

Controlled Microfluidic Flow of Nonpolar Substances

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Introduction

Using sugar cubes and PDMS (Polydimethylsiloxane), we were able to create sponges that selectively absorb oil over water. PDMS is a silicone based organic polymer that exhibits hydrophobic properties. These sponges have many uses including a porous lab-on-a-chip system to pump fluid through a micro-channel.

The goal of our project was to create the PDMS sponges and test their abilities. We tested the sponges absorptive abilities using vegetable oil and colored water and created the lab-on-a-chip system with a modified sponge and a micro-channel.

Fabrication

Creating the PDMS sponges is simple and timely meaning mass production is possible. Begin by coating the sugar cubes in PDMS and prepolymer at a ratio of 10:1 by weight. The sponges are then put into a vacuum dessicator for 4 hours so that the PDMS could infiltrate into the sugar cubes by capillary force. Once the vacuuming process is finished, the sponges are heated at 120° C for 12 minutes for curing. Once baked and vacuumed, the sponges are then washed using an ultrasonic cleaner to remove the remaining sugar from the sponge. The result is shown below.



Applications

The properties of these sponges enable them to have a multitude of uses. Some of these include:

- Cleaning up oil spills in the ocean
- Grease and oil cleaner in a garage or shop
- Portable PDMS pump

PDMS Pump

The Lab-on-a-chip PDMS pump was created using one of the sponges using a simple modification. The system would not work with one of the original sponges due to the saline solution leaking out all faces of the sponge when compressed. To fix this problem, we added another layer of PDMS on top of the sponge and then placed 2 holes (one on top and one on bottom) to allow liquid to flow through the sponge. Disadvantages include the added rigidity of the extra PDMS layer as well as a reduction in the volume of the sponge. We plan on looking into potential ways to maximize the volume and compressibility of the sponge while still enabling flow.

Saline solution was used for these experiments because water is not absorbed by the sponge. 20 grams of salt was poured into a beaker with 30 ml of water (0.667 g/ml concentration). Saline is usable with the pump because it is a non polar solution.



Oil Absorption

Oil is selectively absorbed due to the non-polar nature of the sponge. It attracts the non-polar oil while repelling the polar water. The below picture shows the sponge in a combination of vegetable oil (the clear liquid on top) and water containing green food coloring to make it more distinguishable.



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References

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