POSTDOCTORAL FELLOW POSITION OFFER

"Effect of an enrichment in nitrogen in austenite phase field on the mechanisms of phase transformation during the cooling of low-alloyed steels"

Description of the job :

The postdoctoral fellow will participate to a long-term project aiming at improving the thermochemical surface treatments of carbonitriding applied to low-alloyed steels. The objective is to study the influence of an enrichment in carbon and nitrogen in the austenite phase field on the austenite decomposition during cooling. If the effects of a carbon enrichment are well-known [1-2], the effects of nitrogen have been mostly studied in literature on model systems (mostly Fe-N [3-4]), where the microstructures generated differ strongly from those encountered in multi-component alloys dedicated to industrial application [5-6].

A first detailed study on a 23MnCrMo5 steel showed original results concerning the effect of nitrogen (~0.25wt.%N), which induces new microstructures and unexpected kinetic effects [7-10]. Compared to the same steel not enriched in nitrogen (initial or carburized steel), the kinetics of austenite decomposition is strongly accelerated despite the γ-stabilizing character of nitrogen. Moreover, the resulting microstructures are very complex, with a refinement of the ferritic matrix, the presence of various nitrides, mostly CrN, and cementite. These microstructures are associated with an increase of the mechanical properties (hardness).

The origin of these effects is ascribed for the moment to CrN nitrides precipitated in the austenite during the enrichment, which would enhance the ferrite nucleation. Previous experiments did not allow to establish the assumed mechanism. There remains to understand what are the effects of the nitrogen on the phase transformation mechanisms, as a function of the carbonitrided steels composition. New approaches are necessary and the postdoc objective is to follow three innovative axes:

- Explore the possibilities offered by the orientation EBSD microscopy coupled to nanotomography in a FIB-SEM [11-13], in order to better localize the CrN nitrides within the 3D microstructure and their relationship with their environment.
- Identify the nucleation sites of the ferrite by mobilizing in situ microscopy techniques: confocal microscopy, in situ SEM and TEM.
- Initiate an indirect approach for studying the role of the CrN nitrides by elaborating a model 23MnMo5 steel without chromium (so without CrN). In the new steel, the austenite decomposition kinetics will be established by dilatometry (in-house Rapid Cycle Dilatometer), but also in situ synchrotron XRD, to track the phase amounts and cell parameters.

This study should improve the understanding of the kinetics acceleration in the 23MnCrMo5 steel after enrichment in nitrogen, in view of future physically-based modelling. Besides, the study of the steel without CrN nitrides presents an interest for the wider topic of carbonitriding treatments. The approaches developed could then be extended to a broader range of steel compositions.

Localization:
The postdoctoral fellow will be hired for 12 months by IRT-M2P (Metz France) and hosted at **Institut Jean Lamour (IJL, Nancy, France**). The project involves two academic research laboratories linked with CNRS and Université de Lorraine: IJL and LEM3 (Metz, France).
ijl.univ-lorraine.fr
www.lem3.univ-lorraine.fr
www.irt-m2p.eu/fr/accueil.html

Dates, duration: 12 months, starting date from January to July 2020 inclusive.

Wages: 35 k€ per year, gross salary.

Areas of expertise, Skills: Metallurgy, phase transformations, microscopy, EBSD, X-Ray diffraction.

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