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Sub-boundaries induced by dislocational creep in Uranium Dioxide analyzed by Advanced Diffraction and Channeling Electron Microscopy

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Abstract:

The network of sub-boundaries formed in a sintered UO₂ pellet after dislocational creep was examined. Very low angle boundaries, down to 0.1° were reliably detected by Electron BackScattered Diffraction (EBSD). This angular resolution was achieved by optimizing EBSD data collection and processing. Moreover, Accurate-Electron Channeling Contrast Imaging (Accurate-ECCI) was able to image the dislocations produced by creep, directly on the bulk sample. The dislocations were mostly organized in sub-boundaries with low energy configurations. Only a limited number of isolated dislocations were observed. Finally, the deformation substructure obtained after 8% creep deformation (at 1500°C under a 50 MPa uniaxial state) was quantified. The original grains with a mean size of 20 μm were in average fragmented in sub-grains of about 5 μm. The geometrically necessary dislocations density (GND) was evaluated from the filtered EBSD data to 7.9 x10¹² m⁻². This value was 10 times higher than that measured on the as-sintered sample. This confirms that the GND density calculation is sensitive to the dislocation increase after 8% deformation by creep.

Keywords: Uranium dioxide, Creep, EBSD, ECCI, Dislocation, Porous material.

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