Space-Time Controlled DNA Cargo Delivery Performed by

Active Janus Droplets

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Droplets made of a water/ethanol mixture in a continuous squalane/monoolein solution self-propel and evolve in up to three stages depending on droplet composition. With the different evolution stages also the propulsion mechanism as well as the corresponding hydrodynamic flow field change. In the first stage the droplets release ethanol and absorb surfactant molecules which leads to a phase separation of the water/ethanol/monoolein mixture and the formation of Janus droplets composed of a water–rich leading droplet and an ethanol–rich trailing droplet. The appearance and duration of the different stages can be controlled by the ethanol concentration in the droplets. Upon phase separation, DNA added to the initially formed droplets can be precipitated into the ethanol-rich droplet. Taking advantage of the specific swimming properties of the droplet in each stage and the adhesion properties of the ethanol– and water–rich droplets, we can control whether the cargo will be delivered at specific target locations. We can further control the timeframe and maximal distance of cargo delivery with the surfactant concentration in the continuous phase, the chemical composition of the droplets, and the droplet size. (Submitted)