CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Mihika Nadig; Andre Yin

Project Number

S0625

Project Title

Thermolytic Grafting to Stabilize Photonic Crystal Based Porous Silicon Sensors

Abstract

Objectives/Goals

My goal in this project was to stabilize porous silicon (pSi) in basic conditions (pH>7) using thermolytic grafting of trihydridosilane. Many drugs right now are taken orally, and they have to travel through the highly acidic stomach and then the much more basic small intestine to be absorbed in the body. Stabilization of pSi in acidic conditions has already been achieved, so stabilization in basic conditions will be useful for effective drug delivery in these fluctuating pH conditions and for detecting how much of a drug has been released with time.

Methods/Materials

The project started with the transformation of a silicon wafer to porous silicon through electrochemical etching. These porous silicon chips were then submersed in a solution to graft trihydridosilane onto their surface. The experiment consisted of four solutions, in which the pSi chips were immersed: two solutions with water (control), and two with pH 10 buffer. Three instruments were used for characterization of the modified pSi and measurement of stability over time: Fourier Transform Infrared Spectroscopy (FTIR), Spectroscopic Liquid Infiltration Method (SLIM), and Water Contact Angle Goniometry.

Results

The FTIR graphs portrayed that there was successful grafting of -CH groups onto the pSi, and that these groups remained throughout the experiment. The samples with grafting maintained porosity and thickness better than the control samples, as indicated by SLIM. In addition, Water Contact Angle depicted that the grafted samples were more hydrophobic than the control samples.

Conclusions/Discussion

FTIR, SLIM, and Water Contact Angle results provided sufficient evidence that the porous silicon was stabilized effectively in basic conditions. One major application of porous silicon is that it is a highly efficient and suitable drug delivery nanoplatform, given its large surface area and easily variable pore size. With its stabilization in basic conditions, pSi nanoparticles can deliver drugs to parts of the human body with basic pH, such as the small intestine. In addition, pSi can serve as a chemical sensor to detect undesirable gases in the air, such as hexane at gas stations. Because pSi has structural color, it can change colors with a change in refractive index, so it can also detect whether water has been drugged with alcohol.

Summary Statement

I effectively stabilized porous silicon in basic conditions using thermolytic grafting of trihydridosilane, a result that has applications in drug delivery and chemical sensing.

Help Received

Professor Michael Sailor and Dr. Dokyoung Kim generously provided me with a lab space and answered my questions regarding porous silicon. Hannah Nakamoto etched the porous silicon. I handled all the other parts of my project by myself.