COLLEGE OF DOCTORAL STUDIES

PhD research pre-proposal

Code: LERMA-2021/PhD2	
Title: Rare Earth Free alloys use in electric cars: The development of a Mesoscale Phase Field Model (PFM) for MnAl alloy.	
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Host college: I&A college	**Host research unit:** LERMA LAB

SUMMARY OF THE RESEARCH PRE-PROPOSAL

Automotive electrification has served as an efficient technology to reduce GreenHouse Gases (GHG) emissions, fuel consumption, and dependency on volatile resources, while maintaining a high-power density and efficiency of a motor. A new generation of electric propulsion motors is based on Rare Earth Free magnetic materials, such as Manganese Aluminum (MnAl). MnAl is a binary alloy that has a ferromagnetic phase with strong magnetic properties. To capture the behavior of MnAl and thus implement it in electrical engines, a multiscale model predicting the impact of MnAl is needed. To develop a RE-free alloy (MnAl alloy) in industrial applications, the project in hand tends to develop a phase field model that captures the thermodynamics of the ferromagnetic phases of MnAl, on a mesoscale level. The phase-field method models the crystallography of the phase transformation of the material studied (MnAl), to capture the transformation from $\boldsymbol{\varepsilon}$-phase to the ferromagnetic phase ($\boldsymbol{\tau}$-phase), predict the microstructural evolution and quantify the structure-property relations for magnetism.

Phase Field Method (PFM) is an effective tool providing an accurate prediction of the irreversible transformation mechanisms. Phase field models describe the phenomenon that the microstructure undergoes depending on the microstructure compositions and microstructure topology.

The variables obtained from the phase-field model are therefore used in a previously developed Internal State Variable (ISV) constitutive model coupling thermal, elastic, plastic, and damage effects with magnetism effects, to allow a multiscale description of the alloy.

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REQUIRED ACADEMIC QUALIFICATIONS & SKILLS

Materials science background