Formation of normal and reversed nano-sized emulsions in a microfluidic device: insights into the formation mechanism with *in-situ* SAXS

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Abstract

Incorporation of *in-situ* small-angle X-ray scattering (SAXS) onto microfluidic devices allows new interesting possibilities for the study and synthesis of nanomaterials under flow [1-3].

In this work we study the formation of normal oil-in-water (o/w) and reversed water-in-oil (w/o) nano-sized microemulsion droplets in the SDS-pentanol-water ternary system. A lamellar phase composed by the three components (surfactant, water and pentanol) is flowed in the middle channel of a crossed-microchannel device (figure), and mixed with either water or pentanol flowing from the sides. The addition of water or pentanol induces a transition to normal (o/w) or reversed (w/o) emulsions, respectively. By manipulating the individual flow-rates, one can carefully tune the final system composition (hence, the size and shape of the particles), and furthermore, probe different time-scales of the transition. The ongoing structural evolution is simultaneously monitored *in-situ* with SAXS.

The main findings show that the lamellar to o/w droplets transition (by mixing with water) occurs through a gradual stripping down of bilayers from the lamellar phase, with a microemulsion SAXS signature coexisting with the initial lamellar peak since very early mixing times. Conversely the lamellar to w/o reverse droplets transition (through mixing with pentanol) involves the formation of an intermediate lamellar phase with a smaller spacing before giving place to the reverse droplets.

References

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Figures

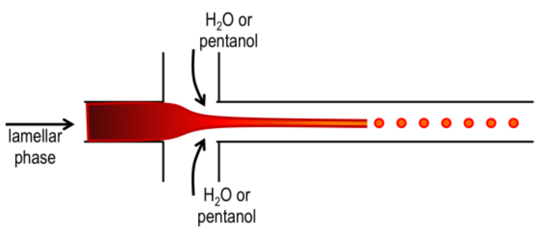

Figure: Schematic of the described experiment. The lamellar phase is flowed in the middle microchannel (100x100 µm cross section), and mixed with either water or pentanol, flowing from the side channels. The three flow rates and their ratios determine the final composition of the system and the observation time.