

Experimental investigation of flow boiling in microgravity

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Boiling physics plays a key role in various industrial fields ranging from nuclear powerplants through microelectronics cooling to propellant fuel management for space applications [1]. For the latter, the undesired boiling in the fuel tank happens under microgravity conditions, largely impacting the bubble dynamics compared to on-earth boiling. The RUBI (Reference mUltiscale Boiling Investingation) experiment [2], which was operated in the International Space Station between 2019 and 2021, was designed to allow detailed investigation of boiling and bubble dynamics under microgravity conditions in various situations (pool boiling, presence of an electric field, flow boiling). In this work, we analyze the experimental results for the flow boiling cases where bubbles first grow on their nucleation site before sliding along the wall, allowing a new nucleation event to occur in its wake. We extract relevant physical quantities : bubble radius time evolution, detachment diameter, sliding velocity, foot diameter and advancing / receding contact angles. First, physical evolution of these parameters with the operating conditions are studied. Then, comparisons with analytical approaches are achieved by comparing fitted radius time profiles with heat diffusion bubble growth models [3]. A force balance approach is also developed to assess the relevance of forces modeling such as drag or surface tension to verify that experimental bubble detachment diameter and sliding velocity can be reproduced.

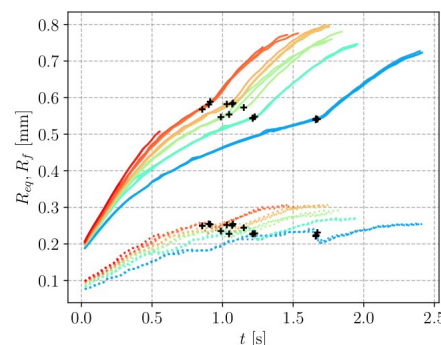
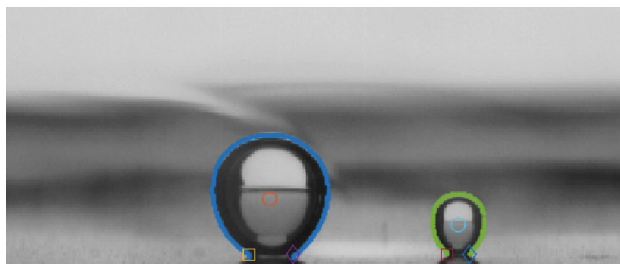


Figure: Flow boiling case post-processing example – Left : bubble contour detection – Right : bubble equivalent (thick) and foot (dotted) diameter, black cross indicates detachment, blue to red coloring represent the experiment time for successive bubbles.

Keywords: flow boiling, microgravity, bubble dynamics, modeling

References :

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