing value.

Results

A reliable method of polymer infiltration and formation of the composite was developed. It was found that a lift-off etch was necessary in order for polymer-film removal from the bulk silicon. The composites demonstrated significant spectral shifts when placed in ethanol, confirming their viability as sensors.

Conclusions/Discussion

I successfully created a novel sensing material integrating the sensing properties of porous silicon photonic crystals with polymers. The discovery that the sensing ability of the flexible and chemically stable composite materials remains relatively secure paves the way for further study and optimization of these novel hybrid sensors.

Summary Statement

A novel flexible sensing material was created that integrated the sensing properties of porous silicon nanofilms with polymers.

Help Received

Used lab equipment at the University of California, San Diego under the supervision of Professor Michael Sailor