Recrystallization study of electrical steel by in situ X-ray diffraction and diffraction contrast tomography

Nowadays, the demand for electrical energy is constantly increasing. To deal with this, energy grids and transformers are continuously optimized and redesigned. In this context, reducing more and more the energy loss in electricity transmission and distribution systems is a real concern.
Electrical steel plays a key role wherever electrical energy is efficiently generated, converted or used. The best example is transformers. They need grain oriented electrical steel (GOES) to be able to function efficiently, their performance being directly determined by the bulk magnetic domain structure and by the mobility of the domains walls.
The magnetic properties of GOES are strongly dependent on material crystallographic texture. Obtaining such oriented grain structure over macroscopic lengths is a real metallurgical challenge and in practice it is difficult to be optimized by industrial processes. In industrial environments, a few hundred of tests could be usually necessary for technology and product development, which is expensive and time consuming.
Within the frame of this master thesis we propose to use high energy synchrotron radiation for following in situ the crystallographic orientation change and grain growth during recrystallization of iron-silicon samples. The in situ approach allows accurate characterization of grain orientation (crystallographic texture) with excellent time and temperature resolution. At the same, diffraction contrast tomography (DCT) also will be used, which allows determining the three-dimensional shape and the volume of the recrystallizing grains. Aim of the internship is to verify the models developed for explaining the recrystallization of GOES. Clarifying the underlying mechanism could improve the quality of the steel and radically reduce technology development cost and time.
Experiments were already done at the European Synchrotron Radiation Facility (ESRF) and the reconstructed granular structure is already available. The evaluation of the 3D structure image analysis will be performed with Python or Matlab. This work is a collaboration between MINES Saint-Etienne and thyssenkrupp Electrical Steel UGO.

Internship duration: 6 months, starting preferably in March 2024
Salary: French SMIC

The application together with a motivation letter should be sent only to the academic tutor:
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