HIGH PRESSURE DEFORMATION STUDY OF ZIRCONIUM

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Abstract
In situ deformation studies of polycrystalline materials using diffraction are an established method to understand elastic and plastic deformation of materials. Parameters studied by diffraction are typically lattice strains and texture evolution, which in combination with the macroscopic flow curve allow improvements of predictive model. In situ uni-axial deformation at ambient conditions has been established over 10 years and in the last 5 years uni-axial deformation at temperatures above and below ambient have become routine. However, only few devices exist which allow deformation at high pressure and only a few investigations using these devices are reported in the literature. Here, we report results on a study of the uni-axial deformation of zirconium alloy (Zircaloy-2) at 2 and 5 GPa and ω-zirconium at the BM13 beamline at the Advanced Photon Source. The deformation-DIA apparatus generates a confining hydrostatic pressure using a cubic anvil setup. Two differential rams allow to increase (compressive) or decrease (tensile) the uni-axial loading in the vertical direction, resulting in plastic deformation at high pressures. The stress is measured from the lattice response while the macroscopic strain is measured using the beam line in radiography mode. In diffraction mode, diffraction of a monochromatic beam (λ=0.1901 Å) is detected using CCD detector. Deviations from Debye rings allow derivation of the lattice strains resulting from the uni-axial deformation. Intensity variations along the ring allow quantitative texture analysis. Both quantities are compared with our previous studies at ambient conditions for the same material. Our results indicate an increase in the twinning activity for the Zircaloy at elevated pressures whereas the ω-zirconium appears to deform by slip rather than twinning.

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Oral Presentation

Session suggestion: Synchrotrons: Macrobeam And High Energy Techniques

Not invited.

Yes, to be published in *Advances in X-Ray Analysis*.