Leidenfrost on liquid baths

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As far as the eighteenth century, the phenomenon that is nowadays known as the Leidenfrost effect has always fascinated minds. This state where a drop levitates over a bed of its own vapour has shown a lot of interesting properties. During the twentieth century, most researchers focused on ways to suppress this effect that significantly lowers the efficiency of the cooling of hot surfaces. Recently, the use of these drops have begun to show interesting possibilities such as the self-propulsion and transport of objects [2], or the organisation of particles [3, 4]. The preservation of this state seems more and more crucial.

Roughness has been shown to increase the Leidenfrost temperature [5], the idea of our work is then to use the smoothest substrate possible: a liquid bath. And indeed, we observed stable Leidenfrost drops with differences in temperature between the boiling point of the liquid of the drop and the temperature of the bath down to 1°C. This extraordinary behavior has been seen notably for ethanol drops on silicon oil baths. However, the viscosity of the liquid of the bath seems to be an important parameter as no ethanol drop can be in Leidenfrost on high viscosity baths (kinematic viscosity $\nu \sim 200$ cSt). As the viscosity increases, the heat transport due to convection may be reduced and local cooling of the substrate may then be the reason why we do not observe Leidenfrost droplets on high viscosity baths. We also investigate the evaporation of these drops. It appears that the scalings for the evaporation are different from those applying in the case of a solid substrate.

Finally, we also investigate impacts of HFE drops on hot liquid baths. We observe three main regimes depending on the Weber number, the Froude number, and the temperature and viscosity of the bath. First, the bouncing on the drop that stays in the Leidenfrost state for seconds after its stabilization on the surface of the bath. Second, the creation of an anti-bubble, i.e. a drop in a shell of vapour surrounded by the liquid of the bath (see Fig. 1 (b)). Third, the drop spreads quickly, touch the substrate, and forms a cavity.

![Figure 1](image1.png)

FIG. 1: (a) Ethanol drop in the Leidenfrost state over a bath of silicon oil at 115°C. (b) An anti-bubble made by impacting a drop of HFE in liquid bath of silicon oil at 140°C.