Electronic Supplementary Material (ESI) for Lab on a Chip

Supporting information

Photolithgraphy and soft lithography details

Briefly, SU-8-3025 (MicroChem, Newton, MA, USA) a thick negative photoresist was spincoated onto a 100 mm silicon wafer. The wafer was softbaked on a hotplate at 90 °C for 13.5 minutes. A transparency photomask (CAD/Art Services, Inc., Bandon, OR, USA) was placed in contact to the softbaked photoresist and exposed to UV using a Canon Mask Aligner PLA-501F (Canon Inc, Tokyo, Japan). Following exposure the wafer was postbaked on a hotplate in two stages at 65 °C for 1 minute and 90 °C for 4 minutes. The wafer was placed in SU-8-Developer (MicroChem, Newton, MA, USA) for 13 minutes to remove any uncrosslinked photoresist. Finally the wafer was hardbaked for 20 minutes in a 150 °C oven to further crosslink photoresist hardening the mold.

Inverse images of the SU-8 molds were replicated using Sylgard 184 (Dow Corning, Midland, MI, USA), commonly known as polydimethysiloxane (PDMS), using standard soft lithography[1] as shown in Figure 1 (a). PDMS, a compliant polymer, has long been the material of choice in fabricating microfluidic devices due to its ease in prototyping and biocompatiblity.[2, 3] The PDMS was mixed at a curing agent to base at ratio of 1:10 in an ARE-250 mixer (THINKY USA, Laguna Hills, CA, USA) for 2.5 minutes and degassed for 1.5 minutes. Next, the liquid PDMS was in a poured over the SU-8 mold, degassed in a vacuum dessicator and cured in a 65 °C oven for a minimum of 6 hours.

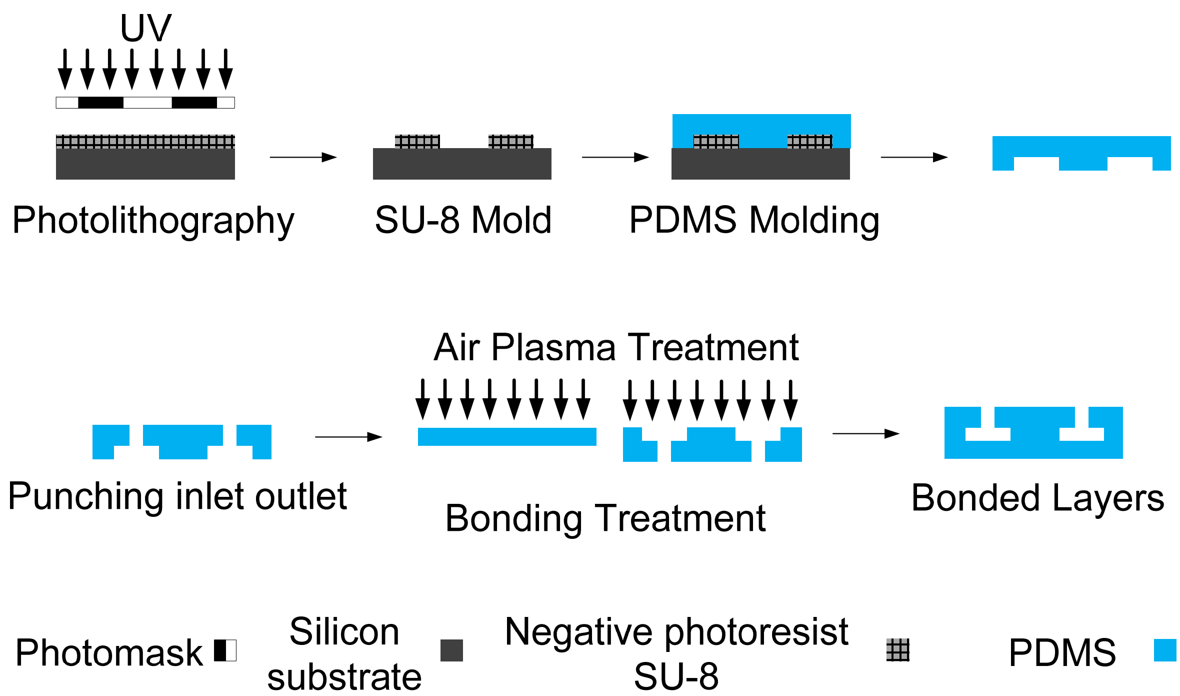

Figure 1 Soft lithography technique used in fabricating check valve

To bond the PDMS layers together the contacting surfaces were activated using air plasma for 60 s. After placing the activated surfaces together and applying slight pressure, the part was put in a 65 °C oven for 2 hours to strengthen the bond. The bonding steps to fabricate the micropump were as follows:

1. Bonded flow layer to spacer layer
2. Bonded bottom side of spacer layer to diaphragm layer on treated silicon wafer
3. Peeled device with diaphragm attached from silicon wafer, bond bottom side of diaphragm layer to control layer. After bonding all PDMS layers of the micropump was complete a through hole was punched using a 0.5 mm Harrris Uni-Core in the inlet channel of the control layer
4. Bonded control layer to glass slide

Steps 1 and 3 required careful edge alignment of the 5 mm punched through holes. This ensured that volume in the control layer would translate directly pump chamber.

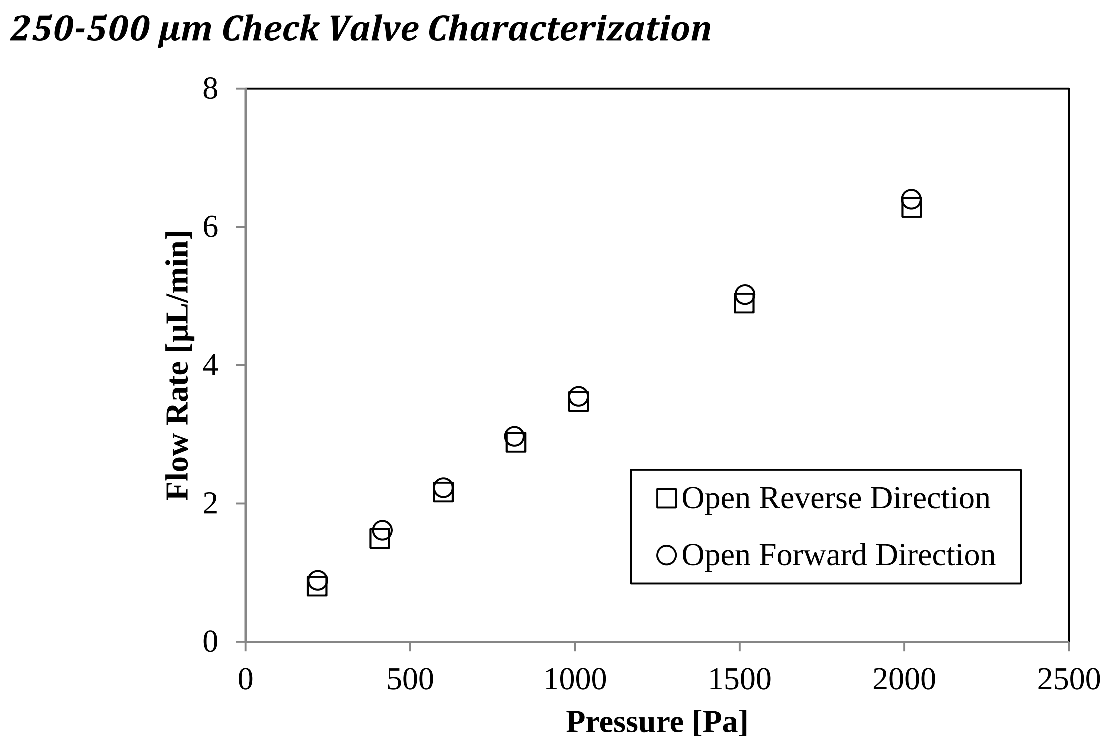

Figure 2 Flow rate of valve channel with no microspheres for 250-500 µm check valve.

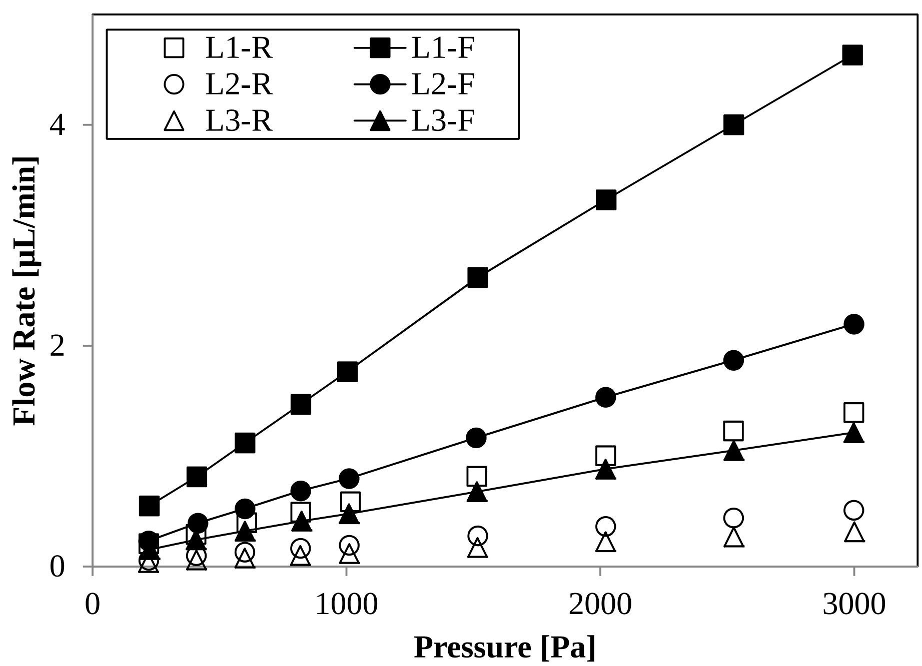

Figure 3 Flow rate versus pressure difference at porous lengths L1-L3 for 250-1000 µm check valve.

500-1000 µm Check Valve Characterization

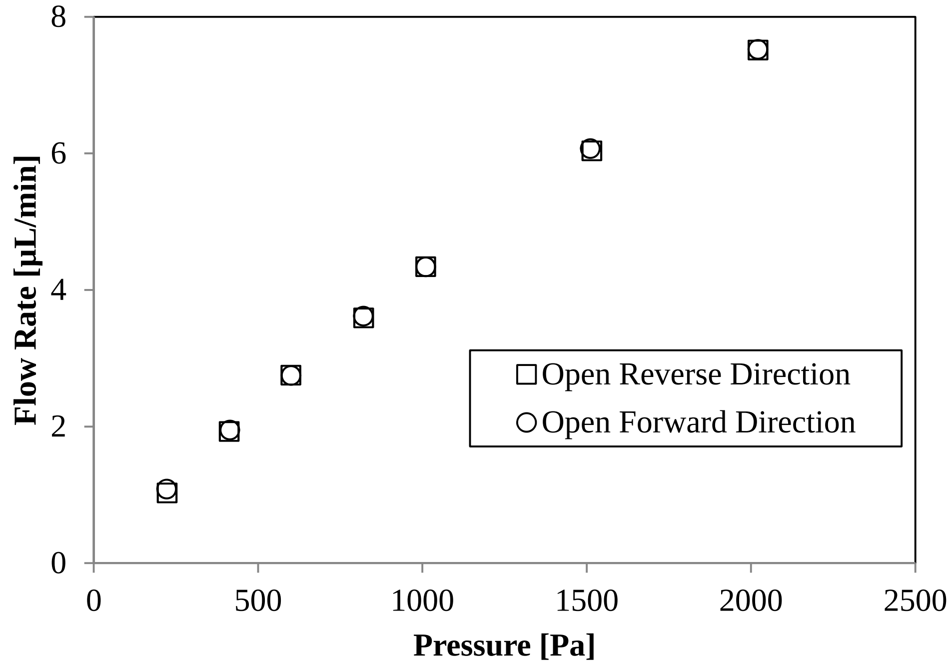

Figure 4 Flow rate of valve channel with no microspheres for 500-1000 µm check valve.

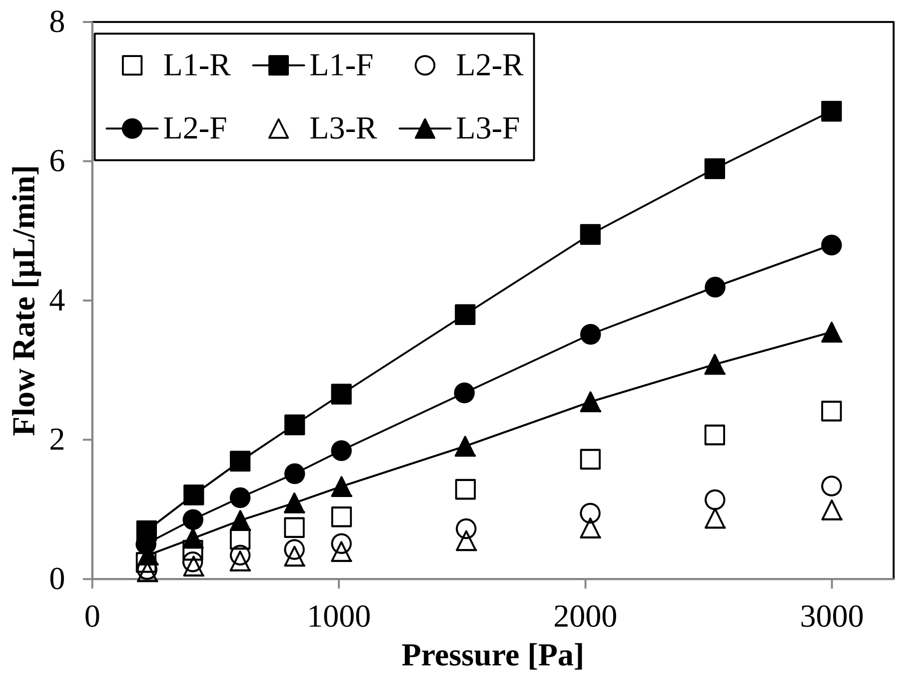

Figure 5 Flow rate versus pressure difference at porous lengths L1-L3 for 500-1000 µm check valve.

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250-2000 µm Check Valve Characterization

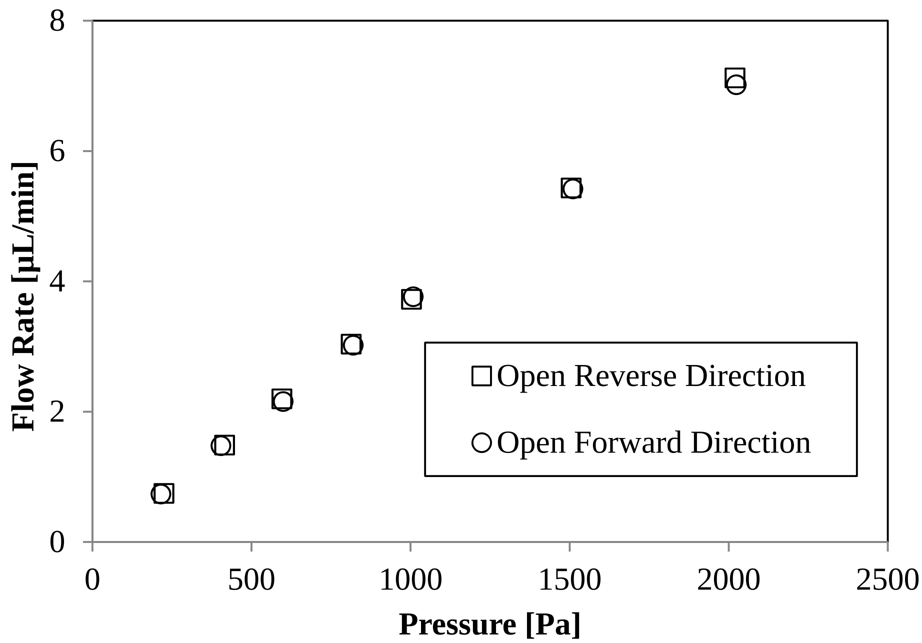

Figure 6 Flow rate of valve channel with no microspheres for 250-2000 µm check valve.

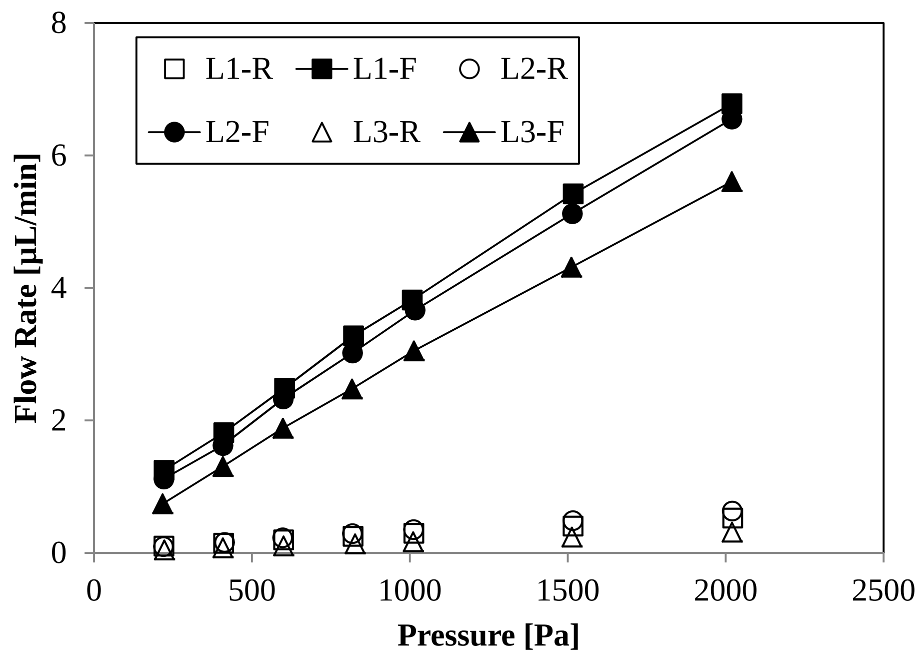

Figure 7 Flow rate versus pressure difference at porous lengths L1-L3 for 250-2000 µm check valve.

Volume Flow from Micropump

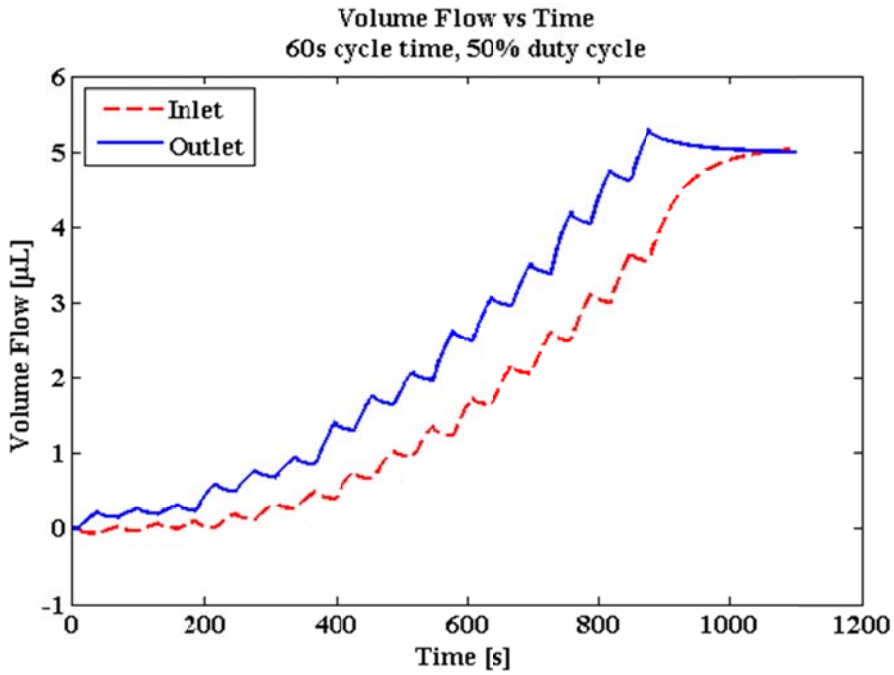

Figure 8 Volume flow measurement of the micropump with 60 s cycle time and 50% duty cycle

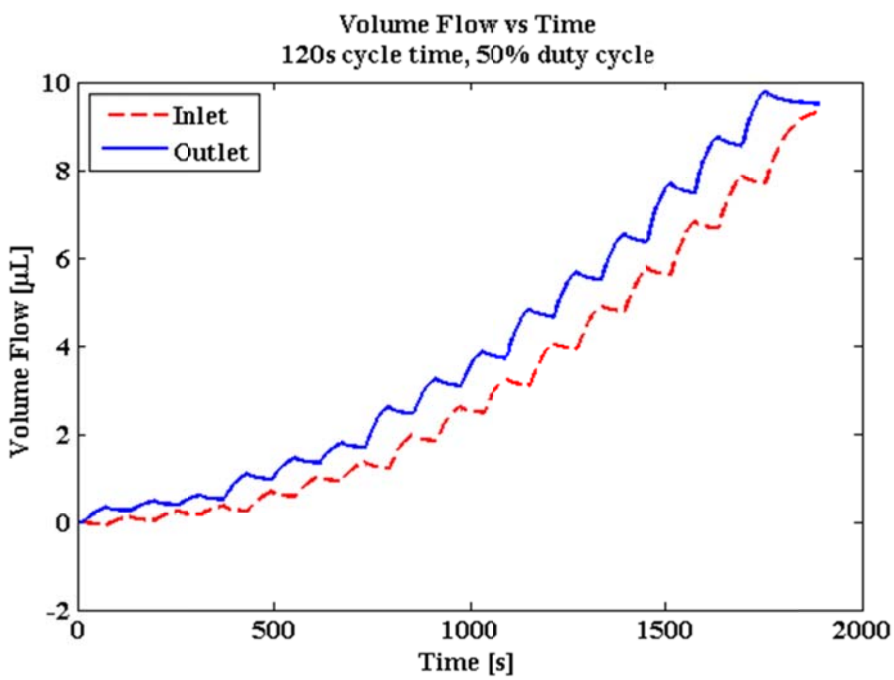

Figure 9 Volume flow measurement of the micropump with 120 s cycle time and 50% duty cycle

References

1. G. M. Whitesides, E. Ostuni, S. Takayama, X. Y. Jiang and D. E. Ingber, *Annual Review of Biomedical Engineering*, 2001, **3**, 335-373.
2. J. C. McDonald and G. M. Whitesides, *Accounts of Chemical Research*, 2002, **35**, 491-499.
3. M. C. Belanger and Y. Marois, *Journal of Biomedical Materials Research*, 2001, **58**, 467-477.