Postdoctoral fellow
CETHIL (18 months)

Design and experimental characterization of an innovative polymer two-phase heat spreader with integrated fins

CAPIT4L[1] project, funded by Institut Carnot I@L

Context:

The development of effective, light and cheap passive two-phase cooling systems is a major challenge in various industrial sectors, especially in the thermal control of on-board electronics. The objective of the CAPIT4L project is to design, manufacture and characterize a polymer heat pipe with integrated fins enabling to meet this need (figure 1).

Concerning the technical aspect, the manufacturing of these systems presently faces the difficulty to define and shape the technical polymers having properties compatible with the targeted application. The recent progresses in the additive fabrication methods allow foreseeing the possibility to remove this bottleneck at middle term.

Concerning the scientific aspect, our knowledges on heat transfer phenomena by condensation on hydrophobic polymer surfaces have to be improved, in the confined space made up of the hollow fins (figure 2). This step is necessary to result in a relevant sizing of the heat pipe.

The present project aims to remove these technical and scientific bottlenecks, by combining the experimental skills gained by the CETHIL on passive two-phase devices to the IPC[2] skills on the control of the whole polymer processing chain, from its formulation to its final shaping. It is based on an experimental approach, preceded by a detailed literature review. The writing of specifications detailing the criteria that should respect the heat pipe envelope will allow selecting the most adapted polymer(s) and the most relevant additive fabrication method. A study dedicated to the phenomenon of condensation in confined spaces will be performed in parallel and will allow the optimum sizing of the complete system. A demonstrator consisting of a polymer heat pipe with integrated fins will be manufactured by IPC, filled and tested by the CETHIL on an experimental bench that will reproduce the operating conditions of on-board electronic systems.

At the end of the project, the characterization and technical economic analysis of the demonstrator will allow to better understand the remaining bottlenecks to lift to lead to a reliable industrial product in a real environment. In the context of electrification of the transportation systems, the substitution of a metallic cooling system by a polymer one, having identical performance, leads to a weight reduction allowing significant fuel economy.

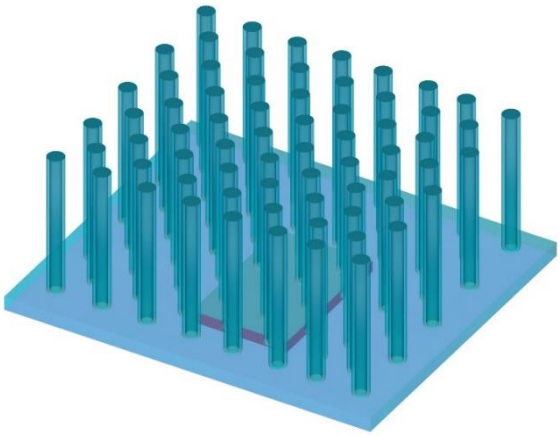

Figure 1: Schematic of a two-phase heat spreader with integrated fins

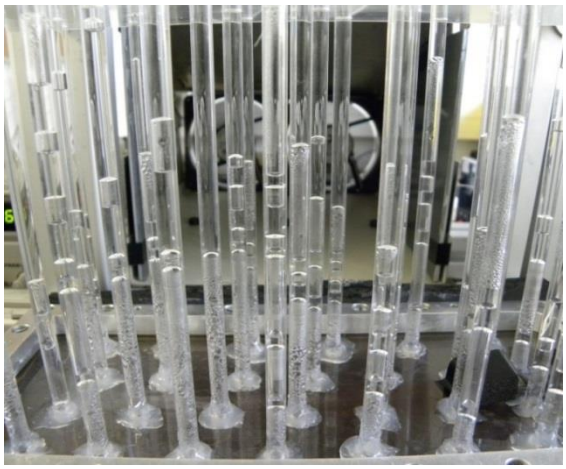

Figure 2: Example of condensation pattern in an array of transparent tube

[1] **C**onception of **A** polymer heat **P**ipe for **I**ndustry, **T**ransport and **T**elecommunication **T**owards a **T**hermal **L**ight-weight system

[2] IPC is the industrial technical center for plastics and composites, located in Bellignat. For further information: http://ct-ipc.com/

Job description

The global objective of the postdoctoral work is to perform an experimental characterization of prototypes, which should permit to validate the concept of an innovative and efficient finned heat spreader made of polymer. The work will start by an extensive literature review, in order to identify the main mechanisms governing the behavior of this kind of system. A specific attention will be given to confined condensation. A preliminary experimental study could be specifically dedicated to it.
The second step will consist in designing the heat spreader prototype. Numerical tools already available at the CETHIL will be used for this task. The main design parameters are the fin dimensions, their spacing and their arrangement. The prototype will be manufactured by IPC, using polymer additive manufacturing.
A test bench will be designed and fabricated at the CETHIL to experimentally determine the maximum wall temperature at the evaporator side and the various thermal resistances involved in the systems. The working limits will be identified and analyzed.
The understanding of physical phenomena operating within the finned heat spreader may require the design and manufacturing of other prototypes, specifically dedicated to visual observations or to local measurements with high speed or infrared cameras. The fundamental character of this part of the work will lead to publications in scientific international journals and conferences.

Profile
The candidates should have a PhD and have a strong experience on two-phase heat transfer phenomena. Good experimental skills are also preferred.

Expected start date
Between September 2017 and May 2018

Administrative framework and location: The candidate will be hired by INSA. The work is to take place in Lyon (France), at the Centre for Energy and Thermal Sciences (CETHIL). The laboratory is located in the National Institute of Applied Sciences (INSA) on the Campus La Doua – LyonTech of Université de Lyon (www.universite-lyon.fr).

Net salary: around 2000 €/month, according to the INSA scale

Contacts
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