NANOTECHNOLOGIES

Electrowave - ELECTROWetting heat pipes for cooling Applications in electric Vehicles

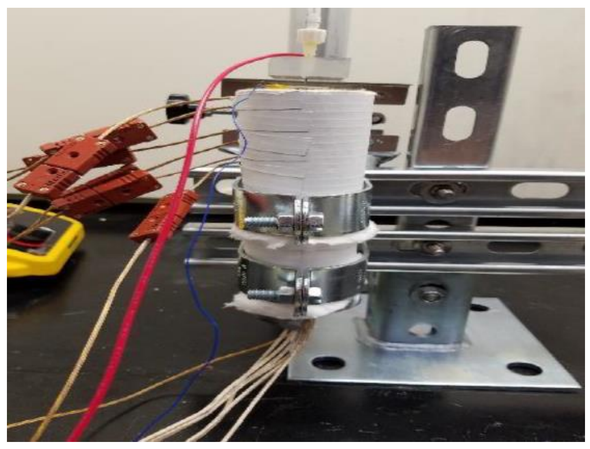
I. Maia - MEtRiCS, University of Minho/IN+ Instituto Superior Técnico
E. Freitas - MEtRiCS, University of Minho/IN+ Instituto Superior Técnico
J. Miranda - CEFT/FEUP, University of Porto
R. Lima - MEtRiCS, University of Minho/ CEFT/FEUP, University of Porto
V. Bahadur – UT Austin
A.S. Moita - IN+ , Instituto Superior Técnico

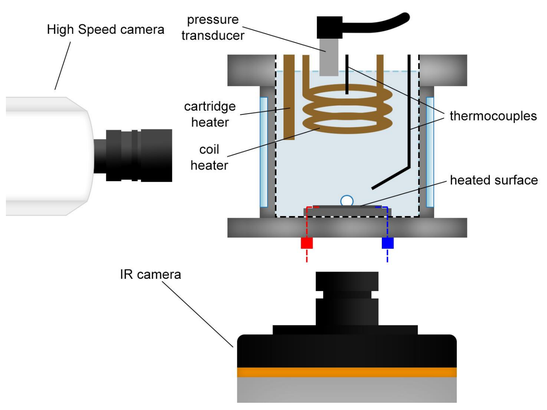
Background

Electrowave addresses the development and test of an innovative electrowetting heat pipe (EHP). Heat pipes passively transport heat by absorbing heat at the evaporator (evaporation of the working fluid) and rejecting it at the heat sink (condensation of the fluid). Here one explores electrostatic actuation to improve the heat transfer in the evaporator for heat dissipation conditions relevant for thermal management in electric vehicles.

Methodology

Experiments are combined with a numerical approach to explore the benefits of the electrostatic actuation in dryout prevention and to enhance heat transfer coefficients. The model and experimental conditions are extended to work on boiling conditions in the evaporator, combining the use of modified surfaces and nanofluids to further enhance heat transfer.





Results

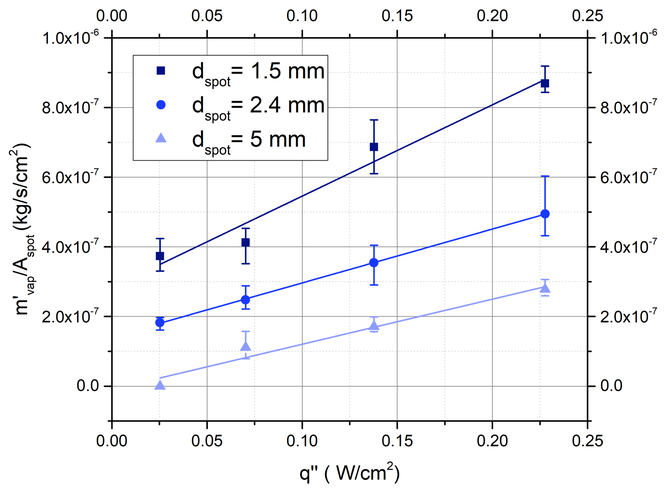
Experimental results obtained for high superheat values evidence up to 3X enhancement in heat transfer seen in these experiments upon application of voltage (which eliminates dryout).
For boiling (low superheat conditions) and for patterned surfaces, the pattern of the geometry seems to play a major role in the evaporated mass and consequently in the (latent) heat transfer.
Preliminary results show good agreement between the model and the experiments.

Bubble growth

Exp

Num

t=2s after bubble nucleation



Impact/Conclusions

This project will impact on the heat pipes technology as it is developing and testing a new concept. The work proposed here includes two main innovative aspects, namely: i) First ever effort on active control and enhancement of evaporators and ii) the research will enable a new category of thermal management devices (heat pipes and vapor chambers).

The successful development of an integrated solution for electric vehicles will have a significant impact towards the solution of an important issue which is limiting the autonomy of electric vehicles.