Name(s)
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Project Number
S0603

Project Title
Photo-induced Degradation of Porous Silicon via a Redox Active Etchant: A Potential Novel Drug Delivery System

Abstract

Objectives/Goals
Porous silicon's (PSi) unique properties, including biocompatibility and biodegradability, contribute to its potential as a drug delivery agent. If chemotherapy drugs are enclosed as a payload within porous silicon nanoparticles (PSiNPs), along with a redox-active etchant, then the drug can be targeted to the tumor sites, minimizing harmful side effects, as well as enabling a higher dose of the therapeutic to be delivered to the tumor. Exposure to light at certain wavelengths can stimulate the electrons in the porous silicon to react with the etchant, hexamminecolbalt (III) Chloride, (Co(NH(3)6^3+)(abv. HXC), reducing the HXC, causing it to release its ammonia groups, resulting in a degradation of the PSi shell. In the loaded nanoparticles, this degradation results in the release of the drug payload at the site of the tumor if concentrated light at a certain wavelength is also applied to that tumor region.
This project sought to prove the above reaction empirically, as well as looking at the effects of different wavelengths and intensities of light, and finally, using calcein dye within the system to simulate a drug payload.

Methods/Materials
Porous silicon wafers were etched in 3:1 HF: EtOH solution and partially oxidized in a borate solution to produce photoluminescence (PL) from the quantum confinement effect. Several experiments were done on these wafers looking at empirical values for different components of the proposed redox reaction. These included pipetting a 10 mM solution of HXC on top of etched PSi wafers, exposing the chips to 365 nm light , and measuring the decrease in PL from the degradation of the chip surface, as compared to a control solution with no HXC. Experiments were also done looking at the effect of light in the reaction as well as the component of NH^3 production.
Partially-oxidized PSi nanoparticles (PSiNPs) were also made and placed in solutions of different concentrations of HXC and exposed to 365 nm light, and absorbance of nanoparticles was measured over 30 minutes. Finally, PSiNPs were loaded with calcein dye (to simulate a drug) and HXC or a control solution, and exposed to the same light conditions for 10 minutes, before measuring the absorbance of dye released

Results
The findings indicate that the reduction reaction of HXC causes the degradation of PSi matrix due to release of NH^3, and that the reaction is light and concentration dependent.

Summary Statement
A potential novel drug delivery system, utilizing a photo-induced reduction reaction resulting in the degradation of a porous silicon shell surrounding a payload only when exposed to certain lights, was created to minimize side effects.

Help Received
Dr. Michael Sailor and Geoff Hollett from UCSD helped mentor me throughout this project in addition to allowing me to use UCSD lab facilities and materials.