Delayed Coalescence of Sessile Drops with Different but Miscible Liquids

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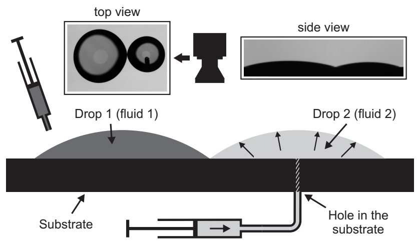
Due to capillary forces two sessile drops of miscible liquids will fuse when they get in contact with each other because one large drop has a smaller interfacial energy than two smaller drops of the same volume. Usually the drop fusion proceeds very fast, delayed mostly by viscous forces. However, quite unexpected, under certain conditions the coalescence of sessile drops from completely miscible liquids can be delayed up to several minutes [1]. After a first contact of their three phase lines, those drops remain separated by a thin liquid neck and often even push each other across the substrate before they finally merge (see figure 1).



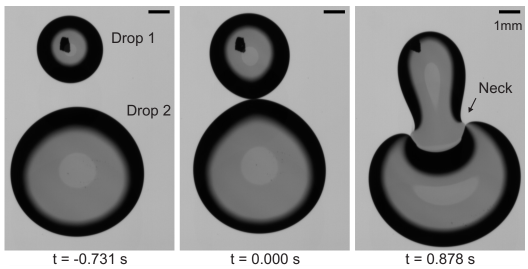


FIG. 1: Left: Experimental setup [2]. Right: Two sessile drops of different but miscible liquids.

It is assumed that the coalescence is delayed by a marangoni convection through the thin film connecting the drops [1]. The convection originates from the different surface tensions and causes a dynamic pressure which keeps the drops separated. This suggests that the effect is quite common. It is relevant for technical applications, e.g. in the field of semiconductor manufacturing where one needs to control the displacement of three phase lines.

Recent results from imaging the droplet shapes/topologies show that there is a remarkably sharp change in the coalescence behavior as the difference in surface tension between the drops exceeds a certain value [2]. Drops with similar surface tensions coalesce fast, not significantly differing from the case of identical liquids. For sufficiently different surface tensions the behavior changes drastically: the drops remain separated, only connected through a thin liquid neck, and travel across the substrate. Other liquid parameters like viscosities and absolute surface tensions seem to play only a minor role.

Having mapped how liquid parameters alter the global characteristics of drop coalescence, we address the fluid mechanical explanation of these phenomena: By analyzing the evolution of the liquid-air interface topology, several successive stages during the coalescence delay have been revealed. Particle-tracking and -image velocimetry shed light on the underlying flow field. A thin film equation, coupled to an advection-diffusion equation, is used to describe the quasi-steady state of non-coalescing sessile drops.

[1] Riegler, H. and Lazar, P., *Langmuir* **2008**, *24*, 6395.
[2] Karpitschka, S. and Riegler, H., *Langmuir*, **2010**, *26*, 11823.