Thermocapillary instability of an ionic liquid-water mixture in a temperature gradient

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Ionic liquids have remarkable properties and are commonly harnessed for green chemistry, lubrication and energy applications. We study a thermoresponsive Water - Ionic Liquid (IL) binary mixture which has the property of phase separating above a critical temperature (LCST system). We are interested in the separation process of both phases in order to recover the phase of interest. For this purpose, we generate a temperature gradient in a microfluidic cavity where the confinement strengthens wetting effects and enhances the demixing [1].

In this experimental configuration, we observe three different separation patterns along the phase diagram of the binary mixture composition (see Fig. 1). Only two regimes lead to a complete spatial separation of the two phases. Interestingly, one of these regime (Fig. 1(B)) is reminiscent of a Marangoni instability in radial geometry, even at confinement below 100 μm.

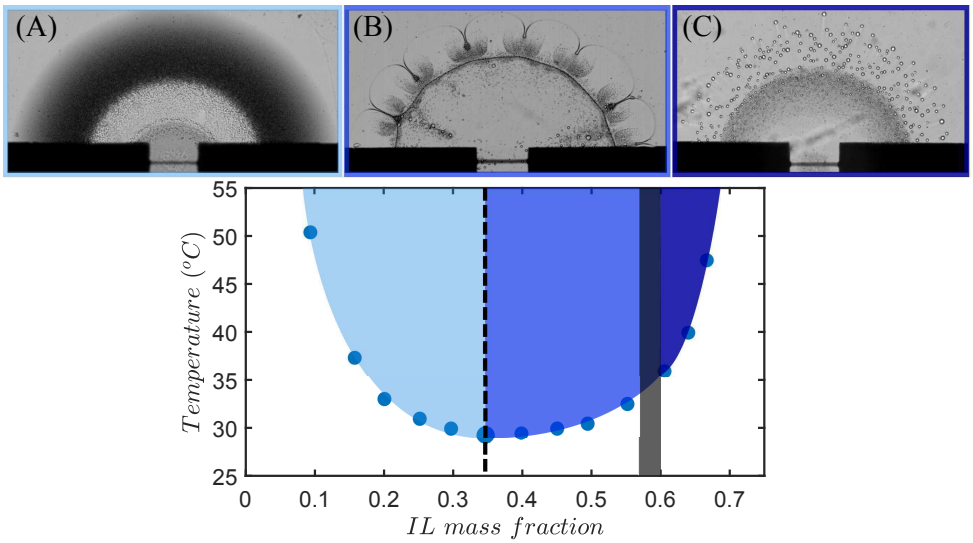

Figure 1. Phase diagram of the IL-water mixture with the three phase separation patterns observed experimentally. The transition from first to second regime is indicated by the vertical dashed line centered on the consolute point. The transition from second to third regime is given by the dark gray area, when the composition is between 55 and 60 wt% in IL.

We have rationalized all the observed regimes [1,2]. In particular, we interpret the Bénard-Marangoni-like periodic pattern of Fig. 1(B) as a thermocapillary driven instability, whose mechanisms involved are actually different from the classical Bénard-Marangoni instability.

Références

1. M. Pascual, A. Poquet, A. Vilquin, M-C. Jullien,, *Phys. Rev. Fluids*, **6**, 024001, (2021),
2. M. Pascual, A. Amon, M-C. Jullien,, *Phys. Rev. Fluids*, **6**, 114203, (2021).