Multi-channel peristaltic pump for microfluidic applications featuring monolithic PDMS inlay: Supplementary information

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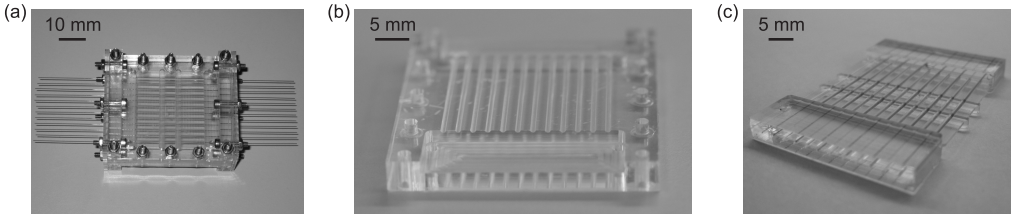

Fig. S2 PI fabrication. (a) Mould used to cast PI. Fibre inserts can be seen passing through the mould (b) Bottom part of mould showing the semi-circular grooves which result in raised channels. (c) Completed PI. Integrated channels loaded with dye to facilitate visualisation. Within the middle section of the PI, the integrated channels are raised above a supporting PDMS layer to facilitate compression and reduce friction between the PI and multi-roller (MR).

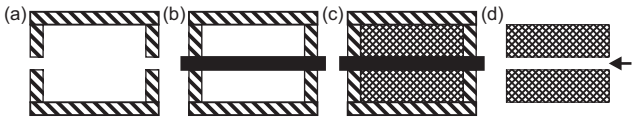

Fig. S1 Schematic representation of PI fabrication. Drawings not to scale. (a) Cross-sectional view of mould used for casting PIs. Openings at end represent through holes through which fibre inserts are placed. (b) Fibre inserts resulting in integrated channels are placed through terminal mould pieces. (c) PDMS is cast into mould and subsequently cured. Following PDMS curing, fibre inserts are removed and mould is disassembled. (d) Cross section of completed PI. Arrow indicates integrated channel.

Micropump Design and Fabrication

Pumping Inlay (PI)

The monolithic PI is cast from PDMS (Sylgard 184, Dow Corning) inside a PMMA (Nordisk Plast, Denmark) mould in a process depicted schematically in S1.

Mould pieces were aligned by 2 mm screws. An assembled PI mould is shown in S2a. Before injecting PDMS into the mould, 240 µm optical fibres (Polymicro Technologies, Phoenix, Arizona) were threaded through 250 µm holes in the end pieces (S1b). PDMS was mixed in a 10:1 mass ratio of elastomer to curing agent and placed under vacuum to remove air bubbles. Mould vents allowed PDMS injection via syringe and prevented air from being trapped in the finished part (S1c). The filled mould was placed in an oven at 80ºC for two hours to cure. Once the mould had cooled enough to be handled, fibres were removed to yield integrated channels and the mould disassembled (S1d).

A completed PI is shown in S2c. The PI is 30 mm in width and 45 mm in length. Two PDMS blocks bookend the middle section of the PI and facilitate handling, alignment and securing of the PI. The middle section of the PI measures 30 mm in width by 25 mm in length. Centred across its width are 12 half-tube structures. These are raised above a 0.5 mm thick support layer (2b, S2bc) and are spaced 2.25 mm apart, equivalent to the standard published by SBS/ANSI for 1536 well microtiter plates. The half-tubes have a radius and height of 0.4 mm and were created by using a 0.8 mm ball mill to form a mould piece (S2b). The 12 integrated 240 µm channels are centred at the intersection of the support bed and half-tubing planes (2b). The middle portion of the PI also contains crossbeam structures which hold the PI in place in the RB when the pump is in use.

For the offset configuration of the pump, another version of the PI was made. The offset PI version was manufactured as above, however following casting/curing channel pairs were separated from one another by scalpel. Prior to testing, all PIs were inspected for damage and/or blocked channels.

Rotor Bed (RB)

The PI rests on a RB (2a) made of PMMA sections held together by 2 mm alignment pins. The RB provides the PI with rigid support complementary to the curvature of the MR.

Multi-roller (MR)

The MR assembly is made from eight 2 mm diameter brass rods placed equidistantly around a 4 mm brass drive shaft (1b). The rods are mounted in aluminium disks with oversized 2.1 mm holes. These allow rods to freely rotate and prevent mechanical damage to the PI. The aluminium disks are secured to the drive shaft by pointed screws and are placed against ball bearings made from 2 mm stainless steel balls fit into 5 mm aluminium ball bearing holders with an outer footprint of 20 mm by 25 mm. At one end of the MR a 16 mm diameter toothed wheel (Synchroflex 16T2.5/20-2) is secured to the drive shaft by a pointed screw A toothed belt (Synchroflex 6/T2.5/145) provides a mechanical connection to the stepper motor. The MR is centred over the PI and RB and has a total width of 77 mm. The MR was lubricated with graphite powder.

Stepper Motor

The MR is driven by a geared stepper motor (p/n 415-8532, McLennan Servo Supplies Ltd, England) with a gear ratio of 250:3 controlled by an in-house built stepper circuit using 1/8th microstepping. This provides 32,000 steps per revolution and smooth rotation. The control is triggered by a function generator (digimess FG 100) or a clock built in-house and powered by a DC power supply (ISO-TECH IPS2303D).

Notes and references

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