

Université de technologie de Compiègne – Thesis proposal

Part 1: Scientific sheet	
Thesis proposal title	Study of the microscopic mechanisms at the origin of the interactions between plastic deformation and oxidation in Fe-25Cr and Fe-25Cr-1Si model alloys
PhD grant	French research agency (ANR22-CE08-0022)
Research laboratory	unité de recherche : Roberval research team: Materials and Surface web site: https://roberval.utc.fr/
Thesis supervisor(s)	Jérôme Favergeon (Pr - UTC), Valérie Parry (MCF HDR – Grenoble-INP)
Scientific domain(s)	Engineering Science Physical-chemistry of materials
Research work	<p>The thesis focuses on the high temperature durability of steels, a challenge of major industrial interest. In this work, the behavior of Fe-25Cr and Fe-25Cr-1Si model alloys will be studied. The overall objective of the thesis project is to understand the effect of a plastic deformation applied before or during the oxidation heat treatment (in air between 300°C and 700°C) on the thickness and morphology of the oxide scales as well as on the characteristics of the zones affected by oxidation. To achieve this objective, several experimental approaches will be carried out during the thesis:</p> <ul style="list-style-type: none"> - Two types of pre-deformations will be performed: i) in bulk, by rolling or by tensile test and ii) at the scale of one or more grains by micro- or nano-indentation. Oxidation tests will then be carried out to study the impact(s) of the pre-deformations - In-situ mechanical tensile and bending tests monitored by acoustic emission, in an SEM (possibly in temperature) with monitoring of the deformation fields by image correlation to characterize the damage to the oxide scales - Uniaxial mechanical tests at temperature, under oxidizing atmosphere, in order to activate viscoplasticity mechanisms in metallic alloys and to identify their effects on oxidation rates and on the morphology of oxide scales <p>The doctoral student will carry out the chemical and microstructural characterizations of the oxide scales, the mechanical damages and the zones affected by oxidation using SEM-EDS, EBSD, TEM-ASTAR-STEM, XRD, GDOES and Raman spectroscopy (chemical analysis and stress measurement)</p>
Key words	Steels, High temperature oxidation, Durability, Physico-chemical characterizations, In situ mechanical tests, Thermogravimetry
Requirements	The candidate, motivated by scientific research and experimental work, holds a master's degree or equivalent. He/she must have solid knowledge in the physico-chemistry of materials and in the mechanics of materials. Basic knowledge of characterization techniques (chemical and microstructural) is desirable
Starting time	1/10/2023
Location	The first 18 months of the thesis will take place in Compiègne (60) in the Roberval laboratory of the UTC. The second half of the thesis will take place in Grenoble (38) at the SIMaP laboratory of the University of Grenoble Alpes.

Part 2: Job description	
Duration	36 months
Additional missions available	Possibility of carrying out teaching as a complementary mission
Research laboratory	<p>The Materials and Surface team of the Roberval Laboratory in Compiègne has been pursuing research for many years on understanding the couplings between the oxidation and corrosion phenomena at high temperature, and the mechanical behavior of metal alloys.</p> <p>The Metal Physics team of the SIMaP laboratory in Grenoble brings together physical chemists and interface mechanics. It has a long experience in the study of the oxidation of Fe-based alloys.</p>
Material resources	The Roberval and SIMaP laboratories have experimental facilities covering a wide range of characteristic scales associated with in situ monitoring experiments. The experimental means are supplemented by skills in modeling and numerical simulations
Human resources	The doctoral student will receive support from the technical staff assigned to the experimental platforms of the Roberval and SIMaP laboratories.
Financial resources	The ANR RACCOON project benefits from approximately 90 k€ to support the work of this thesis
Working conditions	<p>The doctoral student must be able to access a good autonomy in the organization and the realization of his/her work. Progress monitoring will be ensured by a six-monthly schedule and at least bimonthly meetings with the thesis supervisors.</p> <p>The doctoral student will be required to work with the partners of the ANR RACCOON project and in particular with a doctoral student recruited by the ONERA microstructure study laboratory (LEM).</p> <p>Travels between Compiègne, Grenoble and Paris are to be expected.</p> <p>The doctoral student will be required to participate in one to two national and/or international congresses during his/her thesis.</p>
Research project	The thesis is part of the RACCOON project (relations microstructures mechanics oxidation) funded by the ANR for a period of 4 years (2022-2026) This project aims to describe, characterize and model the couplings between chemical processes, diffusional processes, microstructure, mechanical effects and thermal effects during high temperature oxidation of Fe-25Cr and Fe-25Cr-1Si model alloys.
National collaborations	Laboratoire SIMaP, UMR 5266 CNRS, Grenoble INP, UGA Laboratoire d'Étude des Microstructures, UMR 104 ONERA, CNRS
International collaborations	-
International cosupervision (cotutelle)	No
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Please contact first the thesis supervisor before applying online on <https://webapplis.utc.fr/admissions/doctorants/accueil.jsf>