Supplementary Information for
Digital Microfluidics and Nuclear Magnetic Resonance Spectroscopy for *in situ* Diffusion Measurements and Reaction Monitoring

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1 Two-Plate-To-One-Plate Transition: Devices

DMF devices were formed using the same materials, methods, and facilities indicated in the main text. Briefly, bottom plates were formed from chromium-on-glass substrates (Telic Inc.) and (after patterning) featured linear arrays of rectangular chromium driving electrodes (2.25 x 5.5 mm) separated from each other by 30 μm gaps; within the pattern, each electrode was connected via a chromium trace to a contact pad at the edge of the substrate. Top plates were formed from indium tin oxide (ITO)-on-glass substrates (RileySupplies, Richmond Hill, ON, Canada) and were unpattterned. The electrodes on top and bottom plates were each coated with Parylene-C, and the thicknesses were measured using a Bruker ContourGT-K optical profilometer located in the Centre for Microfluidic Systems at the University of Toronto. Bottom-plate Parylene-C thicknesses were found to be 5.3 μm, and top-plate Parylene-C thicknesses were found to be 6.7 μm, 13.2 μm and 21.0 μm. After coating with parylene-C, all surfaces were spin-coated with 50 nm Fluoropel PFC 1101V (as described in the main text). The contact pads on the bottom plates and small regions of ITO on the edges of top plates were protected during the parylene and Fluoropel deposition steps such that they were coating-free (for electrical connections). Top and bottom plates were joined together with spacers formed from two pieces of double-sided tape (approx. 0.18 mm thick). Top- and bottom-plate electrodes were connected to the open-source DropBot actuation system[1] and droplets were manipulated by applying 160 V_{RMS} at 10 kHz between the top-plate electrode and sequential electrodes on the bottom plate.

2 Two-Plate-To-One-Plate Transition: Experiments

Deionized water containing 100 mM NaCl was used for all experiments. One device each was formed with top-plate Parylene-C thickness of 6.7 μm, 13.2 μm and 21.0 μm. Each device was divided into a series of origin electrodes (i.e. the left electrodes in the Figure S1 insets) and destination electrodes (i.e. the right electrodes in the Figure S1 insets). Four 2.9 μL droplets were loaded onto each device (for four measurements per condition) and actuated such that the droplets were centered over the origin electrodes. When needed, devices were "tapped" or tilted to assist in centering the droplets on the origin. Driving potentials were applied to the destination electrodes until the droplets stopped moving. The distance between origin and the stopped droplet was defined as its equilibrium position x_{equil} (see main text for details). With the destination-electrode potential still applied, an image of each droplet was acquired with a Nexus 5X phone camera through a 10x eye-piece of a dissection microscope equipped with a 2x zoom using a ring illumination light source. Images were imported to Inkscape (v. 0.92.0) to determine the distance travelled by the center of mass of each droplet relative to the length of the electrodes. Results are shown in Figure S1; these data are also plotted in Figure 1 in the main text.

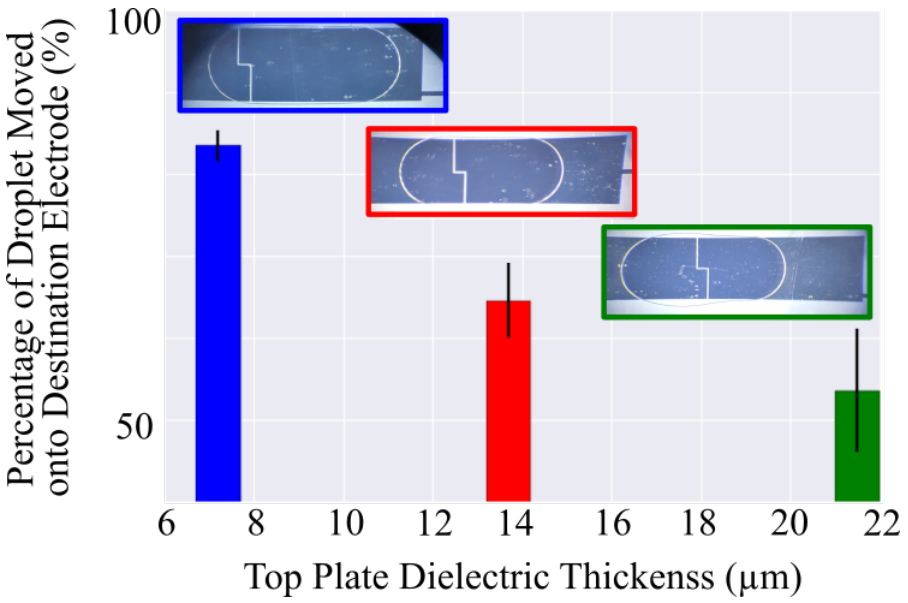

Figure S1: Two-plate-to-one-plate transition. Plot of the distance traveled by droplets onto destination-electrodes actuated at 160 V_{RMS} at 10 kHz (the "right" electrode in the inset-images) for three different top plate dielectric (Parylene-C) thicknesses, 6.7 μm (blue bar and blue highlighted inset), 13.2 μm(red bar and red highlighted inset), and 21.0 μm (green bar and green highlighted inset). The bottom plate dielectric thickness was kept constant at 5.3 μm. Error bars represent one standard deviation (n=4 for all thicknesses).

References

[1] Ryan Fobel, Christian Fobel, and Aaron R Wheeler. Dropbot: An open-source digital microfluidic control system with precise control of electrostatic driving force and instantaneous drop velocity measurement. *Applied Physics Letters*, 102(19):193513, 2013.