Vertically-Aligned Carbon Nanotube Membrane for Solar Hydrogen Generation

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Principal Investigator(s): Prof. Todd D. Krauss
User(s): Jenneke Jalink

Affiliation(s): Department of Chemistry, University of Rochester
Primary Research Funding: United States Department of Energy
Contact: krauss@chem.rochester.edu, jjalink@mail.rochester.edu

Abstract:
We are developing a vertically-aligned carbon nanotube (VA-CNTs) membrane for solar hydrogen production. To fabricate the membrane, we have been growing vertically-aligned carbon nanotubes on micro porous silicon with an iron catalyst using chemical vapor deposition (CVD). Following the carbon nanotube growth a polymer is deposited to fabricate the membrane [4,5].

Summary of Research:
To be able to use hydrogen as a clean and environmentally friendly source of fuel on a large scale, production of it using a clean source of energy and not fossil fuels is necessary [1]. Out of the possible energy resources, solar is the most widely available and most abundant source for long-term carbon free energy although there are still many challenges in reaching that goal [1,2]. In this project, we are developing a vertically-aligned carbon nanotube membrane that will ultimately be used to harvest solar energy and store it in the form of hydrogen.

Using p-type micro-porous silicon as a substrate and e-beam evaporated 5 nm Fe catalyst, a dense forest of vertically-aligned carbon nanotubes (VA-CNTs) was grown by a chemical vapor deposition (CVD) process, using ethylene gas at 1000 sccm as the carbon source at 700°C for 10 to 20 minutes with the samples set in a quartz boat [3]. The samples are first oxidized at 300°C open to air for 12 hours, and the chamber is then cleared with Ar and the temperature is set to 700°C before introducing the carbon source [3]. A film thickness of over 100 µm covering a 1 cm² area was achieved (Figure 1).

For fabrication of a conductive VA-CNTs membrane, a polymer (PMMA) was deposited on the VA-CNTs, spin-coated at 2500 rpm, and then set to dry at 70°C and 15 inch Hg [5].

Future work includes conductivity measurements of the VA-CNT membranes and systematic studies of the membrane integrity.

Figure 1: Scanning electron microscope image of vertically-aligned carbon nanotube on micro-porous silicon.

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