

Leidenfrost explosions

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Abstract

We present a fluid dynamics video showing the behavior of Leidenfrost droplets composed by a mixture of water and surfactant (SDS, Sodium Dodecyl sulfate).

When a droplet is released on a plate heated above a given temperature a thin layer of vapor isolates the droplet from the plate. The droplet levitates over the plate. This is called the Leidenfrost effect.

In this work we study the influence of the addition of a surfactant on the Leidenfrost phenomenon. As the droplet evaporates the concentration of SDS rises up to two orders of magnitude over the Critical Micelle Concentration (CMC). An unexpected and violent explosive behavior is observed. The video presents several explosions taken with a high speed camera (IDT-N4 at 30000 fps). All the presented experiments were performed on a plate heated at 300C. On the other hand, the initial quantity of SDS was tuned in two ways: (i) by varying the initial concentration of SDS and (ii) by varying the initial size of the droplet. By measuring the volume of the droplet just before the explosion, we were able to estimate the final concentration of SDS. We found that the explosion always occurs around a critical concentration, about 100 times the CMC.

The droplets have also been studied just before the explosion. By isolating the droplet on a cold plate just before the explosion, we evidenced the presence of a shell surrounding a liquid core.

We conclude that above a critical concentration a solid shell is formed. This leads to an increase of pressure into the droplet until the shell breaks. The release of the pressure is accompanied by a violent explosion, and in some cases foaming.