Green Synthetic Routes to Porous Silicon for Drug Delivery Devices

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INTRODUCTION

- This research explores the sustainable synthesis of porous silicon nanoparticles using eco-friendly materials and accessible techniques.
- Porous silicon, known for its high surface area and biocompatibility, has important applications in biomedicine, electronics, and energy storage. Traditional synthesis methods rely on electrochemical etching of costly silicon wafers, limiting scalability.
- This project explores a greener, low-cost alternative using sand-based silica and a 12V electric current to drive the reduction of SiO_2 with magnesium.
- A wooden block was used as the reaction chamber for its eco-friendliness, low cost, and accessibility; tungsten wire was chosen for its durability under high temperatures.
- Rigaku Powder X-ray diffraction (XRD) was used to evaluate the crystallinity and purity of the synthesized silicon materials.

PROCEDURE

Magnesiothermic Reduction Reaction

$$SiO_{2(s)} + 2Mg_{(s)} \xrightarrow[600°C \text{ or } 12V]{NaCl} 2MgO_{(s)} + Si_{(s)}$$

- A combination of SiO_2, Mg, and NaCl was meticulously ground and placed into a closed reaction chamber. SiO_2 was used as the oxidizing agent, magnesium served as the reducing agent, and NaCl acted as a thermal stabilizer during the reaction.
- The reaction started by applying a **12V electric current** to the mixture for about 10 minutes in an outside environment to minimize fire hazards.
- Upon completion, the compartment was cooled to ambient temperature and subsequently opened. The solid products were collected, isolating the material on the ignition wire from the unreacted residue.
- The reactive product was dissolved in hot concentrated HCl (~70°C) for two hours, followed by vacuum filtration and washing. The pure silicon was analyzed using **X-ray diffraction (XRD).**

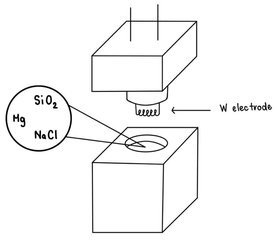


Figure 1. Wooden Reactor

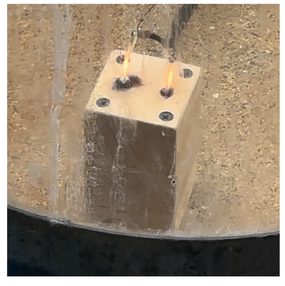
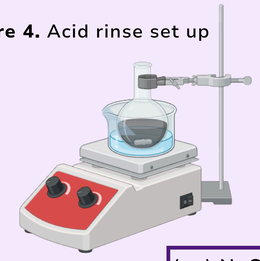


Figure 2. Experimental Wooden Reactor

RESULTS

Figure 3.
Reacted collective products
(A) Product near the electrode
(B) Product far away from the electrode

Figure 4. Acid rinse set up



(•) NaCl
(∧) Mg
(⁎) Si
(#) Unknown

Before Acid Rinse

After Acid Rinse

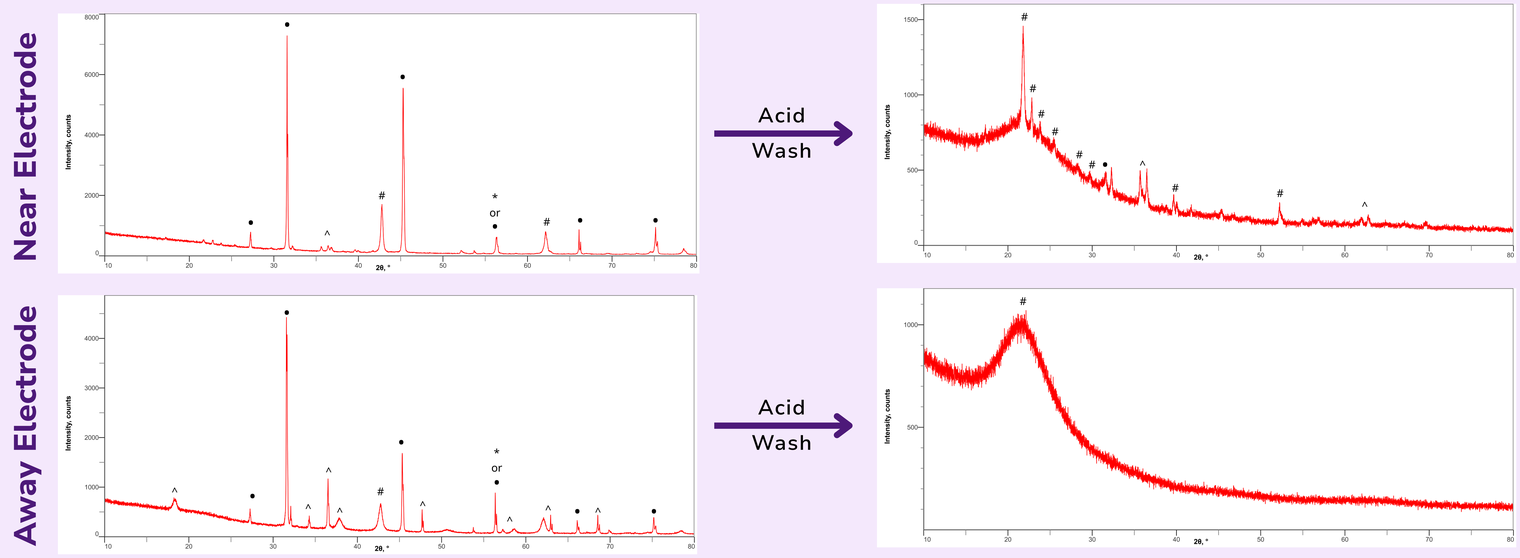


Figure 5. Rigaku Powder X-ray Diffraction (XRD) Spectroscopy for sample run for 10 minutes

CONCLUSIONS AND FUTURE WORK

- Control reaction at the high temperature produced porous silicon as expected.
- Reaction product away from the electrode produced some small silica structures.
- Reaction product near the electrode yield series of product that undefined composition, possibly Magnisium Silicate or Silicon Carbide.
- Future experiments will evolve in longer time and different voltages.

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