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FLOw boiling REgimes iN microgravity Conditions Experiment (FLORENCE): REXUS-27 sounding rocket campaign

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Abstract

Thermal management is continuously attracting interest from micro/nanoelectronics (high power density within limited physical dimensions) to aerospace (absence of buoyancy and need for heat recovery), and nuclear plants (cooling of reactors). Hence, flow (forced) boiling into channels represents one of the most efficient ways to transfer heat from hot spots. Although flow boiling is exploited in many engineering fields and is of large interest in space applications, it has not been fully explored in reduced gravity due to the additional complexities arising from fluid flow. The understanding, prediction, and control of flow boiling in reduced gravity are strongly hampered by the absence of validated mechanistic and numerical models. Therefore, the creation of reliable and accurate experimental databases is essential to assess the accuracy of the model predictions. For instance, in fluidic systems with simple channel geometries, the absence of gravity sometimes declines the convective boiling heat transfer. On the contrary, complex geometries yield enhancement according to the recent studies on Sounding Rocket experiments of the flow boiling of cryogenic nitrogen [1-2]. It is important to underline that each of these two experiments has occupied the entire JAXA's sounding rocket S-310-43 (7 m in length and only 310 mm in diameter). To the best of the authors' knowledge, no other breadboards have been designed for the investigation of flow boiling.

In this framework, the scope of this communication is first to present the design and the qualification of the FLOw boiling REgimes iN microgravity Conditions Experiment (FLORENCE), which was on board the REXUS-27 sounding rocket in November 2022. The aim of the FLORENCE bread board is the following: to what extent would the low-budget and miniaturized flow boiling experiments be developed and performed in sounding rockets? To that end, we will compare the on-ground results to that of the reduced gravity in terms of bubble detachment frequency and void fraction.

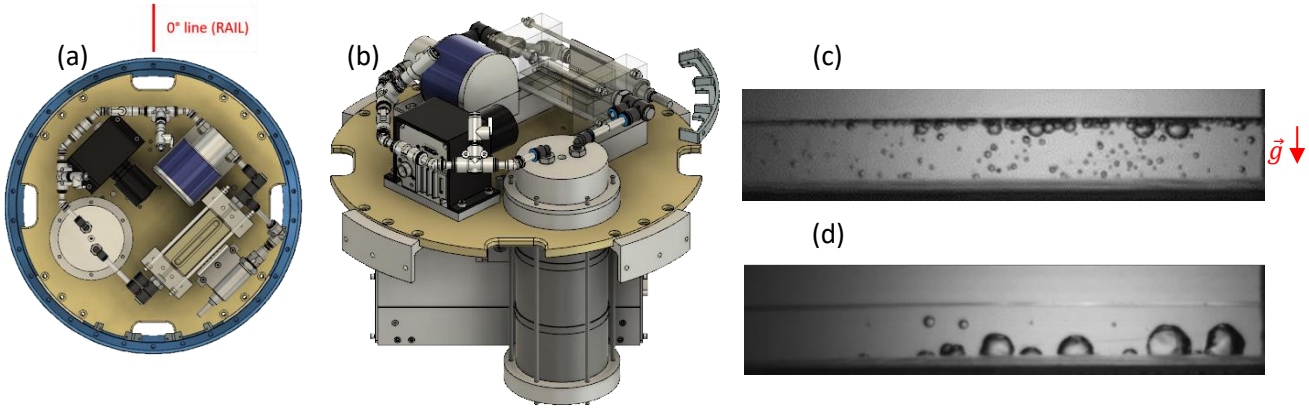

Figure 1: FLORENCE experiment module: (a) top view, (b) oblique view. Flow boiling experiment performed: (c) on the ground, (d) on the REXUS-27 sounding rocket under reduced gravity.

References

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