Graphene Loop Heat Pipes for Thermal Control in Space Missions

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Under the Graphene Flagship of European Commission, a graphene enhanced capillary pump has been developed for a Loop Heat Pipe.
The Loop Heat Pipes (LHP) are passive devices for thermal control of equipment and payloads on board satellites and space probes. capable to transfer heat from the heat sources to the satellite radiators, LHPs use the own waste heat of the devices to be cooled as the driving energy for pumping a fluid through a loop. The core of a LHP is clearly its capillary pump, a phase separator that allows pressure being generated by capillarity across a porous structure.
Traditionally, LHPs capillary pumps are sintered metal wicks. Various properties of graphene have been considered for enhancing the LHP performance: the small scale of its porosity, its wettability and its thermal conductivity [1].
Major issues in using conventional, i.e. with metallic wicks, LHPs in operational space missions are related to their non-deterministic start-up behaviour and the necessity to ensure operations without interruption for the entire mission duration.
Superior start-up capabilities have been measured on an acetone experimental LHP [2] with a Graphene Oxide deposition on a sintered Nickel wick, operated in space-like environment.
In addition to these first results, the roadmap for the space qualification of a graphene LHP goes through a further research on ground models with a combination of various fluids (water, ammonia, propene,…) and capillary pump bulk materials (nickel, stainless steel).
The second step (2017) is a zero-g experiment on a parabolic flight of 20 seconds, to eliminate the gravity effects and confirm the ground results.
The third and last step (2019-2020) is a demonstration on-orbit to confirm, in the long-term, the performances measured on ground and during the zero-g parabolic flight.

References

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[2] M. Molina, C.S. Iorio, P. Queeckers, J. Colloux, A. Lo Presti, ICES conference 2016, Vienna, Graphene Loop Heat Pipe Testing

Figures

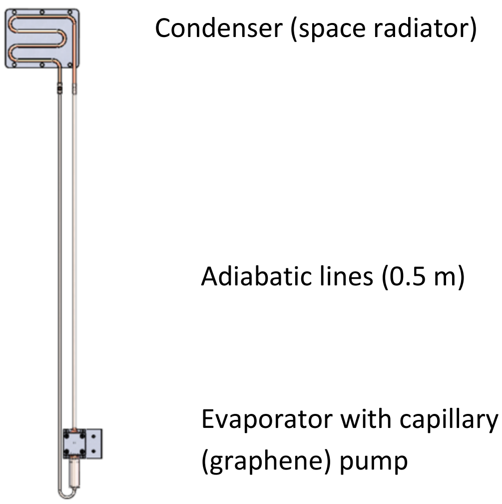

Figure 1: Experimental LHP layout [1]