Abstract:
Using conventional photolithography, we have fabricated 500 nm wide square fluidic channels in optical grade fused silica wafers. The channel walls act as a physical barrier confining a dilute sample of fluorescently labeled species allowing for sensitive single molecule fluorescence measurements. Additionally we have fabricated fluidic channels that can be used for fluorescence image calibration and for determining distortion due to deep tissue imaging.

Summary of Research:
Fluorescence detection allows for sensitive visualization and quantification of molecules in solution and microfluidic devices have developed as a platform for analyzing, separating, and investigating small samples. Additionally, the sensitivity of single molecule fluorescence is enhanced in nano-structures due to focal volume confinement. Previous work from our laboratory has demonstrated high signal-to-noise ratio (SNR) fluorescence measurements in nanofluidic devices [1,2].

In our device, a dilute sample of fluorescently labeled particles is driven by voltage from the inlet to the outlet passing through the focal volume of the excitation beam one molecule at a time. The focal volume confinement region of the channels is a square channel that is 500 nm wide and deep, and 10 µm long. The device pattern is transferred into a positive tone resist using the 5x Autostep 200 i-line wafer stepper. The device pattern is then etched into fused silica wafers using the patterned resist as a mask. Finally, inlet and outlet holes are blasted in the wafer and it is sealed using a fused silica coverslip wafer.

In addition to the focal volume confinement project, we are also working on the fabrication of chips for aberration testing for fluorescence imaging application. Aberrations of the point spread function are often a problem in deep tissue multiphoton microscopy. We have fabricated channels of standard dimensions — from 2 to 50 µm wide — which can be used for both image calibration and evaluation of aberrations that occur while imaging through tissues such as skin and cartilage. Fused silica wafers are regularly patterned using standard soft contact lithography. The mask pattern is transferred to the resist which is then used to pattern a layer of chromium. Ultimately, the patterned chromium is used as a hard mask for etching on the Oxford PlasmaLab 100.

References: