Orientation dependence of dislocation transmission through twin-boundaries studied by in situ μLaue diffraction

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Motivation

Dislocation-twin boundary interaction is not entirely understood but gains attention due to the outstanding mechanical performance of nano-twinned materials. Here, we show µLaue compression experiments on a coherent Σ3 (111) twin. The samples are all tested in different crystallographic loading direction with the twin boundary being parallel to the loading direction.

Sample production

-TB production in Bridgman furnace
-Seed crystal A
-Seed crystal B
-Seed crystal B + Bi-crystal
-Size 1 cm
-etching: coarse 15V fine 2V
-radius at the tip ~ few µm
-no taper formation

Meso- & micro sample preparation
-electrochemical etching
-FIB milling
-etching: coarse 16 nA fine 600 pA
-radius at the tip ~ few µm

in situ µLaue compression

-Displacement control mode
-Strain rate 10^{-3} s^{-1}
-Engineering stress strain curve
-Straining analysis (pending)
-Crystallographic orientation
-Point to origin misorientation
-Peak width Estimate the GNDs density
-Straining analysis (pending)

Single crystals

-grain A
-flow stress @ 70MPa no hardening
-Stress-strain curve
-SEM after deformation
-IPF after deformation

-grain B
-primary slip system activated (single slip)
-large slip steps formed
-streaking only at top and bottom
-in the same direction due to instrumental constraints [1]
-no streaking in the center → low amount of GNDs

Samples containing a CTB

-Stress-strain curves
-SEM after deformation
-Laue spot evolution of CTB crystals during compression

1. [123]
-Flow stress comparable to Sxx
-no hardening observed
-only small change in misorientation (≤ 0.5 grad)
-peak shape stays circulaț → low amount of GNDs

2. [325]
-primary slip system activated (single slip)
-large slip steps
-slip steps meet at TB as observed by Imrich [2]

3. [112]
-peak shape stays unaffected during straining up to about 10% independently of the compression direction
-unsolvable low amount of GNDs
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Conclusions

-Strain-strain behavior, occurrence of the large slip steps and diffraction peak shape during deformation show "single crystal" like behavior
-For all orientations the CTB does not occur as a obstacle for dislocation movement

References


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