Supplementary Material (ESI) for Lab on a Chip
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Standing Surface Acoustic Wave (SSAW) Focusing of Microparticles in a Microfluidic Channel

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1. Device Fabrication

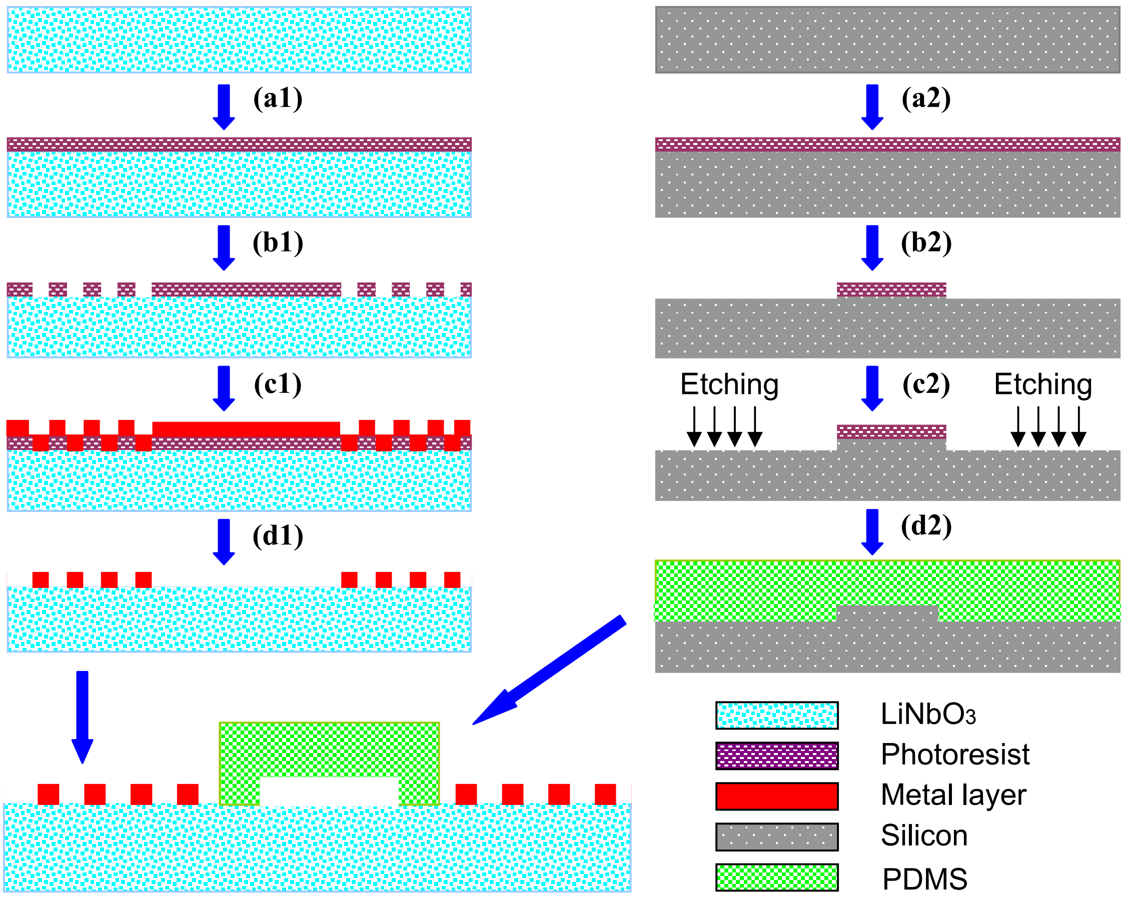

Fig. S1. Fabrication process of the device

The device fabrication process (Fig. S1) includes: (1) SAW substrate fabrication; (2) PDMS microchannel fabrication; (3) the bonding of PDMS microchannel to the SAW substrate. Fig. S1(a1)~(d1) shows the fabrication of SAW substrate. A thin layer photoresist SPR3012 (MicroChem, Newton, MA) was spin-coated on a Y+128° X-propagation lithium niobate ($LiNbO_3$) wafer, patterned using a UV light source and developed in photoresist developer (MF CD-26, Microposit). A double metal layer (Ti/Au, 50A/800A) was subsequently deposited on wafer using an e-beam evaporator (Semicore Corp), followed by a lift-off procedure to form the interdigitated electrodes (IDTs) for generate SAW. The Polydimethylsiloxane (PDMS) microchannels were fabricated with the procedure shown in Fig. S1(a2)~(d2) using the standard soft-lithography and mold-replica technique. The silicon mold for microchannel was made by photoresist patterning (Shipley 1827 (MicroChem, Newton, MA) and a subsequent Deep Reactive Ion Etching (DRIE, Adixen, Hingham, MA). The etch depth was set at 50 μm. In order to reduce surface energy and hence the damage to the PDMS channel during the demolding process, the silicon mold was coated with 1H,1H,2H,2H-perfluorooctyl-trichlorosilane (Sigma Aldrich, St. Louis, MO) in a vacuum chamber after DRIE. Sylgard™ 184 Silicone Elastomer Base and Sylgard™ 184 Silicone Elastomer Curing Agent (Dow Corning, Midland, MI) were mixed at a 11:1 weight ratio, cast onto the silicon mold, and cured at room temperature for overnight. After peeled from the silicon mold, inlets and outlets are created using a silicon carbide drill bit. Surfaces on both the PDMS substrate and the SAW device are activated with oxygen plasma (Oxygen flow rate 50 sccm, chamber pressure 750 mTorr and power 150 W) to facilitate the bonding. In order to achieve precise alignment between the channel and the IDTs, four Ti/Au metal alignment markers were fabricated in the same fabrication process for the IDTs. The alignment marks were located between two parallel IDTs, corresponding to the four inner corners of the side openings parallel to the channel, as shown in Fig. S2. The alignment of SAW device and PDMS channel was conducted manually under the microscope. A drop of ethanol was placed on the surface of the SAW device as lubricant so that the PDMS channel could slide on top of SAW device till the alignment marks overlap the corresponding corners of the side openings.

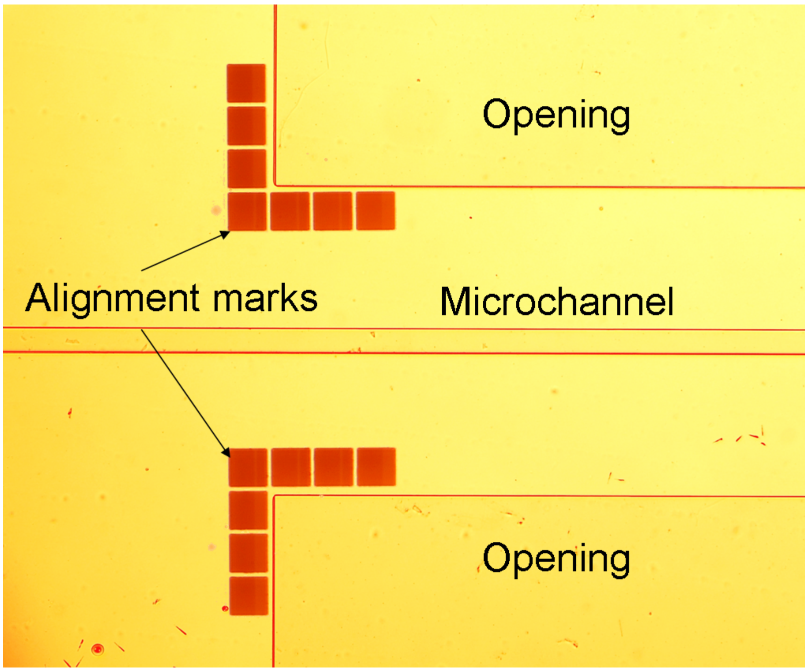

Fig. S2. Alignment between the PDMS microchannel and the SAW substrate showing two alignment marks (on $liNbO_3$ substrate) on the left sides of the openings (in PDMS) along the microchannel.

After alignment, ethanol was removed by leaving the aligned device in a vacuum chamber with the temperature of 50°C for 15 minutes. The entire bonding process was processed in a clean room to avoid the contamination the channel. Finally, polyethylene tubing (Becton Dickson, Franklin Lakes, NJ) were inserted into the inlets to connect the device to a syringe pump (KDS 210, KD scientific, Holliston, MA). In order to obtain the working frequency, an AC signal with fixed input power but varying frequency was applied to one of the IDTs, and another IDT served as a receiver. When the output signal reached its maximum, the applied frequency was determined as the working frequency.

Still images and a real-time video of beads focusing process were recorded using an inverted microscope (TE 2000U, Nikon, Melville, NY) and a CCD camera (CoolSNAP HQ2, Photometrics, Tucson, AZ).

2. Real-time Video of fluorescent polystyrene beads focusing inside a microchannel (Flow Direction: left to right)

Video of Fig. 3b, c, d and e:

The video started with a flow at monitoring site I (outside of SSAW) at t=0 sec. The fluorescent beads were uniformly distributed through the entire channel. At t= 2 sec the monitoring position was moved to site II (the left edge of the SSAW working area), where beads began to be focused toward the center of the channel. At t= 6 sec he monitoring site was subsequently moved towards downstream to site III (center of the channel), where the beads focusing in the center of the channel had completed. At t= 10 sec, the monitoring site was moved to site IV (downstream outside of the SSAW), and beads still remained focused due to the laminar property of the flow.