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COMBINING DIFFRACTION MICROSTRUCTURE IMAGING AND FFT SIMULATIONS TO STUDY POLYCRYSTAL PLASTICITY

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ABSTRACT

Key mechanical properties are governed by the three dimensional arrangement of the material microstructure. Synchrotron (and to a lesser extent laboratory) X-ray based characterization methods now allows for non destructive analysis and in situ multi-modal, correlative measurements in microstructures containing thousands of grains. This has the potential to revolutionize material characterization, deformation and fracture mechanisms investigations, and constitutive behaviour identification at the grain scale. Yet, the 4D nature of the data make this intrinsically challenging [1].

In this work, we report our latest results on coupling non destructive Diffraction Microstructure Imaging (DMI) experiments with high fidelity crystal plasticity simulations to study plasticity at the scale of the grains. Commercially pure Ti samples were strained in situ at the synchrotron and followed by Diffraction Contrast Tomography and 3D X-ray diffraction [2] to capture plastic activity inside the grains (namely slip system activation and lattice rotation). EBSD analysis was also carried out on the sample surface before and after mechanical testing.

Image based FFT simulations (using Amitex FFTP) were carried out using the experimental microstructure. The Pymicro library¹ was leveraged to fuse all the data modality. It provide a convenient way to manipulate large multimodal polycrystalline data sets and allows to bring together experimental and simulation data mindlessly. The comparison between experimental and simulation data on a grain by grain basis provide important insight on materials parameter identification and deformation mechanisms.

REFERENCES

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¹<https://github.com/heprom/pymicro>