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# Coupling micro-compression testing and Laue micro-diffraction

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## Abstract

White-beam Laue micro-diffraction is a robust technique for probing the crystalline structure and orientation of materials, which, in particular, can highlight local crystalline deformations. Through detailed shape analysis of individual Laue spots, this method can also evidence the activation of specific slip systems (1). By tracking Laue diffraction spots over time, Laue micro-diffraction can also capture *in situ* structural changes such as phase transitions, making it highly suitable for *in situ* mechanical testing. In this communication, we will present two original studies based on the coupling between micro-compression testing, using a FT-NMT04 nanoindenter equipped with a diamond flat punch, and Laue micro-diffraction performed at BM32 ESRF synchrotron beamline.

The first investigation explores the TRansformation Induced Plasticity (TRIP) effect in ceria-doped zirconia single-crystalline micropillars with varied crystalline orientations (2). The TRIP effect in zirconia ceramics, which arises from the transformation from the tetragonal phase to the monoclinic phase under applied stress, is responsible for substantial plastic deformation, reaching up to 7%. Understanding this phase transformation is essential for advancing the development of 'ductile' ceramics. In this study, micro-pillar compression was conducted *in situ* during Laue micro-diffraction to investigate the effect of pillar orientation on the ease of phase transformation. The deformation pathways through various possible variants in the crystalline transformation between the tetragonal and monoclinic phases were compared with the crystallographic theory of martensitic transformation.

The second investigation focuses on plastic deformation in ferromagnetic intermetallic Heusler

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alloys (3). In these alloys, magnetic ordering is strongly influenced by local atomic environments and, consequently, by the introduction of plastic defects. Therefore, understanding how plasticity impacts the magnetic properties of these alloys requires a detailed analysis of plastic deformation mechanisms. In this study, the initial stages of plastic deformation in a MnCuAl Heusler alloy were examined. Laue diffraction patterns were recorded at multiple stages of deformation, providing insight into crystal orientation and defect formation. In particular, the distribution of crystallographic orientations following micro-compression was analyzed. The elongation of orientation distributions on the inverse pole figure in the deformed state, as well as elongated features in the Laue spots, indicated lattice rotations, from which specific slip systems were identified.

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