PULSED IMPINGING MICRO-JETS GENERATED BY FLUIDIC OSCILLATORS FOR THE COOLING OF EMBEDDED SYSTEMS

Supervisors
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Type of funding: doctoral internship

Duration: 36 months

Salary: €2240 gross salary (€1800 net) per month (in average over the total duration of the contract)

For more information and application
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What is it about?
In the aeronautical industry, where the trend towards more electric aircraft is continuing, embedded electrical power is increasing and power electronics devices are tending towards highly integrated structures to reduce weight, size and cost. All these electronic components, and the structure into which they are inserted, are sensitive to temperature. Effective heat dissipation is therefore essential to ensure high performance. To achieve this objective, it is worthwhile using pulsed impact gas micro-jets, which create unsteady convection with increased efficiency. Fluidic oscillators are a promising candidate for generating this type of jet, because of the wide range of frequencies they can cover and their robustness due to the absence of moving parts [1]. Their operating principle relies on the Coanda effect, where a jet generated by a nozzle supplied with pressurized fluid attaches to the wall. The presence of two feedback loops causes the switching of the jet between the two branches of the oscillator (Fig. 1). The two alternating pulsed jets created in this way produce locally very energetic convection, enabling effective cooling of the facing component.

![Fig. 1: Operating principle of a fluidic oscillator [1]](image-url)
In this context, recent research [2] conducted at the Clément Ader Institute (ICA) has led:

- on a macro-scale, to a better understanding of the physics of the flows and the identification of influential parameters such as the distance between the actuator and the surface to be cooled, the pulsation frequency, and the velocity of the generated jet.
- on a micro-scale, to the development, in partnership with LAAS, of micro-oscillators (Fig. 2) obtained by a microfabrication process involving lamination of dry films, integrating suspended polysilicon thermal sensors with the aim of reducing their thermal inertia and improving strongly their dynamic characteristics [3].

**Goals of the project**

Following on from the work already carried out, the aim of this project is to take a further step forward in our understanding of heat transfer phenomena in pulsed impact micro-jets, using an experimental approach that includes the development of original techniques for measuring temperature in micrometric devices, coupled with the development of specific numerical models to take account of turbulent phenomena in the jet and rarefaction effects linked to the confinement that can occur near the impact wall.

Following on from the work already carried out, the aim of this project is to take a further step forward in our understanding of heat transfer phenomena involving impinging pulsed micro-jets. This will be achieved through an experimental approach that includes the development of original techniques for measuring of temperature in micrometric devices, coupled with the development of specific numerical models considering both the turbulent phenomena in the jet and the rarefaction effects, linked to confinement, that can occur near the impact wall.

**Project proposal**

- Literature review: It will focus on micro-jets (generation, usage, modeling), and numerical and experimental methods for the simulation and characterization of micro-scale rarefied unsteady flows and conjugate heat transfer.
- Testing and characterization of integrated temperature sensors: the technology to create them has been developed [2], and they now need to be tested and qualified.
- Experimental analysis of micro-jets in an unconfined environment: The results will be used to validate the hybrid numerical models developed in parallel.
Ph.D. POSITION

- Numerical study of confined micro-jets to gain a better understanding of the characteristics of the interaction between flows generated by the jets and impact surfaces. This approach will be coupled with an experimental characterization of heat transfer on the instrumented plate already developed.
- Development of an instrumented prototype to assess the effectiveness of the proposed network of jets in enhancing heat transfer.

Required skills
- Master of research (M2) degree or equivalent in mechanics, fluid dynamics or energetics.
- Solid knowledge in fluid mechanics and heat transfer.
- Solid knowledge of CFD simulations (Fluent / OpenFOAM).
- Very good command of Matlab.
- Initial experience in the field of microfluidics would be appreciated.
- Excellent written and verbal communication skills in English (French would be a plus).

References