

Simultaneous Production and Separation of Droplets in a Flow Focusing Device

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Submicron droplets and particles with nearly monodisperse sizes can be produced using flow focusing microfluidic devices. These so-called “satellite” droplets are produced simultaneously with the larger primary droplets (panel a). Under typical operating conditions, these differently sized droplets travel through the device and elute together, requiring downstream separation of the droplets based on size. Furthermore, if only the satellite droplets are desired, the order of magnitude size difference between the primary and satellite droplets means that significant amounts of material are wasted in the primary droplet. To solve these operating challenges with flow focusing devices, we have developed a protocol to simultaneously produce and separate primary and satellite droplets (as well as tertiary satellite droplets) based on size. By operating the device with asymmetric inlet flow rates, we are able to move the droplet fluid cusp (i.e., the point of droplet generation) away from the center of the flow focusing orifice. The location of the cusp in the orifice affects the location of droplets downstream of the orifice in a way that depends on the size of the droplets (panel b). As a result, we are able to achieve separations of several hundred micrometers between satellite and primary droplets (panel c), enabling efficient size separation and recycling of the primary droplet material.

