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Controlling the stability of droplets with thermotropic liquid crystals in a microfluidic device

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For handling liquids in microfluidics, controlling the stability of droplets, not only stabilizing them, has a critical importance in various situations. To stabilize droplets surfactants have mainly been used so far: They reduce the interfacial tension between polar and non-polar fluids and stabilize droplets against coalescence. In addition various methods have been studied to make the stabilized "emulsions" coalesce: Coalescence by squeezing emulsions, electro-coalescence [1] etc.

Here we use thermotropic liquid crystals (LCs) to control the stability of droplets in a microfluidic device: Due to the symmetry break at an interface between LC and the other liquid, a particular alignment of the LC phase is selected depending on the anchoring condition. These alignments, such as parallel layering of smectic phase and homogeneous alignment of nematic phase, could stabilize droplets of the other fluid against coalescence. Furthermore the stability of the "LC film" between droplets could be sensitive to the phase transitions between LC phases. Therefore controlling droplet stability via phase transitions in LC film can be a new, useful method.

In our experiment first we observed the stability of water droplets in water-surfactant-12CB system with microfluidic devices: The devices are made of PMMA (polymethylmethacrylate) with microchannels in the range of hundreds to tens micrometers. 12CB is the matrix or continuous phase and water is the dispersed phase (droplet) in the device. The droplets are produced by the shearing off at T-junction or step emulsification of co-flow liquid stream [2] and then they were observed in the wider channel (e.g. Fig. 1). We have observed that the stability of water emulsions against coalescence depends on the temperature around the phase transition point. Details and other experiments will be reported in our presentation.

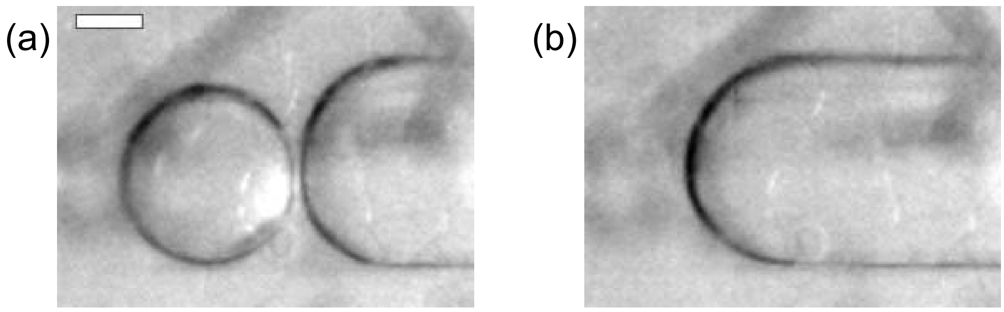

Figure 1: (a) An example of water droplets surrounded with 12CB in the wider channel (height/width = 109/417 [μm]). The scale bar corresponds to 200μm. (b) 11s later from (a). The droplets coalesced in 11s.

[1] C. Priest, S. Herminghaus and R. Seemann, *Appl. Phys. Lett*. **89**, 134101 (2006)
[2] C. Priest, S. Herminghaus and R. Seemann, *Appl. Phys. Lett*. **88**, 024106 (2006)