Laplace
LABORATOIRE PLASMA ET CONVERSION D'ÉNERGIE

Internship proposal
5 months – Master 2 level

Title: Electrical insulation materials with improved thermal conductivity for rotating machines

Background:

The volume reduction in electrical systems, such as rotating machines, is driven by the need for more compact and light systems, in particular for mobile applications (i.e. transportation). Along this size reduction, the demand for total electrical power is also required to increase. As a result, power density is the key design parameter for future power electrical systems (converters, cables and rotating machines). Several challenges arise from this race to high electrical power density, as it imposes high constrains to all materials within the system. These constraints can be electrical, thermomechanical and thermal ones. In the present internship, the objective is to address the thermal properties of materials, since it is one of the most limiting parameters for the performance of rotating machines. When current passes through the windings it heats the conductor, this heat needs to be extracted to the exterior of the rotating machine. Thermal properties of all materials along the heat flow path, like thermal conductivity, impact directly the total heat that can be evacuated by the machine to avoid overheating. From all materials composing the machine, electrically insulating materials, used for machine insulation (winding enamel, potting resin) are intrinsically of low-thermal conductivity (0.1 - 0.3 W/(m.K)) compared to other. An increased value of thermal will allow for limiting dielectric losses and/or allow to be able to work at a higher overall temperature and therefore reduce the size of the cooling sub-system.

Objectives:

The main objective is to identify a candidate material for machine insulation application with a thermal conductivity of at least 1 W/(mK).
A first phase will aim to evaluate the properties of thermal conductivity and dielectric permittivity of commercial filled resins with regard to their initial viscosity and to verify their performance.
A second part of the study will be devoted to formulating a new composite resin allowing to push back the limits of thermal conductivity of the state of the art.

Profile of the applicant:

Basic training in materials science and physics or electrical engineering is required. Skills in physics, electrical and thermal characterization and instrumentation, notions on electrostatic or thermal modelling will be appreciated.
The strong experimental character of the internship will require to apprehend and perform numerous experiments and characterizations (diffusivity, thermal conductivity, dielectric spectroscopy, viscosity measurement, processability, etc.). **Practical (manual) and task management skills are fundamental**.
The student will be part of a multidisciplinary project: curiosity, openness of mind towards material sciences and engineering applications is required.

Perspectives:

The subject might obtain the support for a PhD trainee position.

Contacts:

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Place of work:

The intern will develop his/her activity at LAPLACE laboratory, located on the site of the University Paul Sabatier – Toulouse III campus, France. There will be a strong interaction and exchange with IRT Saint-Exupery.