

# Microfluidic Sensors with Impregnated Fluorophores for Simultaneous Imaging of Spatial Structure and Chemical Oxygen Gradients

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## Supplementary Information

### Fabrication of oxygen sensor incorporated pore network

The pore network device in polystyrene was prepared by hot embossing polystyrene against a glass-backed PDMS structure. The overall approach is shown in **Figure SI\_1**.

Pore network device fabrication begins with spin coating of 20  $\mu\text{m}$  photoresist AZ 4620 on a 4" 500  $\mu\text{m}$  thick silicon wafer. AZ photoresist was exposed to UV light through a chrome-on-glass pore network photomask. Exposed AZ was developed in 1:3 AZ 400K developer in water. 100- $\mu\text{m}$ -deep channels were made with DRIE (Oxford Instruments) as AZ served as a protective layer. A silicon primary mold was obtained after removing AZ in 80°C AZ 400T stripper. The silicon mold surface was processed in  $\text{C}_4\text{F}_8$  plasma to help with demolding in the following steps.

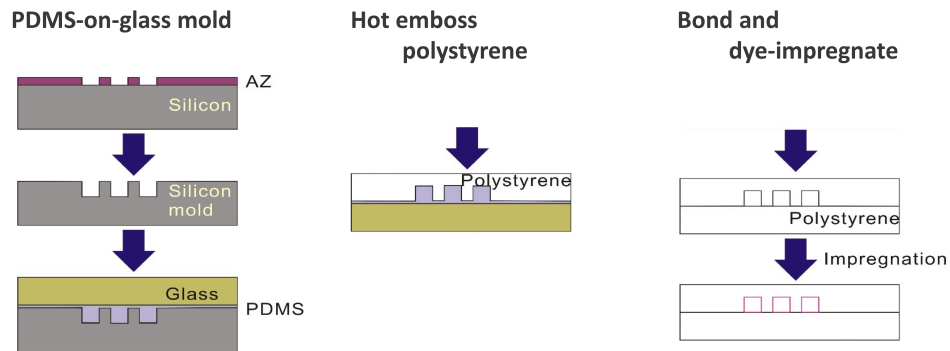
A 10:1 ratio (w/w) of PDMS base and curing agent (Sylgard 184, Dow Corning Co.) were thoroughly mixed, degassed under vacuum, and poured on the silicon mold. A clean 2"x3"x1 mm thick glass slide was placed on the PDMS mixture and a 500 g weight placed on the glass slide to thin the PDMS layer. The whole system was placed in an oven at 70°C for 2 hours. After curing, glass/PDMS and the silicon mold were separated to have a PDMS-on-glass hybrid flexible mold that will help with demolding polystyrene after hot-embossing.

Hot-embossing was performed using a wafer bonder (AML, Didcot, UK). A piece of polystyrene (Goodfellow) was placed on the PDMS/glass mold, and a clean 2"x3" 1 mm thick glass slide was placed on the polystyrene sheet. The bonder temperature was increased to and stabilized at 140°C. A 100 N force was used for imprinting for 20 min. When the temperature cooled down to less than 80 °C, the bonder was opened, and the polystyrene sample was carefully demolded from the PDMS/glass mold.

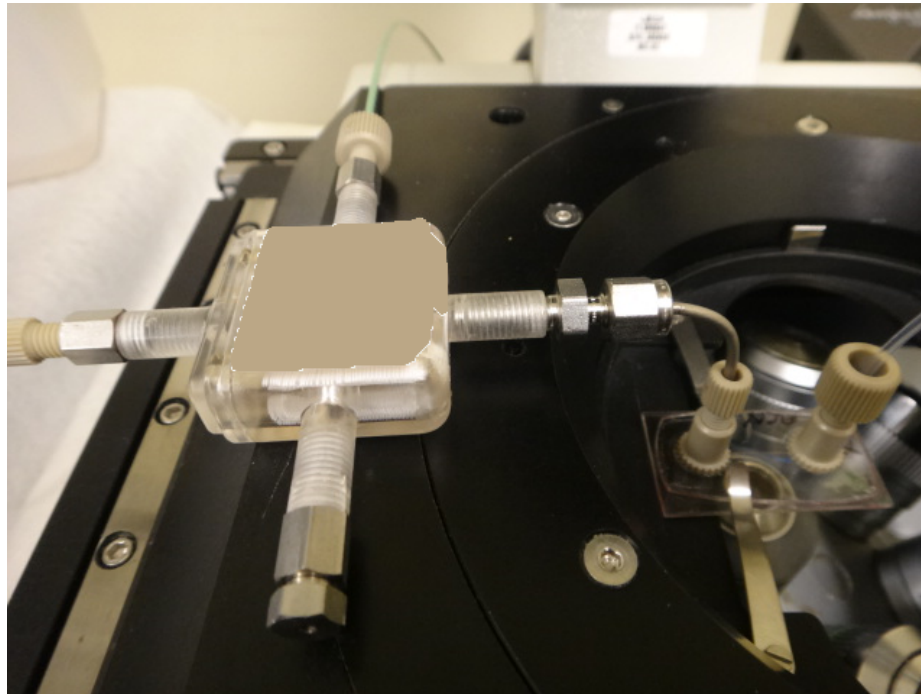
Polystyrene bonding was also done in the AML wafer bonder. The imprinted polystyrene and another piece of blank polystyrene sheet were sandwiched between two glass slides, and placed in the bonder. When the temperature was increased to and stabilized at 100°C, a 2000 N bonding force was applied for 20 min. When the temperature cooled down to less than 80°C, the bonder was opened and the polystyrene pore network device was obtained.

PtTFPP was impregnated into channel walls according to the conditions as described in the manuscript. Briefly, the impregnation solution of PtTFPP in acetonitrile was added from one

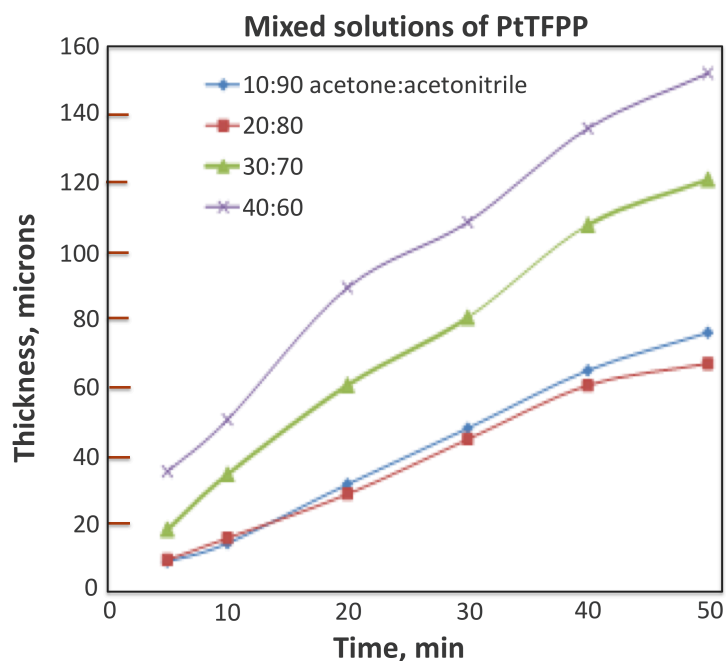
reservoir and it easily flowed into the network channels due to capillary force. After 30 s, the impregnation solution was blown out immediately.



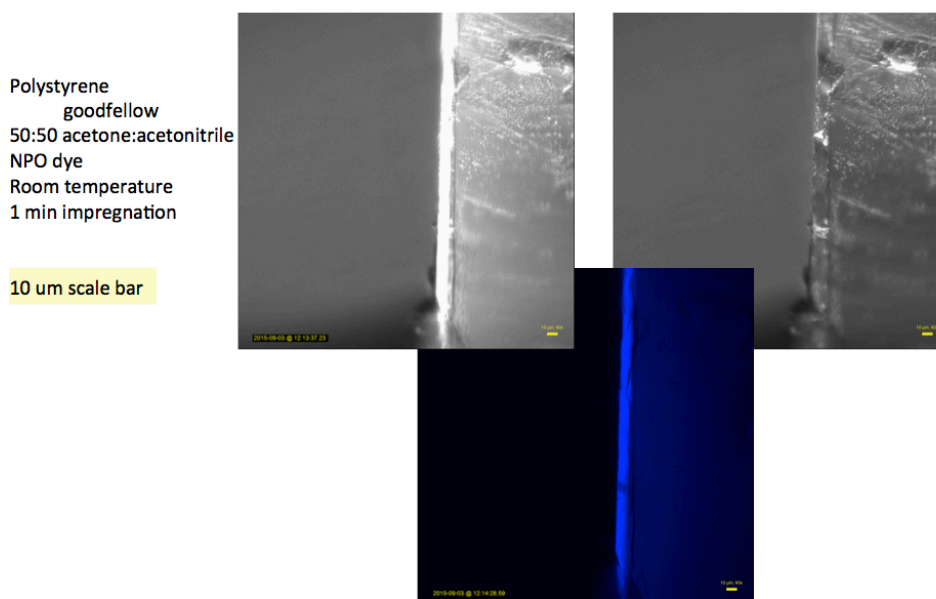
**Figure SI\_1.** Process diagram for creating polystyrene microfluidic pore network structures.



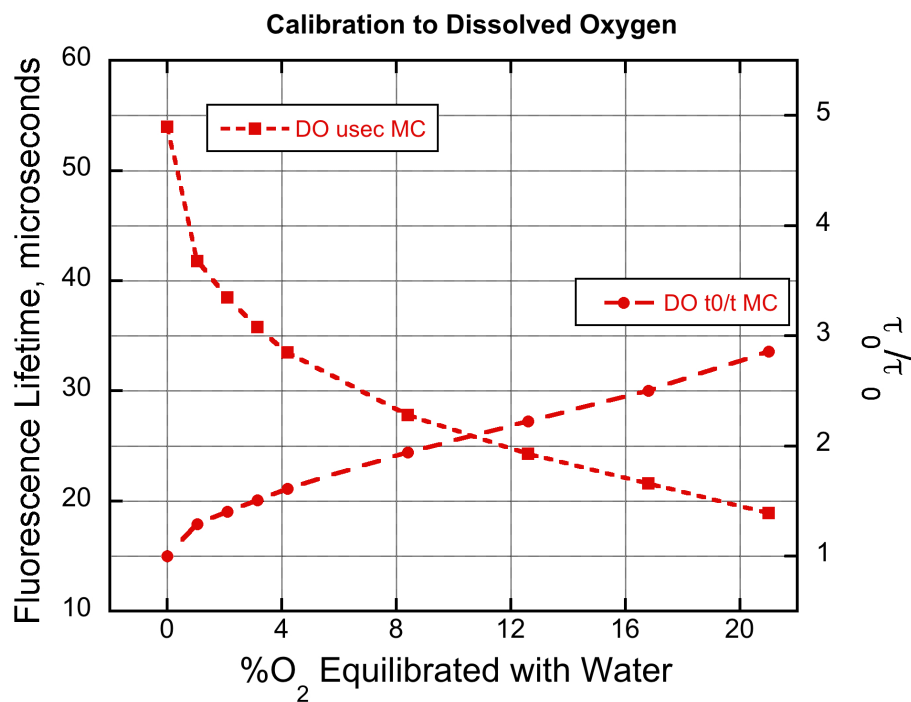
**Figure SI\_2.** Gas exchange device(see Experimental) for delivering aqueous solutions to the microchannel device, via a metal tubing. Liquid water flow is left to right. Gaseous flow is from the back (peek tubing) to the front, with the gas passing through the insides of a multiplicity of hydrophobic hollow fiber membranes.



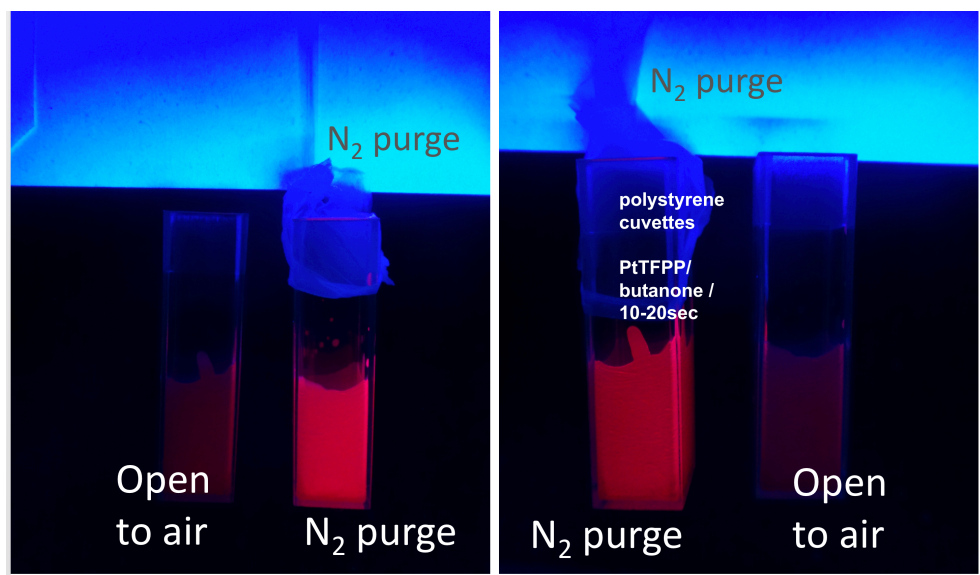
**Figure SI\_3.** *Impregnation using solvent mixtures at room temperature.*



**Figure SI\_4.** *NPO dye impregnation at room temperature using 50:50 acetonitrile:acetone solution for one minute. The scale bar in yellow is 10 microns. Clockwise from the upper right, imaged with white light, UV light, and a combination of white and UV light.*



**Figure SI\_5.** Calibration of microchannel and pore network devices against dissolved oxygen in flowing aqueous solution.



**Figure SI\_6.** PtTFPP dye impregnated into the interior surfaces of polystyrene cuvettes, and shown under UV light, with nitrogen flow in one cuvette in each image illuminated with long wave UV light. The fluorescence is much brighter under anoxic conditions as expected, and moving the nitrogen flow from one cuvette to the other shows that both are responsive.