Electronic Supplementary Material (ESI) for Soft Matter

Supplementary Information

Microfluidic Elastomer Composites with Switchable Vis-IR Transmittance

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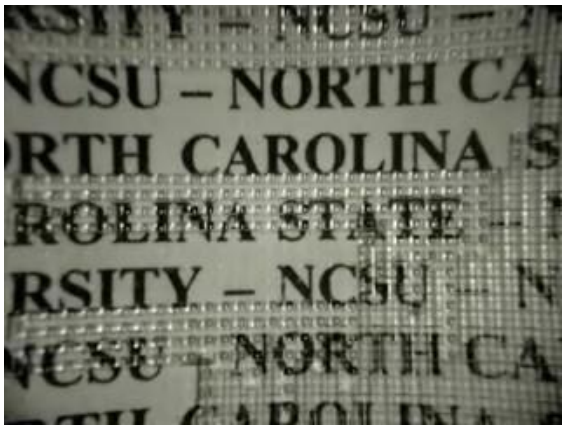
Description of the Supplementary Movies

Transparent Channels.avi



Movie 1. Refractive Index matched 61 wt.% Glycerol-Water mixture is pumped through the double-channel PDMS network, making the microfluidic channels optically disappear.

Replacement of Index Matched Liquids.avi

Movie 2. Air filled single-channel PDMS network is filled with refractive index matched liquids: Clear, green, red, blue and clear, respectively.

Additional RI and Spectral Data

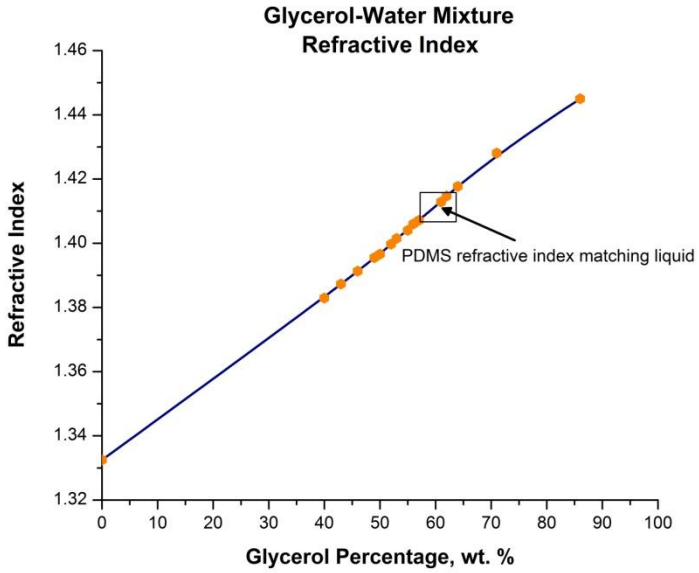


Figure 1. (a) Refractive indexes of glycerol-water mixtures. The refractive index increases linearly with increasing glycerol mass fraction in the mixture. A 61% glycerol-water mixture matches the PDMS network's refractive index.

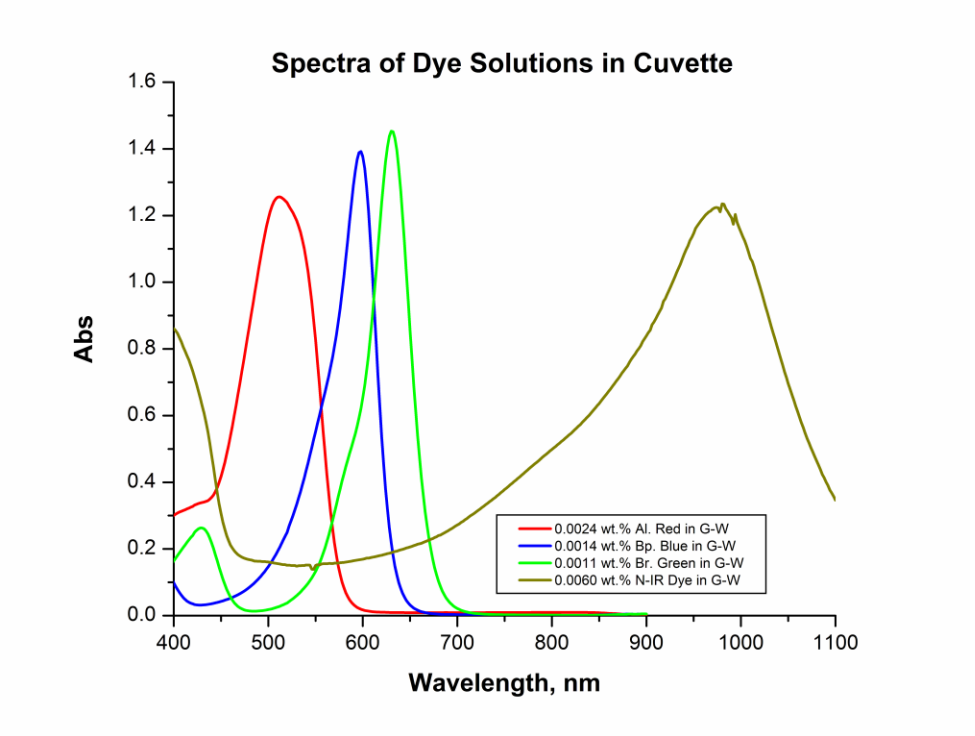


Figure 2. Absorbance spectra of Allura Red, Bromophenol Blue, Brilliant Green, and N-IR dye solutions in 61 wt.% glycerol-water mixture measured in cuvette

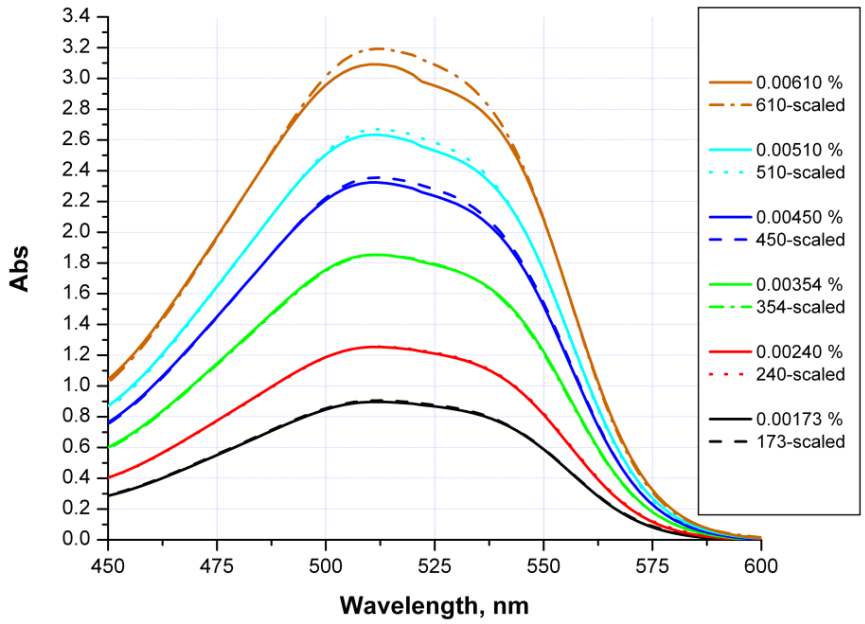


Figure 3. Absorbance spectra for dilute Allura Red solutions of different concentrations measured in cuvettes. Based on the most dilute concentration, which was 0.00085 wt.% Allura Red in 61 wt.% Glycerol-Water mixture, each spectrum was calculated by using modified equation 2. Straight lines correspond to the original spectra and the dashed/dotted ones are the ones obtained through scaling.

Experimental

The flexible sheet prototypes were fabricated using Si wafers (Silicon Quest International) and PDMS (Sylgard 184, Dow Corning) based on standard soft lithography method. The photomasks are designed using CorelDraw software. Both the channel width and the distance between two adjacent channels are 400 µm. The channels are fabricated on the wafers by first spin-coating them (Model P6700, Specialty Coating Systems, Inc.) with SU-8 2050 photoresist, (MicroChem, Inc.). After soft-baking the wafer at 65°C and 95°C, it is exposed to UV light (IntelliRay 400, Uvitron International) to transfer the design on the photomask to the photoresist. Unpolymerized SU-8 is dissolved by SU-8 developer (MicroChem, Inc.) and the Si wafer is hard-baked. The thickness of the channels is ~ 300 µm. This master is used to fabricate multiple prototypes: After mixing silicon elastomer base and silicon elastomer agent in a 10:1 ratio, the mixture is degassed to minimize bubble formation. The PDMS precursor (Sylgard 184, Dow Corning) is cast on the channel masters and cured in the oven at ~70 °C for ~30 minutes. After cutting and peeling off the PDMS layers, two holes were punched at each end of the channel network (using a blunt 16

gauge needle) to allow for inlet and outlet of the liquid flow. Next, two PDMS sheets with embedded channels were irreversibly sealed to each other using air-plasma (Model PDC-32G, Harrick Plasma) forming a double-layer channel network (Fig. 2). Alternatively, a single PDMS sheet was air-plasma sealed directly onto a glass slide forming a single channel network as in Figure 3. The channels in the double channel network prototypes were oriented orthogonal to each other. The PDMS channel network size was ~ 24 mm × 36 mm. Microcuvettes are fabricated by sealing a thin layer (open in the middle) of PDMS on glass slide and covering it with a thin glass slide. The thickness of the microcuvettes varies from ~ 0.5 mm to ~ 1.5 mm.

Liquids at room temperature are pumped through the punched holes into the channels either directly using a syringe (1 ml, Norm-Ject / Hanke Sass Wolf) or through tubing (Tygon Microbore Tubing, Saint-Gobain PPL Corp.). (The steps for fabricating and functioning of the color-changing microchannel networks are also shown in Figure 1). Liquid mixtures consist of glycerol (99+%, Acros), water, and a non-ionic surfactant, Tween 20. For the colored liquids four different dyes are dissolved in glycerol-water mixture: Allura Red AC, Sigma-Aldrich; Bromophenol Blue Sodium Salt, Acros; Brilliant Green-Cert, Acros; N-IR dye 96311S, Fabricolor Holding Inc. The refractive indexes of the liquids are determined using TCR 15-30 Refractrometer (Index Instruments Inc.). The absorbance spectra of the liquids and materials are characterized by UV-Vis Spectrophotometer (Jasco V-550).