**Développement d'un modèle numérique magnéto-thermo-hydrodynamique pour un procédé de fusion par induction d'un mélange métal-verre**

**Rémi BOURROU**

Supervisors: Annie Gagnoud et Olga Budenkova
Co-supervised by Christophe Lafon (CEA-Marcoule)

**Wednesday, December 4, 2019 at 10:00 a.m.**

Room to be defined

**Jury :**
M. Valéry BOTTON, Professeur, INSA Lyon – LMFA, Président
M. Alain JARDY, Directeur de Recherche CNRS, IJL Nancy, Rapporteur
M. Franck PIGEONNEAU, Chargé de Recherche, MINES ParisTech, Rapporteur
M. Emilien SAUVAGE, Ingénieur–Chercheur, CEA Marcoule, Examinateur
M. Regis Didierlaurent, Orano, Invité

**Abstract**: In the PIVIC process, aimed to package mixed technological nuclear wastes, a metal-glass bath is melted by electromagnetic induction. The electrical conductivity of the glass being relatively low, the Lorentz forces and the Joule heating are present only in the metal. The glass is therefore put in motion and heated by its contact with the metallic phase, which complicates the control of the process, especially when this material starts to freeze. The goal of this thesis is to study the magneto-thermohydrodynamic coupling in the process to understand the freezing mechanism in order to avoid it. To this end, several numerical modelling tools are used in order to represent the thermal, hydrodynamic, and electromagnetic phenomena in the process. An essential point to take into account is the deformation of the metal's free surface by the magnetic pressure, producing a dome that can emerge from the glass phase.

For the first stage of the numerical modelling, the heat transfers are discarded. The model developed consists in a coupling between COMSOL Multiphysics® (EM induction) and ANSYS Fluent® (turbulent fluid flow). In order to represent the deformation of the interfaces between the fluids, a three phase Volume Of Fluid (VOF) model is used. The results of the numerical model are compared to the measures performed on the prototype of the process. The study highlights the parameters having the most impact on the process and also raises an air entrainment phenomenon between the liquids.

At the second stage, thermal phenomena are added to the numerical model. A separate model is developed to represent radiative heat transfers at the free surface of the liquids with the VOF model. The repartition of the cooling fluxes and the temperature inside the crucible are compared between this numerical model and the prototype. Finally, the impact of the glass mass in the crucible on the thermal behavior of the process is studied.