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Modeling the Dilution of Static Droplet Arrays with Moving Plugs[1] WILLIAM WANG, SIVA VANAPALLI, Texas Tech University — Generation of arrays of immobilized microfluidic droplets with variation in reagent concentration from drop-to-drop is important for a variety of biochemical and screening assays. Recently our laboratory (Sun et al., Lab Chip, 2011) showed that such gradients in chemical concentration can be achieved by coalescing diluting plugs with drops immobilized in a microfluidic parking network. In this study, we investigate the key hydrodynamic mechanisms responsible for generation of concentration gradients in static droplet arrays, with the goal of predicting the dilution profiles observed in experiments. We conduct simulations based on a phenomenological model that includes diffusion, advection due to circulating flow within moving plugs, enhanced material transfer due to coalescence and break-up events, and geometry. Consistent with experiments, we find that the concentration profiles can exhibit segmentation between rows of parked droplets due to coalescence events occurring on alternating sides of the diluting plug. Tail-sweeping of wall material can increase concentrations in the plug tail. Also, coalescence and break-up events can significantly enhance dilution rates and ranges. Our results impact the design of SDAs for creating broad and predictable concentration gradients.

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