

Electronic Supporting Information (ESI)

A disposable on-chip micro valve and pump for programmable microfluidics

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Fabrication of PMMA Mold for Replica Molding

The PDMS actuator shown in **Fig. 1(a)** has been made of four layers as already described, and the valve, pump, and bumper structures on the corresponding layers were fabricated by replica molding technique, using PMMA mold. The mold of each layer has the same dimensions of 35 mm width and 50 mm length, but with different thicknesses. The molds of the first and second layers correspond to the same thickness of 1 mm. There are four valve patterns of the dimensions of 110 μm height, 360 μm width, and 46mm length on the second layer, which are equally spaced with 5 mm interval. To accurately fabricate the PDMS pattern on the mold for the second layer, an adhesive coating film (Cold Pouch Film, Printec, Korea) was laminated on the PMMA substrate. Then, the structures on the PMMA substrate to replicate on the PDMS layer were implemented by laser machining (C30, Coryart Inc., Korea) on the adhesive coating film with 90 mm/s cutting speed, 1 %, and 3.5 mA powers. The output condition of laser machining was determined to selectively remove the coating film from the areas other than the structure, without

any physical damage of the PMMA substrate. The remained coating film was subsequently pressed by hot press (Qmesys Corp., Korea) at 50 °C, 2 atm for 30 s, to normalize the height of the valve pattern with a round boundary pattern. The mold of the third layer corresponded to a 2 mm thickness, including a pattern for the pump. A PMMA rod was sliced into semi-cylindrical shape, and attached to the PMMA substrate to form a cavity after replica molding. To form a mold of the fourth layer to replicate bumpers for the valves and pump on the PDMS, three PMMA pieces, which were cut accordingly, were bonded by hot press, since the bumper layer PDMS had the hetero structures along with different thickness and shape. The thickness of the bumper and plain layer of the fourth PDMS layer were 3 mm and 1 mm, respectively.