Abstract:

To educate undergraduate students on mixing at the microscale, a laboratory experiment was designed where students directly measure diffusive mixing along the length of a simple microfluidic T-channel micromixer. The SU-8-on-silicon facilities at CNF were used to fabricate masters for the micromixers. Students cast PDMS micromixers from the masters and experimentally measured mixing of the fluorescent dye fluorescein using an epi-fluorescent microscope. Results were compared to theory.

Summary of Research:

Molecular transport in fluidic systems at micrometer scale can be significantly different from that at the macroscale [1]. At the macroscale, mixing of different reagents is often realized by the introduction of turbulence (e.g. small vortices introduced by pipetting up and down in an Eppendorf tube). However, at the micrometer scale, the fluid flow is predominantly laminar due to the small length scale, and mixing is a challenging task [2].

To educate undergraduate students on mixing at the microscale a laboratory experiment was designed where students directly measure diffusive mixing along the length of a simple microfluidic T-channel mixer.

Masters for the microfluidic mixer were fabricated for the students at CNF using the SU-8 photoresist on silicon photolithography process. Students used soft lithography to cast PDMS micromixers from the reusable masters. A syringe pump was used to control the flow rate of fluorescein fluorescent dye solution into one inlet of the micromixer and water into the other. Students used an epi-fluorescent microscope to take fluorescent images at different distances along the mixing channel from the point of contact of the two fluids and repeated the experiment at different flow rates (Figures 1 and 2).

The program ImageJ was used to plot fluorescent light intensity vs. distance along the width of the mixing channel to measure the fluorescein gradient. Students compared experimental results to theory.

References:


Figure 1: Fluorescent and brightfield image of the microfluidic T channel where fluorescein (left) and water (right) come into contact. The low Reynolds number of the system results in separate laminar flow streams in the mixing channel (bottom).

Figure 2: Fluorescent image of fluorescein gradient across the width of the mixing channel.