Integration of Complementary Split-Ring Resonators into Digital Microfluidics for Manipulation and Direct Sensing of Droplet Composition

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Supplementary information

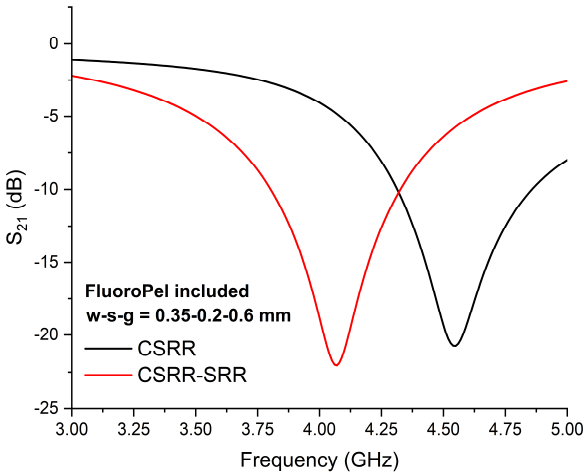

Figure S1. Simulated resonant spectra for single CSRR and CSRR-SRR unit cells with the same dimensions of *w-s-g* = 0.35-0.2-0.6 mm. The CSRR-SRR response (red) shows an appreciable redshift, in addition to increased peak attenuation compared to the CSRR response (black), which is desired to enhance sensor sensitivity.

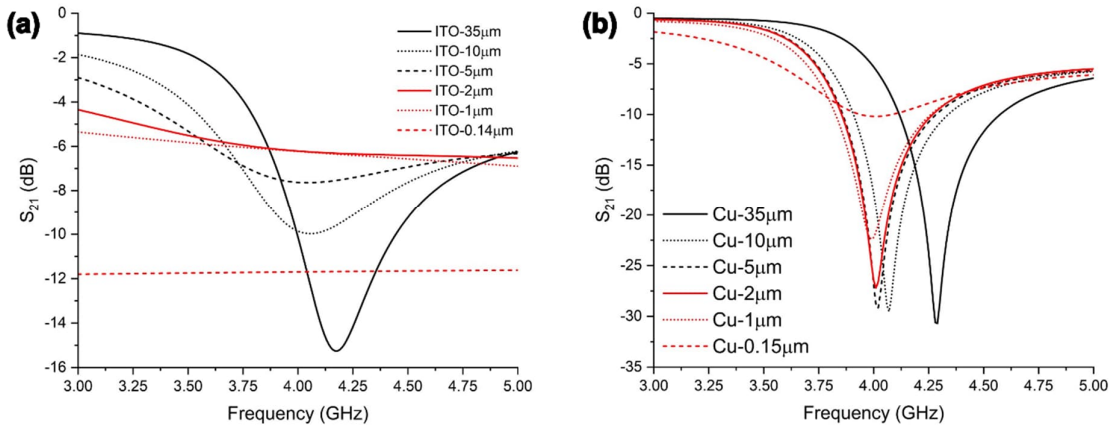

Figure S2. Comparison of simulated resonant response for varying thicknesses of (a) ITO ground plane conductor, and (b) Cu ground plane conductor. Below an ITO thickness of 5 μm, the resonant response is not appreciable due its large skin depth.

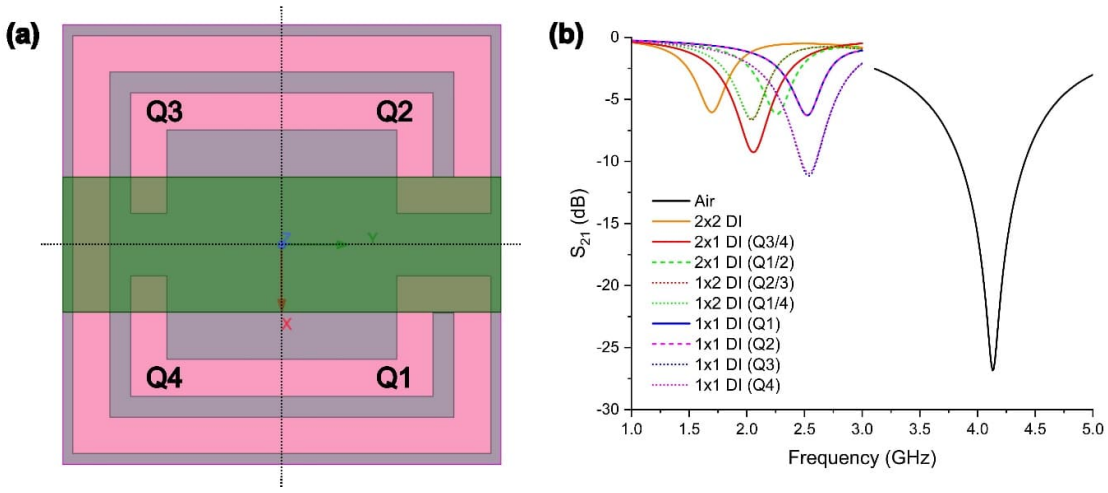

Figure S3. (a) Reference coordinate system used for discretizing the CSRR-SRR into quadrants for (b) the analysis of the effect of varying droplet size and position on resonant response.

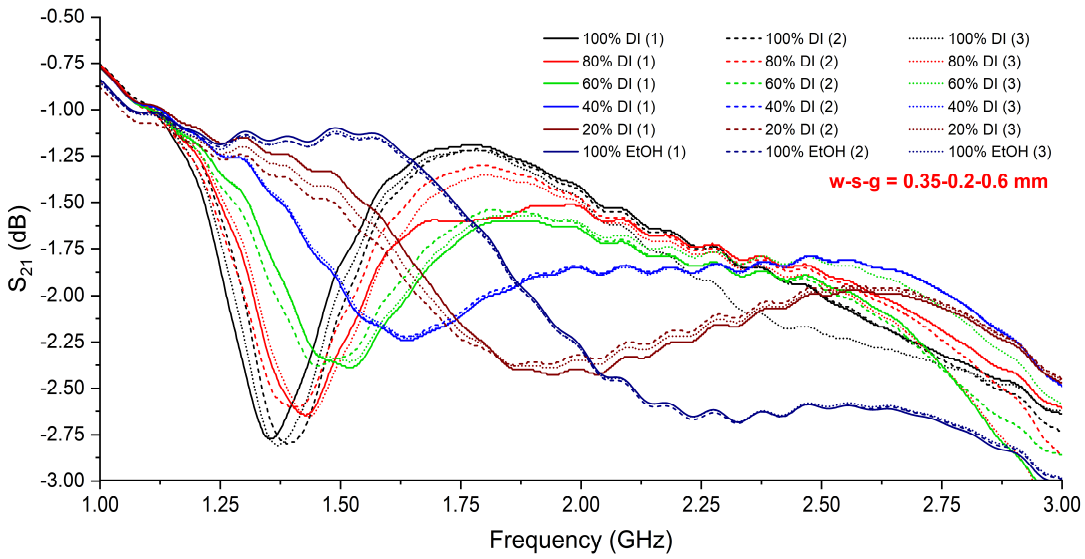

Figure S4. Raw CSRR-SRR response on DMF for individual DI-EtOH sample droplets with varying water fraction. CSRR-SRR dimensions are *w-s-g* = 0.35-0.2-0.6 mm.

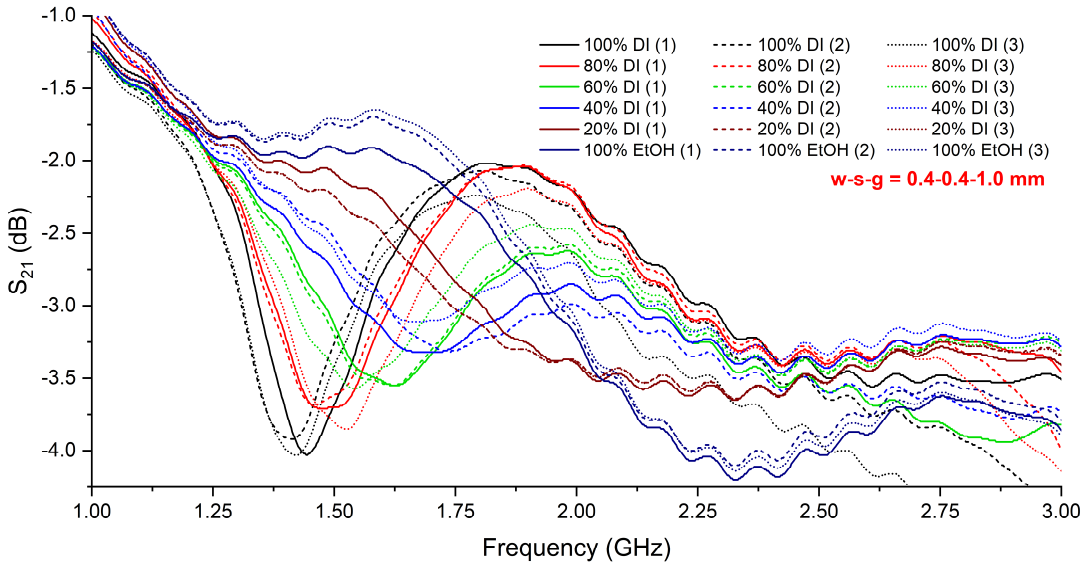

Figure S5. Raw CSRR-SRR response on DMF for individual DI-EtOH sample droplets with varying water fraction. CSRR-SRR dimensions are *w-s-g* = 0.4-0.4-1.0 mm.

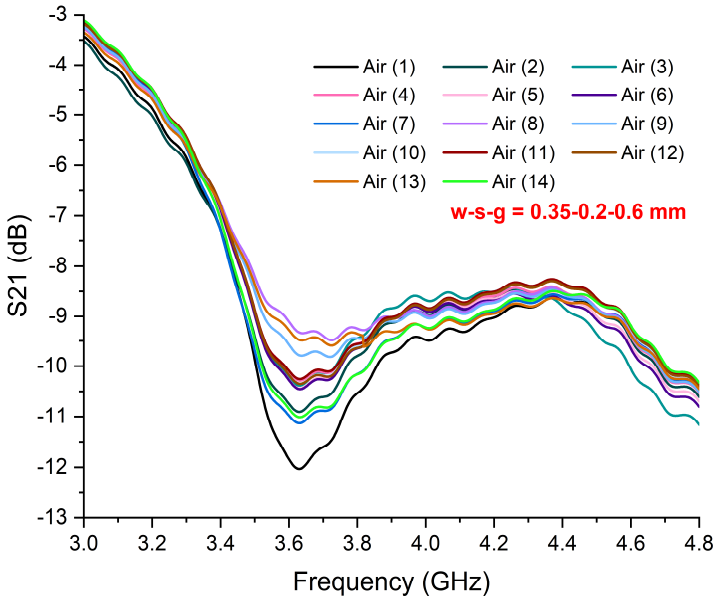

Figure S6. Raw CSRR-SRR response in air on DMF over time for a CSRR-SRR with dimensions *w-s-g* = 0.35-0.2-0.6 mm. As DI-EtOH droplets of varying water fractions are moved away from the sensing region, the resonant frequency in air is restored, with varying S_{21} amplitude.

Video S1 – Droplet movement on a DMF device assembled with top plate containing CSRR-SRR sensing structures and ground grid. Ag layer = 1 µm. Droplet composition is 10 mM PBS with 0.1% Tetronics 90R4. Video sped up 5x.