### Supplementary Material for

**Bubble gate for in-plane flow control**

Ali Oskooei, Milad Abolhasani and Axel Günther

**Table S1.** Summary of representative strategies for active flow control reported in the literature in terms of mechanism of actuation, fabrication and working liquids.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Type of flow control</th>
<th>Mechanism of Action</th>
<th>Substrate Material</th>
<th>Number of Masking Layers</th>
<th>Working Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacobson et al.¹a</td>
<td>valving, sampling</td>
<td>electrokinetic</td>
<td>glass</td>
<td>1</td>
<td>biological buffer</td>
</tr>
<tr>
<td>Schasfoort et al.¹b</td>
<td>sampling, pumping</td>
<td>electro-osmosis</td>
<td>silicon, glass</td>
<td>1</td>
<td>biological buffer</td>
</tr>
<tr>
<td>Unger et al.²a, Thorsen et al.²b, Weaver et al.²c</td>
<td>valving, pumping</td>
<td>pneumatically actuated membrane</td>
<td>glass, PDMS</td>
<td>2, 4</td>
<td>water</td>
</tr>
<tr>
<td>Grover et al.²d, Zhang et al.²e</td>
<td>valving, pumping</td>
<td>pneumatically actuated membrane</td>
<td>glass, PDMS or PMMA, PDMS</td>
<td>3-4</td>
<td>water, whole blood</td>
</tr>
<tr>
<td>Irimia et al.²f</td>
<td>valving, sampling</td>
<td>pneumatically actuated membrane</td>
<td>glass, PDMS</td>
<td>3</td>
<td>whole blood</td>
</tr>
<tr>
<td>Gu et al.³a, Weibel et al.³b,³c, Sundararajan et al.³d</td>
<td>valving, pumping, mixing</td>
<td>deflection of microchannel induced pneumatically or by actuator</td>
<td>glass, PDMS</td>
<td>1</td>
<td>biological buffer, water</td>
</tr>
<tr>
<td>Kaigala et al.³e</td>
<td>valving</td>
<td>phase-change actuated membrane</td>
<td>glass, PDMS</td>
<td>3</td>
<td>biological buffer</td>
</tr>
<tr>
<td>Kim et al.⁴b</td>
<td>valving</td>
<td>pneumatically actuated membrane</td>
<td>PDMS, glass, hydrogel</td>
<td>3</td>
<td>biological buffer</td>
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<tr>
<td>Pemble et al.⁴c</td>
<td>valving</td>
<td>membrane deformation induced by shape memory alloy</td>
<td>silicone microbore tube</td>
<td>N/A</td>
<td>water</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th></th>
<th>Authors</th>
<th>Methodology</th>
<th>Core Material</th>
<th>Repetition</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Beebe et al.</td>
<td>Valving</td>
<td>PDMS, hydrogel</td>
<td>1</td>
<td>Water</td>
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<td>Sanchez-Ferrer et al.</td>
<td>Valving</td>
<td>Liquid-crystalline elastomer</td>
<td>2</td>
<td>Water or buffer</td>
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<tr>
<td>6</td>
<td>Jian et al.</td>
<td>Pumping, flow direction control</td>
<td>Glass, PDMS</td>
<td>1</td>
<td>Water/ethanol</td>
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<td></td>
<td>Wijngaart et al.</td>
<td>Valving</td>
<td>Thermally controlled bubble</td>
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<td>Water</td>
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<td></td>
<td>Lee et al.</td>
<td>Valving</td>
<td>Membrane, electro-chemically actuated bubbles</td>
<td>4</td>
<td>NaCl solution</td>
</tr>
</tbody>
</table>

Figure S2. Photographs obtained during testing of microfluidic device with 124 bubble gates to trap red-coloured liquid displaying the National Flag of Canada. (a) First step: the entire device was purged with red dye (b) Second step: Bubble gates were closed and as a result the dye trapped at the designated locations. The liquid in the remaining (bypass) sections was substituted by clear liquid to display the Maple Leaf as shown in Fig. 7 of the paper. Scale bar is 8mm.
Supplementary Movie S3

The bubble gate in oscillation between open and closed positions. The bubble gate was subjected to a square wave pressure signal with the conditions: $P_{\text{Closed}} = 0.26$ psi, $P_{\text{Open}} = 0.11$ psi, $P_L = 0.00$ psi and $f = 1.00$ Hz.

Liquid sampling in a Y-channel sampling device incorporating the bubble gates for sampling between two liquid reservoirs one labeled with fluorescent dye and one without the dye. The bubble gates were alternated every five seconds and the concentration of the liquid flowing downstream the Y-channel was measured by image processing. The flow conditions in the video are: $P_{\text{Closed}} = 0.3$ psi, $P_{\text{Open}} = 0.19$ psi and $P_L = 0.23$ psi.

Three-layer sampling device incorporating the bubble gates for selective distribution of a fluorescently labeled liquid sample. The bubble gate on the middle layer was closed to block the flow of the fluorescent solution in the layer. As a result the fluorescent solution passed through the bottom and top layers but not the middle layer. The flow conditions in the video are: $P_{\text{Closed}} = 0.30$ psi, $P_{\text{Open}} = 0.19$ psi and $P_L = 0.23$ psi.

References