10.491 February 2001

ICE – Microfluidics Module

Due Wednesday February 14

Problem 1

a. Figure 1 is a schematic of a chemical microreactor for reacting two liquid streams. It has two inlet ports for reactants and an outlet port. The two reactants stream flow side-by-side down the channel and the catalytic reaction takes place very rapidly where the two reactants are both present next to the catalyst. The reactor is constructed of silicon capped with pyrex glass. The inlet ports are etched into another silicon wafer. A thin film metal catalyst (Pt) is located in the center of the reaction channel. The channels are 500 μm wide, and all three wafers (Si as well as pyrex) are 500 μm thick. Create the fabrication process flow for the chemical reactor. The process flow should include sketches of all the masks (for a single reactor), list the processing steps and discuss process conditions.

b. Researchers would like to use KOH instead deep reactive ion etch (DRIE) to fabricate the microreactor shown in Figure 1. The volume of the KOH-etched structure should be equal to the volume of the plasma-etched microreactor. What would the structure look like (top view and cross-section)?

c. Define a process flow to create the same reactor, but use soft lithography.

d. Discuss the usefulness of the proposed reactor for running a catalytic reaction. For example, assuming that the reactants have the same diffusion coefficient (10^{-5} cm^2/s) to what extent have the streams mixed by the end of the reactor and is the mixture contacted effectively with the catalyst? Would the design be more appropriate for a gas-phase reactor? What would be the chemical limitations of the silicon/pyrex reactor, the reactor made by soft lithography?

e. Propose an improved reaction design, justify why your design would be better, and describe how you would build it.