Paper ID: 17783
oral

MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

Author: Prof. Michael Dreyer
ZARM University of Bremen, Germany

HEAT AND MASS TRANSFER AT A FREE SURFACE WITH NON-ISOTHERMAL BOUNDARY CONDITIONS IN A SINGLE SPECIES SYSTEM UNDER MICROGRAVITY

Abstract

In this paper we analyze the heat and mass transfer at a free surface under microgravity conditions. The SOURCE 2 experiment was performed on a suborbital MASER 12 flight in February 2012. The objectives are to quantify the deformation of the free surface and to correlate the apparent contact angle to a characteristic temperature difference between sub-cooled liquid and superheated wall at which the influence of evaporation and condensation at the liquid-vapor interface and at the superheated wall shall be taken into account. The experiment consists of a transparent quartz glass test cell which has a square ground area of 80 mm 80 mm. The height is 120 mm and the bore diameter is 60 mm. Solid, liquid and vapor temperatures are measured by thermocouple groups positioned at specific regions. The test fluid is a perfectly wetting HFE-7000 with a zero degree static contact angle. Data of the saturation curve, provided by the manufacturer, are well known. In the beginning of the experiment the test cell is evacuated and preheated. At steady state its top interface has a temperature of 145 C, whilst the bottom interface has a temperature of 35 C. The temperature evolution within the quartz cell in vertical direction yields a temperature gradient of 1 K/mm in the region of the expected contact line. Automatic filling with cold liquid started at 65 s after lift-off and continues for 25 s. Microgravity is achieved at 75 s. At the same time the test cell was pressurized for 10 seconds with hot vapor up to 0.21 MPa. The final desired position of the free surface was adjusted at 112 s by manual filling with a reduced volume flow rate of 3 ml/s. Afterwards the pressure was adjusted to 0.2 MPa at 126 s. The wall superheat temperature was set to 20 K at the expected contact line and nucleate boiling could be observed. Since the influence of condensation at the free surface is obviously stronger than evaporation effects in the vicinity of the wall the decreasing pressure had to be corrected again at 143 s up to 0.25 MPa. In this way nucleate boiling could be suppressed and an oscillating and fluctuating but stable free surface could be observed until the beginning of the second experiment phase at 180 s.