POLYTECHNIQUE MONTRÉAL

LE GÉNIE EN PREMIÈRE CLASSE

# PhD studies in Montréal (Québec, Canada)
# Experimental reactive fluid mechanics for aerospace applications

From the sustained effort to reduce reliance on fossil fuels for transportation, new research challenges emerge in reactive fluid mechanics. In the aerospace sector, both electrification of propulsion and the use of alternative fuels such as hydrogen are gaining traction. Ironically, although very different these two approaches are associated with a similar combustion configuration: small and fast jets of fuels mixing in air. In the former, when Lithium-Ion cells undergo thermal runaway, the pyrolysis of the electrolyte yields a pressurized hydrogen-rich gas that escapes the vents, with supersonic velocities. In the latter, hydrogen is often mixed with the oxidizer through arrays of microjets to promote efficient mixing and prevent flashback. In both cases, fundamental understanding of the ignition, propagation and stability of these flames is sought, to ensure the safety of the occupants and minimize pollutant formation.

The work proposed here is first and foremost experimental in nature, involving the use of advanced diagnostic tools to characterize the flames produced and extract insights on the underlying physics. On the battery sides, this starts by inducing thermal runaway in commercially available Li-Ion cells. Using our novel time-resolved calorimetry tools, the contributions from processes internal and external to the cell can then be quantified, to isolate the effect of the jet flame produced at the vent. Our hydrogen microjet combustion experiments are conducted in our pressurized crossflow experimental facility. In both cases, quantities of interest including the flame shape, position and stability, which can be used to quantify the combustion efficiency. Experimental results can then be used to support the development of numerical simulation models and validate them. The numerical tools used will include Cantera, Fluent and OpenFoam. Close collaboration with academic and industrial partners with active research programs in the aerospace sector ensures that the results obtained can be quickly integrated into innovative products and enables students to build their own professional networks.

The project will be carried out at the Laboratory for Reactive and Multiphase Flows (LaMuReF) at Polytechnique Montréal, under the supervision of Prof. Etienne Robert.

## Description of positions

The PhD positions available involve experimental work but can also include a numerical simulation component. The students are therefore expected to carry out laboratory work, data analysis and numerical simulation tasks, with a focus to be identified according to individual interests and qualifications.

## Qualifications

The required background for these positions is a Master of Science (MSc or equivalent). Candidates with diplomas in mechanical, physical, chemical or material science engineering will be preferred. Experience with laboratory work and diagnostic tools in fluid mechanics is an asset. Excellent communication skills in technical English (both oral and written) are essential for all positions. The selection process will be made on the basis of academic merit, language skills and publication record. The applicants must be strongly motivated for graduate studies and be able to work independently towards the objectives of the project.

## Application

Individuals interested in joining the project should send:

1. Brief curriculum vitea along with their transcripts;
2. An example of technical writing in English where the applicant is the main author (paper, report or master thesis for example).
3. A list of publications where one section is devoted to articles accepted/published in international refereed journals and one other section where all the other communications (conferences, books, papers not written in English, etc.) are listed;
4. A one-page letter explaining for which position profile (experimental/numerical/hybrid) is the application, the expertise of the candidate and relevant contributions to research.

Applications should be sent by email to Prof. Etienne Robert: LaMuReF.Positions@gmail.com

Incomplete or non-conform applications will not be considered. The applications received will be evaluated as they arrive, starting on May 15th 2024, for a start of studies between September 2024 and May, with a preferred start date in January 2025.

## About Polytechnique Montréal

Founded in 1873, Polytechnique Montréal is one Canada's top engineering teaching and research institutions and first in Québec for the size of its student body and the scope of its research activities.