RECIPROCATING MOTION OF FEMTOLITER DROPLETS BETWEEN TWO LIQUID INTERFACES

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We demonstrate a handling scheme for femtoliter droplets that is based on the reciprocating motion of the droplets between two oil/aqueous interfaces. The aqueous droplets move in a microchannel filled with oil between two interfaces to aqueous phases. The motion is driven by a DC electric field between the interfaces. Under suitable conditions [1], upon touching an interface, a droplet does not merge but bounces back. This is demonstrated in the time-lapse images below that show a 5 µm diameter droplet bouncing back from the interface. The arrows indicate the direction of motion. As a result, a droplet can perform a reciprocating motion between the two interfaces. We characterize the regimes in parameter space where this type of motion occurs.

Upon touching an oil/aqueous interface, a droplet exchanges a tiny amount of dissolved species with the liquid reservoir. We study the mass transfer to the droplet by imaging the transfer of a fluorescent dye contained in one of the aqueous reservoirs. After a few cycles, the dye concentration inside the droplet reaches an asymptotic value, indicating that the amount of dye taken up at one interface equals the amount released at the other interface. That way the droplets qualify as tiny semi-batch reactors, a function that could be important for mimicking the metabolism of cells. The mass transfer to/from the droplets is size selective: While dissolved molecular dyes are able to pass the bridge forming between a droplet and an aqueous reservoir, 500 nm polystyrene beads are rejected. The size selectivity could open new avenues for the selective transfer of smallest sample amounts.

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