CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Lusha W. Liang

Project Number

S0512

Project Title

Control of Hydrophilicity in Nanoporous Zeolite Film by Organic Functionalization

Abstract

Objectives/Goals

Zeolites, nanoporous, crystalline solids, are potential candidates for insulators in integrated circuits. Zeolite however, is quite hydrophilic, so its pores often contain water# a very undesirable feature for an insulator. Thus, the objective of my experiment is to increase the hydrophobicity of zeolite film so that it can be suitable for insulating material in integrated circuits.

Methods/Materials

I prepared zeolite thin films on silicon substrates using the in-situ crystallization method. This required the preparation of a synthesis solution with a molar composition of 165 H_2O: 0.32 TPAOH: 1 TEOS. The solution was allowed to age, and was then grown onto silicon substrates by being placed together in an autoclave under an extremely high temperature. Then I calcinated the films to remove the structure-directing agent, TPAOH. I was able to measure the hydrophilicity of the film using a water contact angle machine, taking measurements from four different locations on each zeolite film. Organic functionalization by liquid phase silyation caused the previously hydrophilic films to become hydrophobic, which was discovered by taking the water contact angle measurements on each film again. Inspecting the films under the SEM allowed me to assess the quality of the films.

Results

The water contact angles of the zeolite films before organic functionalization are much smaller in value than the angles after silyation. The average difference between the two is 79.21 degrees. Small variations in water contact angles measured on each zeolite film can be attributed to dust on the film and/or slightly different water droplet sizes. Using the in-situ crystallization method and a synthesis time of 2 hours and 20 minutes, my crystals were found to be slightly large and not very spherical. However, along with comparative simplicity, the in-situ crystallization method does not produce any cracks in the film.

Conclusions/Discussion

My hypothesis was proven by the data I acquired, but the large magnitude of increased hydrophobicity was unexpected. This development bodes well for liquid phase silyation as a method of increasing hydrophobicity of zeolite crystals. It increases zeolite#s potential as an insulator in fabrication processes for future generation microprocessors.

Summary Statement

I utilized organic functionalization as a means of increasing the hydrophobicity of pure silica zeolite films to improve its potential as an effective insulator in integrated circuits.

Help Received

My father helped me revise my report and introduced me to Dr. Yan, who allowed me to use his lab in UCR for my project. Dr. Yan also instituted a supervisor for me: Chris Lew, who provided me with some useful reading material and was able to answer many of my questions.