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Fluidic Dielectrophoresis of Aqueous Electrical Interfaces

ZACHARY GAGNON, Johns Hopkins University — To date, alternating current (AC) electric fields have been exploited to dielectrophoretically manipulate bubbles, liquid drops, particles, biomolecules and cells. Research and applications in this area, however, has been primarily limited to the interfaces formed between two immiscible metal-liquid, particle-liquid, or gas-liquid surfaces on particles. The influence of AC electric fields across aqueous liquid-liquid interfaces remains relatively unexplored. Fundamentally, many electrokinetic phenomena arise from discontinuities in ionic flux and charge accumulation at electrical interfaces, and here I explore the influence of AC electric fields on the electrical interface created between two aqueous liquids with disparaging electrical properties Using a microfluidic channel with embedded electrodes, two fluid streams - one with a greater electrical conductivity, the other a greater dielectric constant - were made to flow side-by-side. An AC electric field was applied across the flow channel and fluid was observed to displace across the phase interface. The displacement direction is AC frequency dependent, and is attributed to the Maxwell-Wagner interfacial polarization at the liquid-liquid electrical interface. At low AC frequency, below the interfacial charge relaxation time, the high conductive stream is observed to displace into the high dielectric stream. Above this frequency, the direction of liquid injection reverses, and the high dielectric stream injects into the high conductivity stream. An analytical model is presented for this liquid crossover frequency, and applied towards biosensing applications.

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