The Androgynous Twins of Zinc

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Abstract

Zn is a hexagonal metal with a large c/a ratio under ambient conditions (c/a=1.856). Under ambient testing conditions, deformation is predominantly accommodated by basal slip and by {10-12} compression twinning. Increasing hydrostatic pressure drastically reduces the c/a ratio of Zn. As a consequence, the compression twin is predicted to become a tensile twin when c/a< $\sqrt{3}$ at P> 9 GPa.

In this work we strain-cycle a wire of pure Zn in the D-DIA deformation press under multiple superimposed hydrostatic pressures ranging between 3 and 17 GPa. Over this pressure range, the c/a ratio of Zn goes over the compressive-tensile transition. During deformation, the state of the sample is monitored in-situ through powder x-ray diffraction, allowing the extraction of texture and sample stress. Elasto-visco-plastic polycrystal simulations of the cyclic process allow us to interpret the experimental data and to elucidate the type and strength of the crystallographic deformation mechanisms.

The purpose of this work is to elucidate the active deformation modes as a function of pressure. Specifically: 1) to determine if detwinning is a possible mechanism at 3 GPa pressure when Zn is cycled in tension-compression; 2) to find out if at a pressure state where c/a_˜ $\sqrt{3}$ only basal slip is active or whether another slip mechanism operates, and which; 3) to find out whether {10-12} tensile twins are active in Zn when c/a< $\sqrt{3}$. This work will help to better constrain the effect of hydrostatic pressure on the plastic deformation of hcp metals.

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