Examining and Influencing Order in the Flow of Worm-Like Micelles Through Porous Media

CNF Project # 1405-05
Principal Investigator: Robert K. Prud’homme

Abstract:
Surfactants are widely used in industry as rheological modifiers. In particular, surfactants which form worm-like micelles have found use in the energy industry as fracturing fluids [1]. It has been demonstrated that these solutions can align in shear, as well as in flow through porous media—a fact that complicates their usage [2]. In order to better study the behavior of these worm-like micelles, we have fabricated a simple microfluidic flow device which mimics the flow in natural rock formations.

Summary:
We have created a series of devices in silicon, which consist of a narrow flow channel with circular wells at either end for fluid entry and exit. In the center of each flow channel, there is an array of identical offset octagons, which are spaced one diameter apart. The octagons range in size from 30 µm to 1 µm in diameter. Each device is then etched to a depth equal to this diameter, thus ensuring the fluid sees a tortuous flow channel inside this array. The silicon wafer can then be anodically welded to glass. Fluidic connections to the device are established by drilling through the silicon prior to welding, and then using Upchurch Nanoport fittings.

References:
Examining and Influencing Order in the Flow of Worm-Like Micelles Through Porous Media

CNF Project # I405-05
Principal Investigator: Robert K. Prud’homme
User: Brian Figura

Affiliation: Department of Chemical Engineering, Princeton University
Primary Funding: Schlumberger Limited
Contact: prudhomme@princeton.edu, bfigura@princeton.edu

Figure 1: Sample wafer before etching to illustrate the general design of the device.

Figure 2: This micrograph shows a close-up of the offset octagonal array present in the center of each flow channel. This array can be seen in Figure 1.