ESRF | The European Synchrotron

Master student traineeship proposal

Title: *In-Situ Grain-Scale Austenite–Ferrite Transformation in Pearlitic Steels using Dark-Field X-Ray Microscopy*

Abstract:

The research targets a critical metallurgical process for the steel industry: the austenite (γ) → ferrite (α) transformation in pearlitic steels, which controls microstructure and performance in applications such as high-strength railway tracks [1-2]. The student will join a collaborative effort between ESRF (France), DTU (Denmark), and Chalmers University of Technology (Sweden) to conduct the first in-situ, grain-resolved transformation experiment on hypoeutectoid rail steel using Dark-Field X-ray Microscopy (DFXM). DFXM enables non-destructive, 3D mapping of lattice strain, orientation gradients, substructure, and boundary motion during phase transformation [3]. The experiment seeks to capture the disappearance of a single γ grain during cooling and the emergence of pro-eutectoid and pearlitic ferrite as tested on a pure iron sample earlier [4]. This MSc traineeship is part of the ERC-funded DREX project (2024–2029), led by Dr. Can Yildirim, beamline scientist at ESRF-ID03.

Benefits for the Student:

- Training on state-of-the-art synchrotron techniques (DFXM at ESRF-ID03).
- Experience with advanced 3D diffraction-based data analysis, rocking curves, strain/orientation reconstruction, and substructure mapping.
- Opportunity to work with international scientists at ESRF, DTU, and Chalmers, gaining experience in research communication across institutions.
- *Direct contribution and coauthorship to a high-impact scientific publication*, with involvement in experiments, data processing, interpretation, and manuscript writing.
- Valuable preparation for future PhD positions in applied physics, materials science, and X-ray imaging.

References:

[1] Gouné et al., Mater. Sci. Eng. R, 92 (2015) 1–38. doi.org/10.1016/j.mser.2015.03.001
[2] Yildirim et al, Scripta Mat. 197 113783 (2021) doi.org/10.1016/j.scriptamat.2021.113783
[3] Simons et al., Nat. Commun., 6 (2015) 6098. doi.org/10.1038/ncomms7098
[4] Lesage et al, JSR, *in press* (2025)

Scientist in charge: Dr. Carsten Detlefs
Beamline(s)/Host Group: ID03/ XIM group
Traineeship supervisor(s): Dr. Louis Lesage & Dr. Can Yildirim
Access to Instruments/labs/computing/software: DFXM end-station at ID03; ESRF sample preparation labs; high-performance data analysis servers;
Starting date and Duration: February-August 2027 (6 months)

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