PostDoc Position – aluCHORD project

Starting Nov. 2023 for 12 months

Contacts :

MATEIS Laboratory (INSA Lyon) : Cyril LANGLOIS (cyril.langlois@insa-lyon.fr)

CONSTELLIUM : Bianca FRINCU (bianca.frincu@constellium.com)

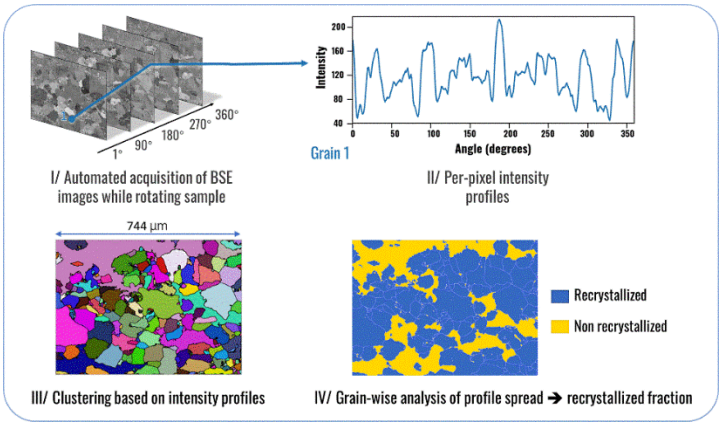
Abstract

The context of the project is the characterization of aluminum alloy microstructures using the channeling contrast of backscattered electron (BSE) SEM images. In close collaboration with CONSTELLIUM, a leader company in aluminium products, it has been shown recently at MATEIS laboratory that BSE image series can be used to efficiently measure grain size distribution, recrystallized fraction and twin proportion, using a fork from the eCHORD method originally designed to obtain orientation maps. Moreover, these measurements are obtained with a very good compromise between spatial resolution, size of region of interest and acquisition time, compared to existing techniques as EBSD for instance.

The project itself consists in further developping our first attempts to obtain reliable software tools that can be deployed in an industrial context at CONSTELLIUM. Microscope control using APIs and image post-treatment are the main work areas. Good knowledge in Python programming language is then required, and SEM experience is a valuable asset.

The project

The recrystallization process of plastically deformed metals and alloys is of paramount importance in the manufacture of metal alloys for two main reasons. The first is to control the granular structure of the final product in order to control material properties. The second is to soften and restore the ductility of a material hardened by low-temperature deformation. For aluminum and all other metal alloys, recrystallization after deformation is the only method that modifies grain size, shape and, in particular, mean orientation or texture. Having a reliable and rapid analytical method for characterizing recrystallization and deformation substructures is therefore essential for both industry and academic laboratories working in this field.



In this context, the latest advances in the use of the CHORD method [PhD Thesis Romain Facchinetti – eCHORD developments for multi-scale characterization of aluminium alloys.] and its derivatives open up new horizons in terms of characterization of the rate of recrystallization, among other things, without having to identify the crystallographic orientation. This

technique is highly promising for work requiring good spatial resolution, which makes the eCHORD method suitable for multi-scale analysis. The workflow is briefly detailed hereafter [1-2]:From a series of BSE images obtained by tilting and rotating the sample in the SEM, the variation of gray level as a function of the rotation angle can be computed, for each pixel (intensity profile on the top-right figure). This is the raw data from which the grain boundaries can be determined. This step is carried out using a Density-Based Clustering algorithm proposed by the SciKit Python library. This is not the only approach, and other routes will be investigated during. Once the grains are identified, it is straight-forward to compute the statistics as grain size distribution and so on. To go further, it has been identified that pixels that do not belong to any identified grains by the clustering step represent the non-recrystallized fraction in certain alloys. A goal of the post-doc is to determine to which extent this approach can be applied on other aluminium alloys microstructures.

The main goal is to end up with a functionnal software that can take as input an aligned image series, and produce grain size distribution and recrystallization fraction as an output, with a Graphical User Interface in Python.

For the data acquisition part, one of the key step in this workflow is the acquisition procedure which is performed by a Python software controlling distantly the microscope. To cover a larger Region of Interest (ROI), a so-called "mosaïc" procedure has been implemented in a sandbox version of the program. A goal of the project is to merge this script into the main development branch of the acquisition software. One final goal will be to install the completed acquisition program on the C-TEC Constellium SEM, and the post-processing program to compute the statistics on the grains as well as the recrystallized fraction.

PostDoc role in the present offer

The hired postdoctoral fellow will be in charge of the experiments, post-treatments and code developments carried out in the framework of the project. She/He will interact with the different partners of the project (CONSTELLIUM and MATEIS laboratory mainly) to gather and synthesize the results.

Who are we looking for?

We are looking for a doctor in Materials Science, with a background in metallurgy or ceramics science, that has a practice in SEM or TEM. Coding knowledge in Python language is a pre-requisite for applying to the position.

Monthly pay : Net Salary : 2200 euros per month ; Duration : 12 months

References

[1] Lafond, C., Douillard, T., Cazottes, S., Steyer, P. & Langlois, C. (2018). **Electron CHanneling ORientation Determination (eCHORD): An original approach to crystalline orientation mapping.** *Ultramicroscopy*, 186, 146-149.

[2] Lafond, C., Douillard, T., Saad, H., Deville, S., Meille, S., Steyer, P., Cazotte, S. & Langlois, C. (2021). **eCHORD orientation mapping of bio-inspired alumina down to 1 kV**. *Materialia*, 20, 101207.