Electronic Supplementary Material (ESI) for Lab on a Chip.

Supporting Information for: Additive Manufacturing of Three-dimensional (3D) Microfluidic-based Microelectromechanical Systems (MEMS) for Acoustofluidic Applications

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These supporting information include: photographs of the multi-material pick-and-place 3D printing process for fabrication of ceramic-based electronics (Figure S1), a magnified view of the profilometry data described in Figure 2 of the main text (Figure S2), calculated transverse displacement profiles in the width direction of the PZT chip upon excitation at each resonant

mode (Figure S3), data regarding the accuracy and precision of the robotic pick-and-place approach relative to hand positioning techniques (Figure S4), a video of the 3D printing process (Video S1), and a video of the droplet-based particle manipulation studies for the first resonant mode (1.9 MHz) using the representative 6 µm particles (Video S2).

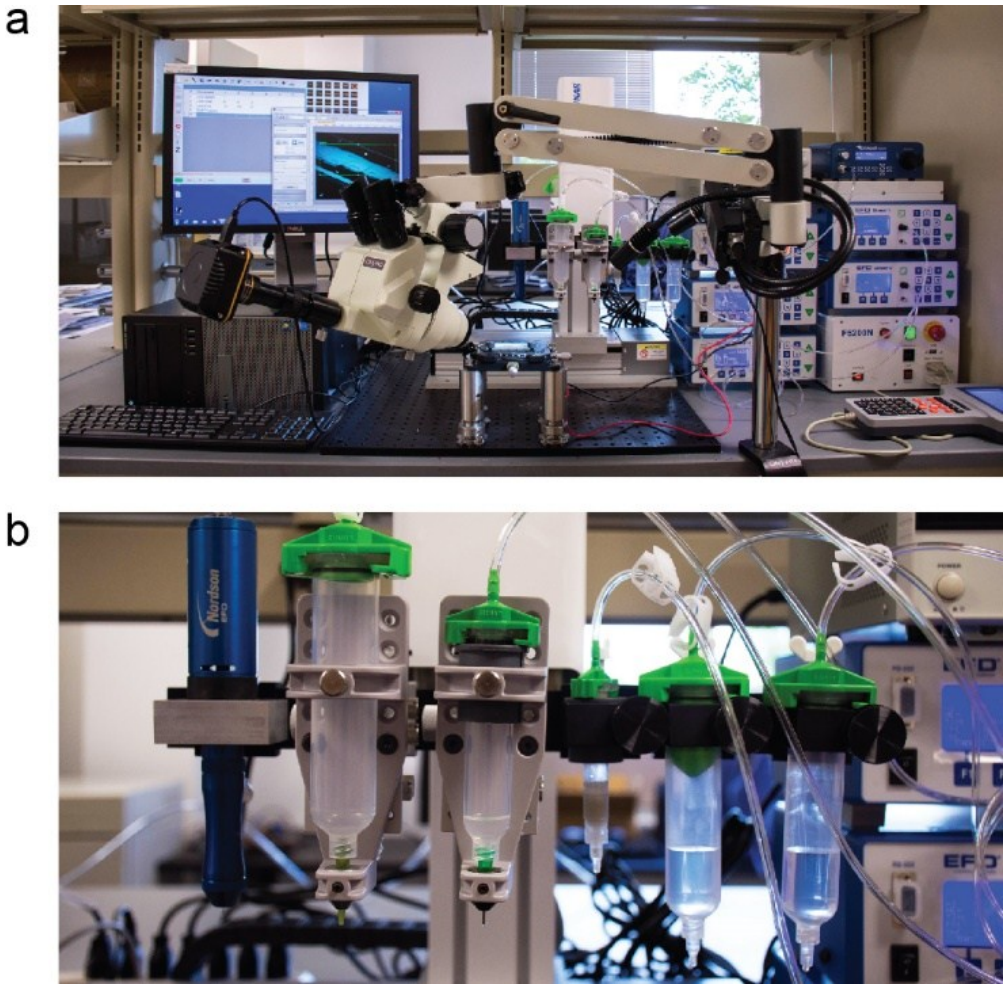

Figure S1 – **a)** Multi-material pick-and-place 3D printing process for fabrication of ceramic-based electronics consisting of a print stage, extrusion nozzles, suction-based pick-and-place tool, 3-axis robot, vision system, and pressure regulators. **b)** Magnified view of the print heads and pick-and-place tool.

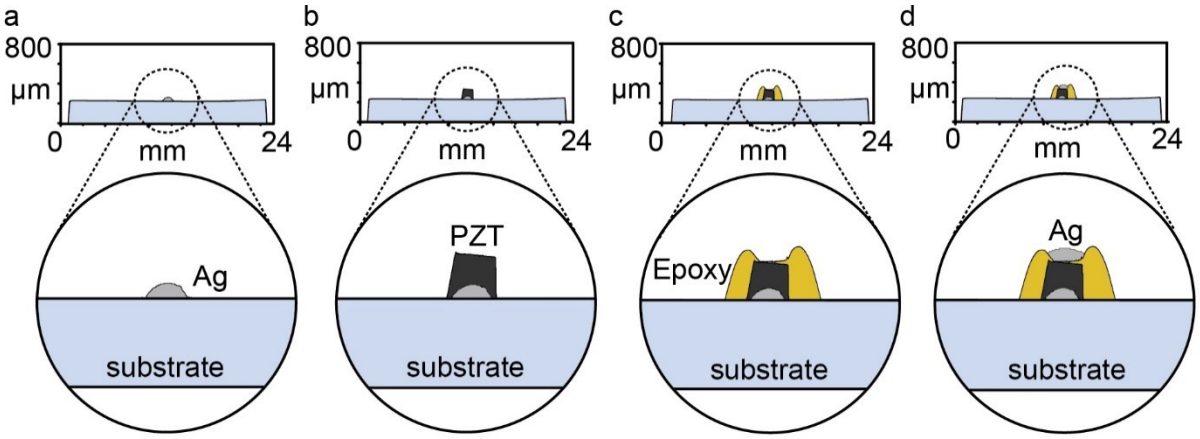

Figure S2 – Magnified view of the profilometry data of 3D printed MEMS devices during the printing process showing: the 3D printed Ag conductive pathway (**a**), the robotically placed PZT chip on top of the Ag conductive pathway (**b**), the 3D printed thermosetting epoxy anchor (**c**), and the second 3D printed Ag conductive pathway on top of the PZT chip (**d**).

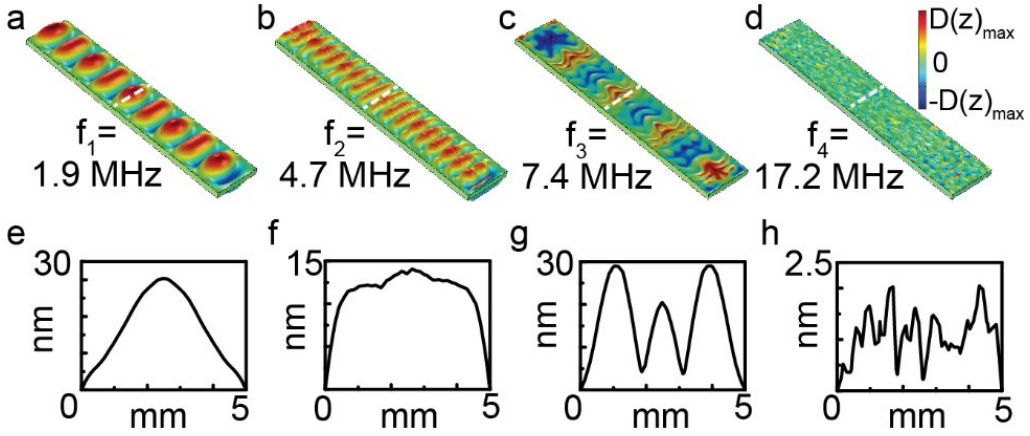

Figure S3 – Calculated transverse displacement profiles in the width direction (dashed line) of the PZT chip upon excitation at each resonant mode (**a** – **d**) and corresponding displacement profiles (**e** – **h**).

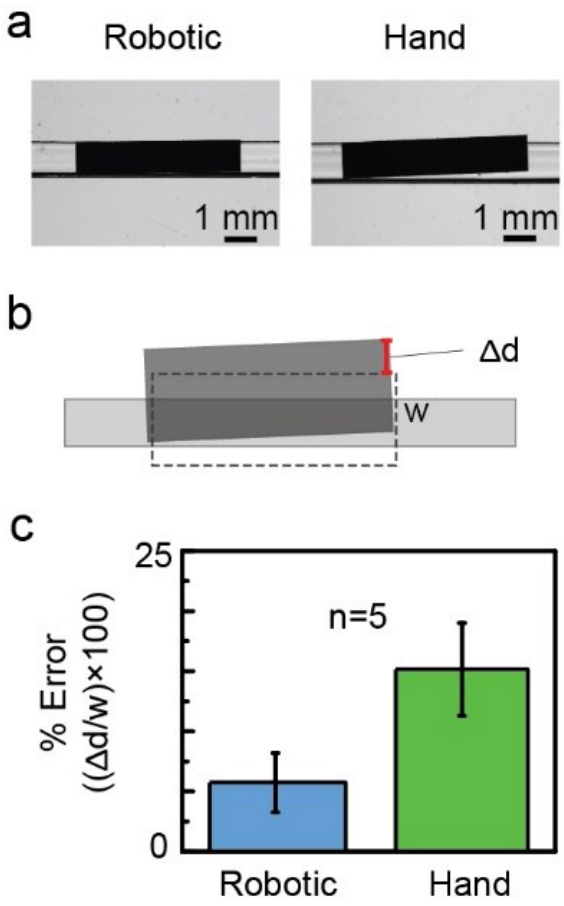

Figure S4 – a) Representative micrographs comparing the accuracy and precision of PZT chip placement via the robotic pick-and-place approach vs. hand positioning. **b)** Schematic showing the percent error in chip placement relative to a target location (*e.g.,* a chip that is centered on a printed trace of adhesive material). **c)** Experimental data showing the chip placement accuracy and precision of each approach corresponding to panel **(b)**.

Video S1. Video of the device 3D printing process.

Video S2. 6 μm particles at f1 - 1.9 MHz.