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The physics of densely-packed emulsions DONALD M. AUBRECHT, Harvard University, DAVID F. MARRAN, DARREN R. LINK, RainDance Technologies, Inc., DAVID A. WEITZ, Harvard University — One strategy for microfluidic lab-on-a-chip applications is to use water droplets as tiny reaction vessels in a carrier stream of oil. As biochemical and cell-based experiments often require control over events that take place over a wide range of time scales, strategies need to be developed to ensure adequate timing without limiting droplet throughput. In general, longer time scales can be achieved by using longer channels or more densely packed droplets. Long channels become increasingly impractical at high throughputs for times exceeding tens of minutes, thus motivating work with densely packed droplets. Dense packing of droplets can be achieved by generating droplets on-chip, collecting them off-chip to allow the oil to drain, and re-injecting them back on-chip as a packed emulsion. This strategy is limited in that it only provides access to time scales in excess of hours. Moderate time scales can be accessed by removing carrier oil from the flow without removing the droplets. Here we present some of the physical principles governing how this can be implemented and discuss the flow of the resulting dense collections of droplets through microchannels.

Donald M. Aubrecht
Harvard University

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