PhD student position open for October 2020

Experimental study of plastic strain localization in polycrystals
by electron microscopy-based techniques

Context: the project 3DiPolyPlast

Understanding the deformation processes leading to the failure of polycrystalline structural materials is one of the key challenges in materials science. Significant progress has been achieved over the past decades, thanks to both cutting-edge experimental characterization techniques and computational methods. Still, the localization of plasticity in slip bands and the propagation of plasticity through a polycrystalline aggregate are not fully understood. The investigation of such phenomena is the goal of the ANR project "3DiPolyPlast" started in 2020, for a period of 48 months.

The key objectives of this project are:

1. Pushing the frontier of experimental characterization of bulk plasticity
2. Determining the contribution of slip band/localization in plastic strain of individual grains
3. Identifying mechanisms governing the propagation of plastic strain in the polycrystal
4. Advancing image-based mesoscale modelling of crystal plasticity

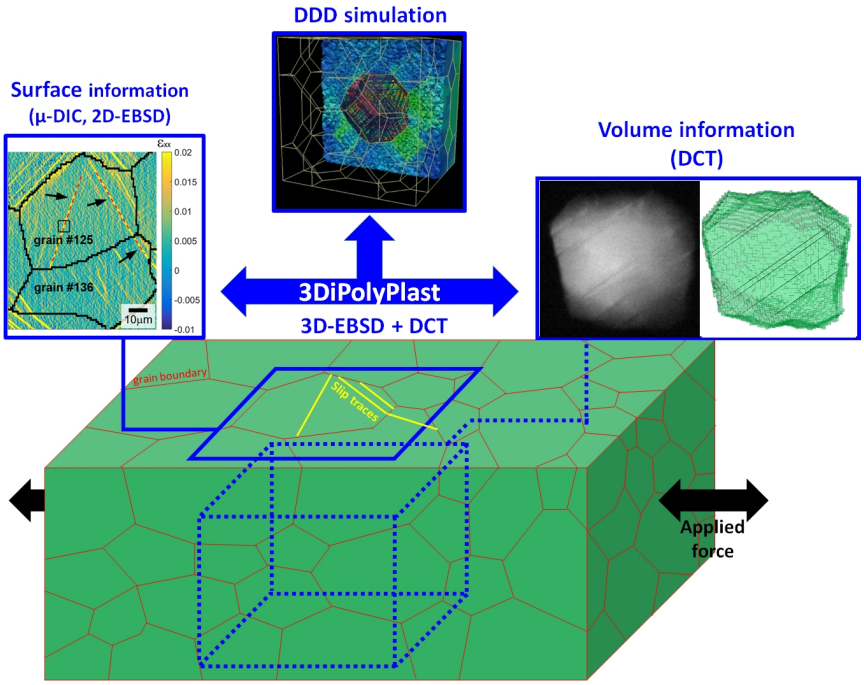

Figure 1: Schematic of the concept of the 3DiPolyPlast project, combining state-of-the-art experimental and simulation techniques into a multi-scale study of the plastic strain localization and propagation in a polycrystalline material.

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PhD project:

This open position will focus on objectives 1, 2 and 3 of the 3DiPolyPlast project, via **electron microscopy-based experimental techniques**. The PhD candidate will work in strong cooperation with two other PhD candidates located at other partners of the 3DiPolyPlast consortium (one at Mines ParisTech/ONERA in Paris and one at ESRF in Grenoble) and working on synchrotron-based characterizations and Discrete Dislocations (DD) simulations. In addition to the experiments performed at Institut Pprime, the PhD candidate will also participate to synchrotron experiments.

In details, the PhD candidate will develop and perform different type of studies:

- **in situ monotonic testing in the SEM, in combination with (HR-)EBSD** on regions of interest composed of ~100 grains. Automated procedures will be developed to acquire the data and extract rotation and strain fields showing the formation of slip bands. This will provide comprehensive evidence of the inelastic deformation mechanisms with very high resolution in a large number of grains while knowing the underlying microstructure entirely.
- from surface EBSD maps or preliminarily collected synchrotron-based 3D X-ray Diffraction Contrast Tomography (DCT) or Topo-Tomography (TT) data, specific grains showing plastic localization will be identified and studied with the highest resolution possible by **TEM**: for this, the FIB-based lift-out technique will be used to extract the TEM thin foils. The dislocations structures will then characterized by TEM.
- from surface EBSD maps or 3D DCT/TT data, specific aggregates will be identified and extracted by FIB milling. The **slice-and-view technique will be combined with EBSD** (and possibly HR-EBSD) to reconstruct the 3D volume in terms of grain boundaries arrangements and crystallographic orientations.

This experimental work will provide important complementary inputs to an improved and physically motivated description of crystal plasticity constitutive behaviour for polycrystalline materials.

Practical information:

Duration: 36 months, starting October 1st, 2020
Funding: ANR Project 3DiPolyPlast
Location: Institut Pprime, University of Poitiers, France
Web site: www.pprime.fr
Doctoral school: SIMME (Sciences et Ingénierie des Matériaux, Mécanique, Énergétique), https://www.u-ldevinci.fr/simme/fr/page-daccueil-ed-simme/

Expected profile: Master degree in mechanics of materials, materials science or physics

Application: motivation letter, CV, Master degree record, letter(s) of recommendation

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