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Structure and Nanomechanics
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Nano-/Micromechanics of Materials
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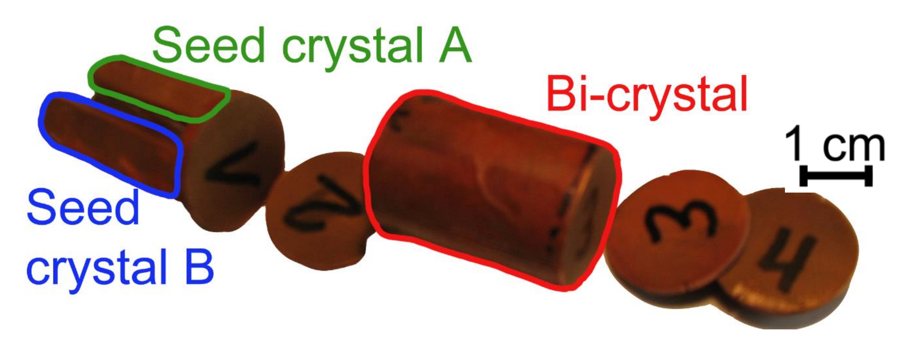
Motivation

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

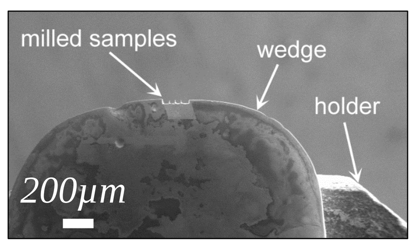
TB production in Bridgman furnace



- material: **copper**
- using graphite crucible
- growth rate 10 mm/hour

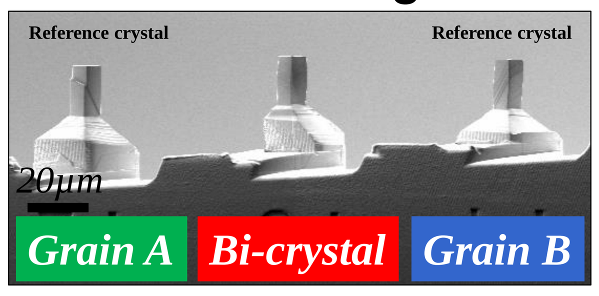
Meso- & micro sample preparation

electrochemical etching



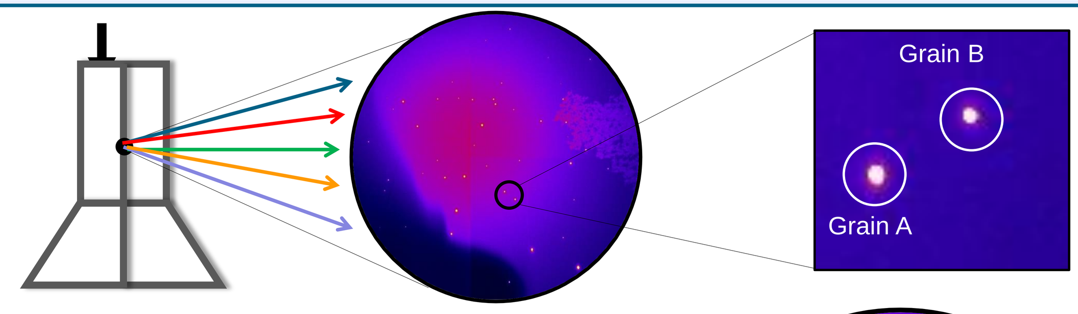
- etching: coarse 15V; fine 2V
- radius at the tip ~ few µm

FIB milling



- milling: coarse 16 nA; fine 600 pA
- 5 µm
- no taper formation

in situ µLaue compression



- displacement control mode
- strain rate $10^{-3}\frac{1}{s}$

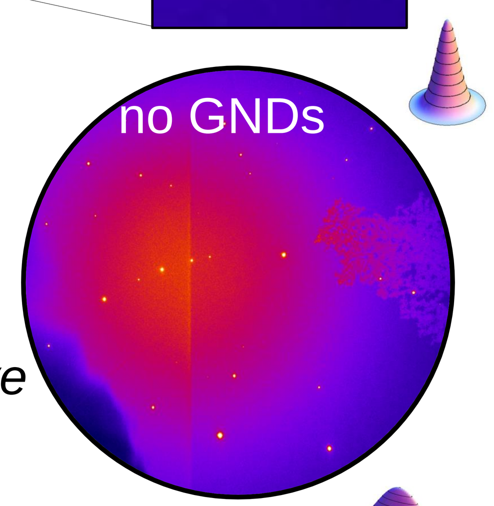
Engineering stress strain curve

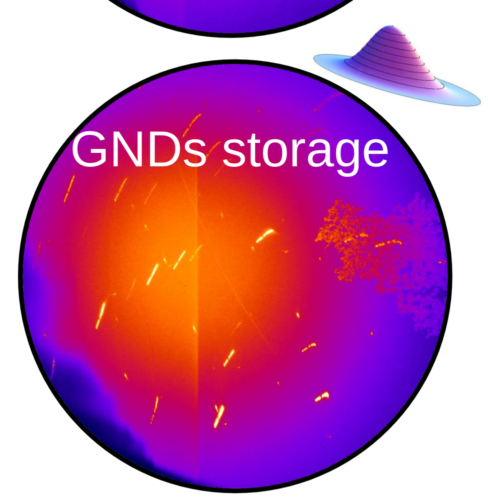
- crystallographic orientation

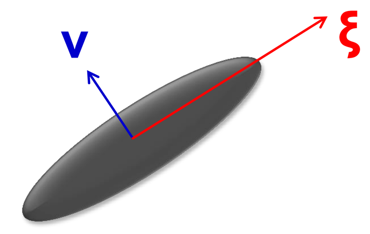
Point to origin misorientation

- *Peak width*

Estimate the GNDs density



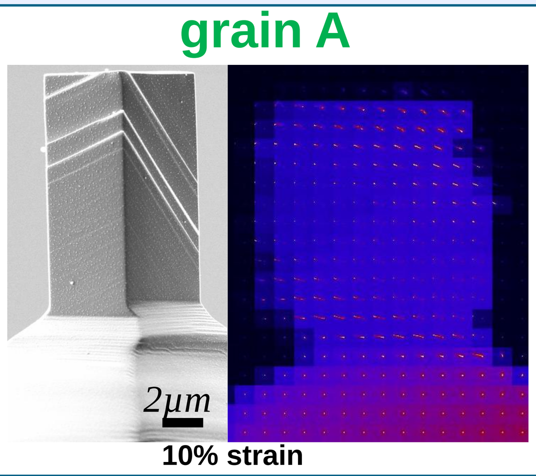


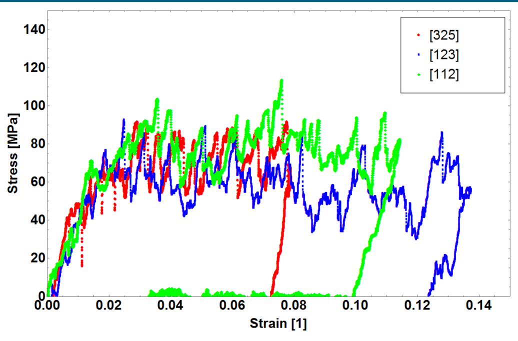


- *Streaking analysis (pending)*

Single crystals

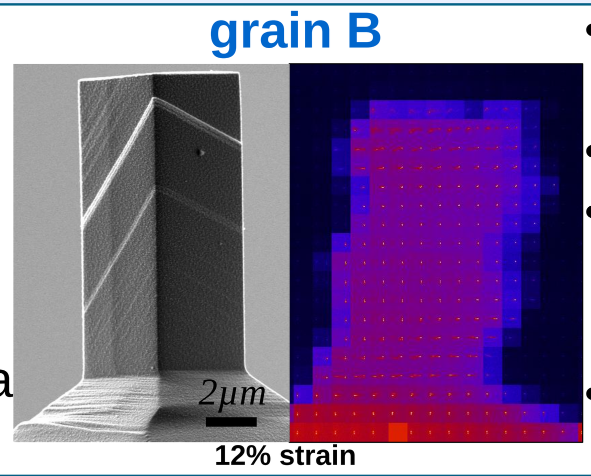
grain A





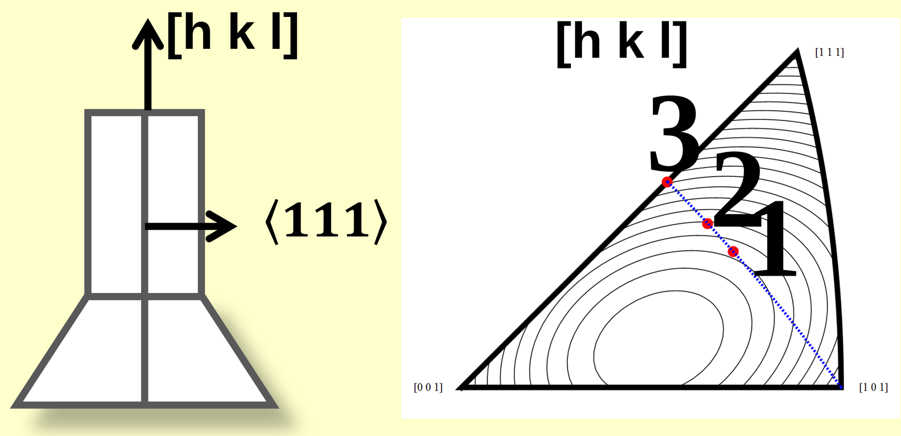
- flow stress @ 70MPa
- no hardening

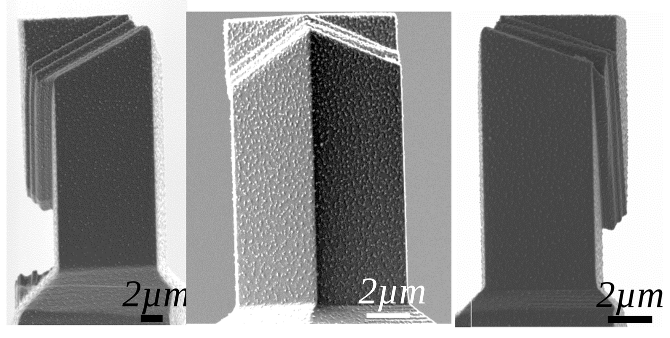
grain B



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

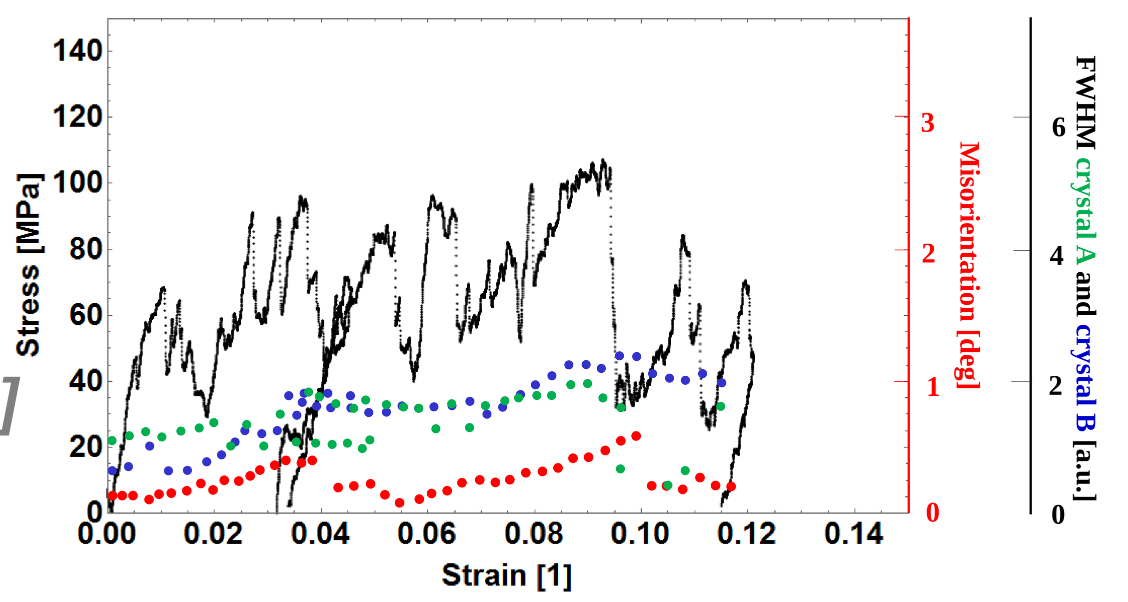
Samples containing a CTB

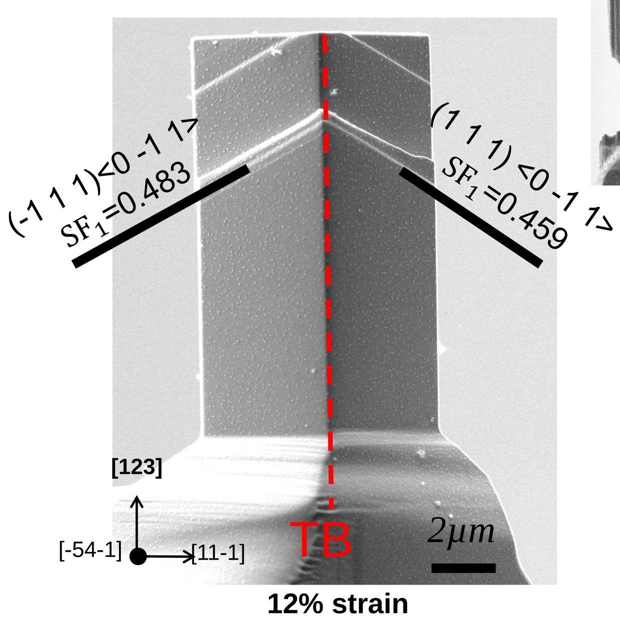


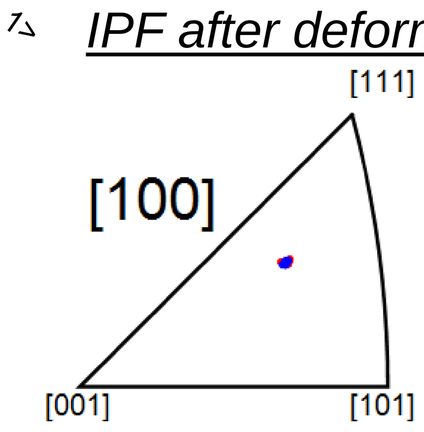


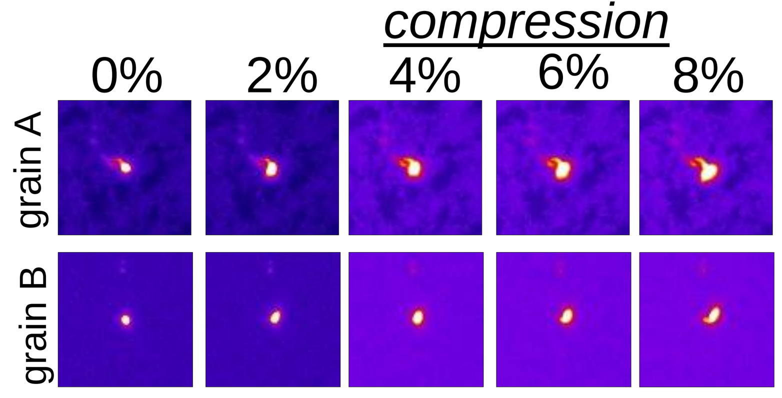
Stress-Strain Curves   *SEM after deformation*   *IPF after deformation*   *Laue spot evolution of CTB crystals during compression*

1. [123]

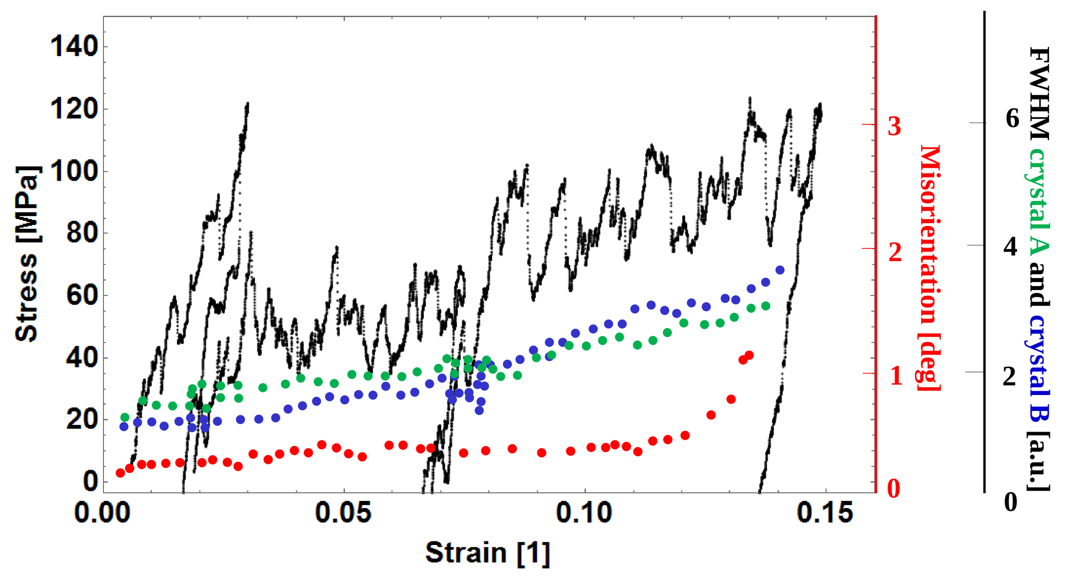


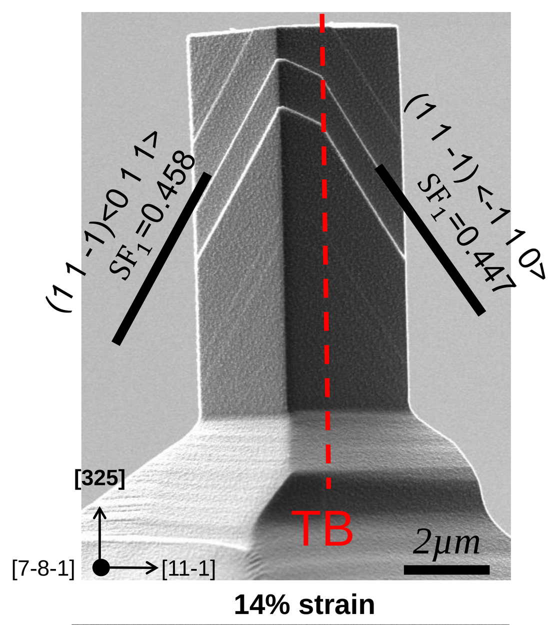


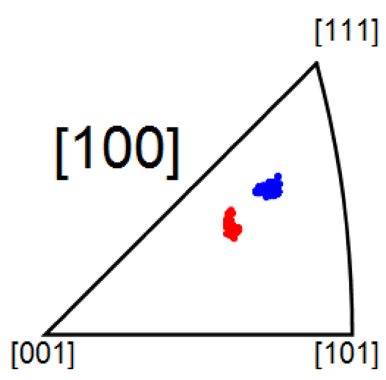


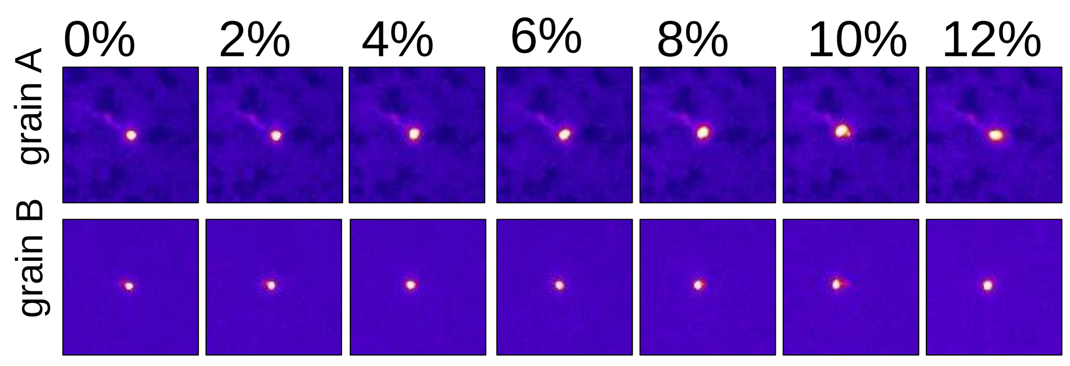


2. [325]

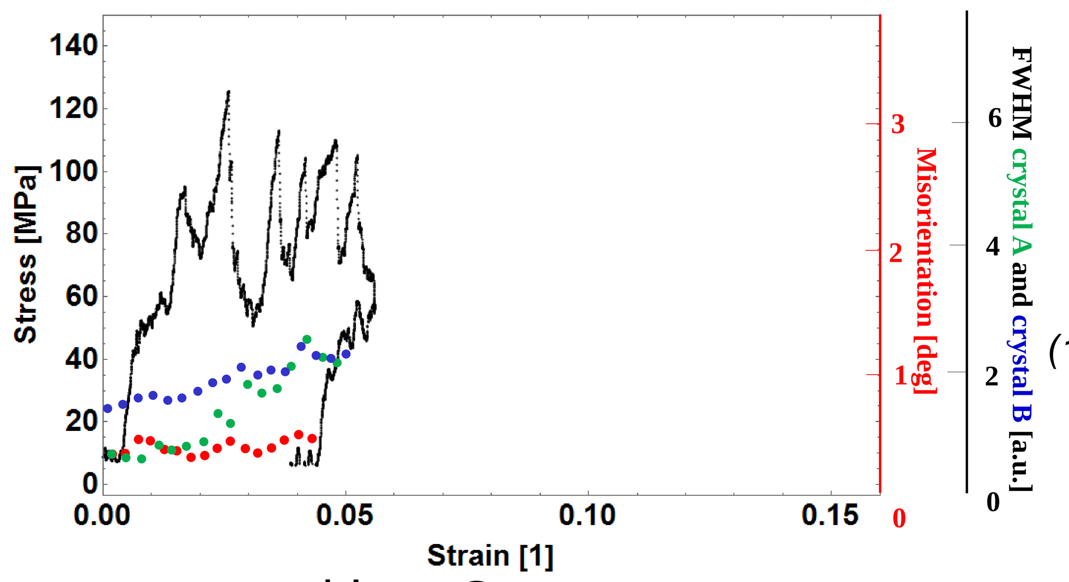


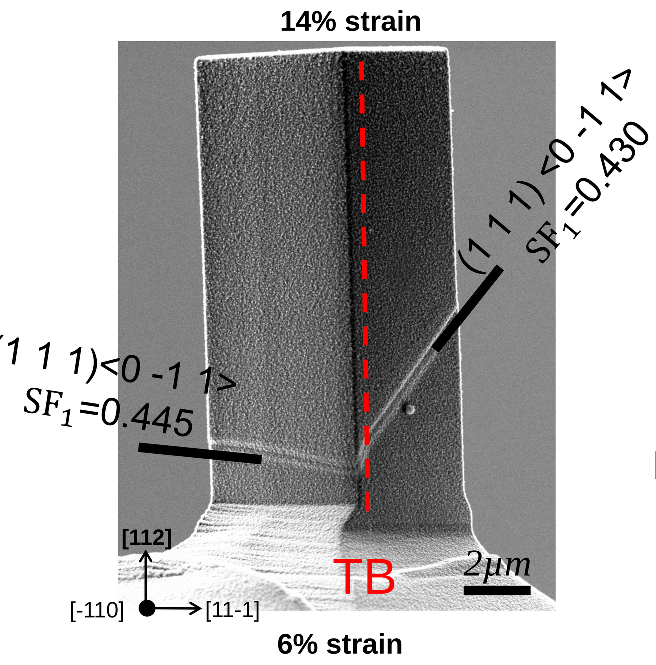


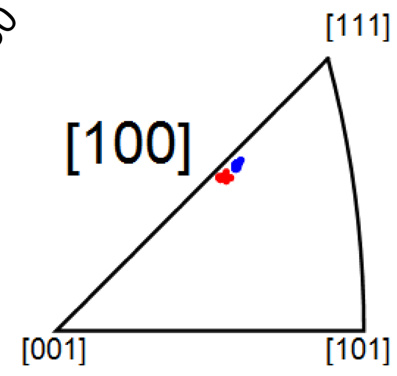


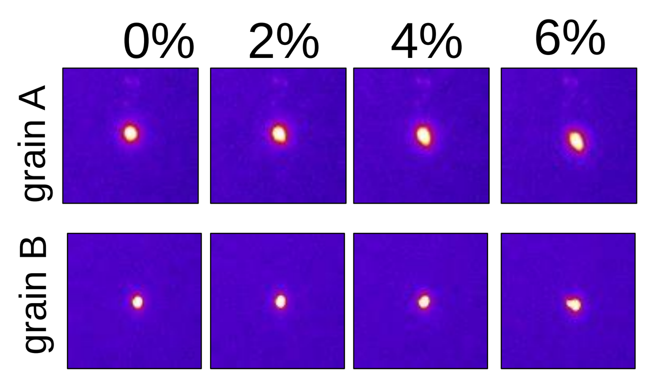


3. [112]









- flow stress comparable to Sxx
- no hardening observed
- only small change in misorientation (≤ 0.5 grad) below 10% strain
- peak shape stays circulat → **low amount of GNDs**

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

- peak shape stays unaffected during straining up to about 10% independently of the compression direction
- **unresolvable low amount of GNDs**
- **"single crystal" like behavior**

Conclusions

- Stress-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

[1] Kirchlechner at all Acta Materialia 59, 2011
[2] Imrich at all, Acta Materialia 73, 2014

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