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EFFECT OF HUMIDITY ON THE EVAPORATION OF SESSILE DROPLETS

Abstract

Evaporating sessile droplets are surprisingly complex. Only recently have experiments using IR thermography revealed the existence of regular thermal patterns in sessile droplets spontaneously evaporating into the room atmosphere. By contrast, experiments conducted with water, ethanol, and HFE-7100 have not shown any of these patterns when monitored with microthermocouples. This raises the question of what is the source of the temperature fluctuations.

Microthermocouples (bead radii < 25 μm) offer several advantages over IR thermography: they can measure the temperature at a point; their calibration curves remain unchanged for different liquids; they have response times on the order of milliseconds; and they can measure the temperature of IR opaque liquids like water.

In the present study, we have used microthermocouples to investigate the temperature in evaporating sessile drops held in an evaporation chamber where the vapour-phase pressure and substrate (PTFE) temperature were controlled. Volatile sessile droplets were examined under two circumstances: the liquid either evaporated into a moist atmosphere, or into its own vapour. In a moist atmosphere, thermal pulsations were observed in the bulk of ethanol droplets, but not when evaporation was into the pure vapour of the droplet. Results for methanol will also be reported.

These observations have important implications for experiments performed both on the ground and in space. The results suggest that the thermal fluctuations observed by others resulted from the water absorption from the atmosphere to the interface of the evaporating hydrocarbons. Thus, the humidity of the environment must be controlled and taken into account when comparing ground-based experiments to those on the ISS.