Internship Offer

Modeling the effect of solute segregation on phase transformation kinetics in steels.

Duration : 6 months

Start date: Feb/March 2025

Workplace: Laboratoire Institut Jean Lamour Nancy

Background

Grain boundaries and phase interfaces are key microstructural features that significantly affect the mechanical properties of metallic alloys. These interfaces play a critical role in a variety of processes, including intergranular and brittle fracture, oxidation, nucleation and growth during phase transformations, recrystallization, and grain growth. In steels, the austenite/ferrite interface is of particular importance as it largely determines the final microstructure and mechanical properties of the material.

Recent research has highlighted the importance of incorporating the physical properties of interfaces — such as energy, mobility, and interaction with alloying elements — into models to accurately predict microstructural evolution during complex thermo-mechanical processes. For example, the solute drag effect, where impurities interact with moving interfaces, affects the kinetics of phase transformation in steels. In addition, the properties of interfaces vary with their crystallographic structure. For example, it has been shown experimentally that solute segregation depends on the character of the austenite-ferrite interface, and the resulting heterogeneous segregation can affect the kinetics of phase transformation and thus the final properties.

However, existing models that describe microstructural evolution in steels are limited to isotropic properties of the interface. While some attempts have been made to account for anisotropic properties in grain boundary migration, the same has not been thoroughly investigated for interphase interfaces.

Objective

The primary objective of the internship is to implement and validate a phase field model that describes how segregation affects the kinetics of the austenite-to-ferrite transformation in steel. This model will form the basis for a more in-depth investigation into anisotropic effects in ***a subsequent PhD project***.

Your Tasks

- Develop and implement a phase field model to describe the austenite-to-ferrite phase transformation taking into account segregation effects.
- Simulate and analyze the influence of segregation on the transformation kinetics in ternary Fe-C-X alloys.
- Validate model predictions using existing experimental data and perform sensitivity analyses.

- Document the implementation and prepare a summary of findings to aid in the transition to PhD-level research.

Your Profile

- Background in materials science, physics, or a closely related field.
- Basic understanding of phase transformations and segregation phenomena.
- Programming experience in FORTRAN, Python, C++, or a similar language.
- Familiarity with phase field modeling techniques is a plus.
- Strong computational and problem-solving skills.

This internship can serve as a launchpad for a PhD program starting in September 2026.

About Institut Jean Lamour

The Institute Jean Lamour (IJL) is a joint research unit of CNRS and Université de Lorraine. Focused on materials and processes science and engineering, it covers: materials, metallurgy, plasmas, surfaces, nanomaterials and electronics. It regroups 183 researchers/lecturers, 91 engineers/technicians/administrative staff, 150 doctoral students and 25 post-doctoral fellows. Partnerships exist with 150 companies and our research groups collaborate with more than 30 countries throughout the world. Its exceptional instrumental platforms are spread over 4 sites; the main one is located on Artem campus in Nancy.

Modalités de candidature

For those interested, please send detailed CV and motivation letter to :
Benoît Appolaire (benoit.appolaire@univ-lorraine.fr)
Imed-Eddine Benrabah (imed-eddine.benrabah@univ-lorraine.fr)