Acoustofluidic actuation of \textit{in situ} fabricated microrotors

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1. Frequency range of microrotors

**Figure S1:** Resonance frequency analysis of a bonded transducer. (a) Impedance and phase angle measurements of the bonded transducer yield a resonant frequency of 4.41 kHz. (b) Dependence of the rotational rate of a one-arm microrotor to the frequency shows a maximum performance at around 4.25 kHz.

Figure S1 shows 1-arm microrotor’s optimum frequency near 4.3 kHz. This is in a good agreement with the resonance frequency (4.6 ± 0.5 kHz) of the driving transducer. For the rest (from 2-arm
to 6-arm microrotor), optimum frequency was slightly tuned (4.3 ± 0.3 kHz) due to imperfection in both fabrication and position of the transducer. The frequency range for each microrotor is still in the resonance frequency range (4.6 ± 0.5 kHz).

**Table S1.** Comparison of the existing microrotor performances.

<table>
<thead>
<tr>
<th>Actuation</th>
<th>Fabrication</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrodynamic(^1)</td>
<td>UV polymerization</td>
<td>650 RPM per flow rate of 130 μl/min</td>
</tr>
<tr>
<td>Laser manipulation(^2)</td>
<td>UV polymerization</td>
<td>60 RPM at 2 W laser power</td>
</tr>
<tr>
<td>Bacterial motion(^3)</td>
<td>lithography</td>
<td>6 RPM</td>
</tr>
<tr>
<td>Magnetic(^4)</td>
<td>lithography</td>
<td>800 RPM</td>
</tr>
<tr>
<td>SAW(^5,6)</td>
<td>lithography</td>
<td>~2000 RPM</td>
</tr>
<tr>
<td>Electro-chemical(^7)</td>
<td>mechanical cutting</td>
<td>1 RPM</td>
</tr>
</tbody>
</table>

### 2. Video Captions

**Video 1: Fabrication of a microrotor**

A 5-arm microrotor is shown to demonstrate the fabrication process. By exposing UV light under the channel for 50 ms, any shape which is printed on photomask (5-arm microrotor in video S1†) can be obtained. The height of the microrotor is a few micrometre less than height of the microchannel due to incurable thin oxygen layer (~ 2.5 μm) on both bottom and top. Therefore, microrotors are loose enough to rotate freely.

**Video 2: Performance of microtors with different number of arms**

Comparison of rotational performance of the microrotors with the number of arms from 1 to 6 at 160 V\(_{pp}\).

**Video 3: Step-wise rotation of a microrotor**
A 4-arm microrotor can rotate and stop almost instantly when acoustic field is turned on and off, which is due to low Reynolds number in our system.

**Video 4: Control of angular speed by tuning the applied voltage**

A 6-arm microrotor is shown to rotate under the applied voltage from 60 $V_{pp}$ to 160 $V_{pp}$. As the applied voltage is increased, the angular speed increases as a consequence of stronger streaming flows at higher voltages.

**Video 5: A simple mixing demonstration**

A 6-arm microrotor is used to demonstrate mixing of pure ethanol and ethanol fluorescent bead solution that are injected into the microchannel side-by-side at a total flow rate of 10 µL/min. The mixing of the two flows occurs rapidly in under 30 milliseconds.

**References**