Experimental Investigation of Plastic Grain Interaction

M. Sachtleber, Z. Zhao, D. Raabe

Max-Planck-Institut für Eisenforschung
Max-Planck-Str. 1, 40237 Düsseldorf, Germany, sachtleber@mpie.de
99.9% Al
- Columnar grain morphology (quasi 2D)
- Grain diameter $d = 3.5$ mm
- OM scan step size 100$\mu$m

- grain boundaries $> 15^\circ$
- grain boundaries $> 5^\circ$
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VON MISES STRAIN
bilinear element, 4 nodes, 4 integration points
5705 elements
12 slip systems \{111\}<110> & visopastic hardening

fully implicit time-integration crystal plasticity method
[Kalidindi et. al.]
Continuum FEM Simulation

Crystal Plasticity FEM Simulation

$\mu = 0.0$

$\mu = 0.1$

$\mu = 0.2$

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CONTINUUM AND CRYSTAL PLASTICITY SOLUTIONS
Experimental Strain Mapping

Continuum FEM Simulation ($\mu = 0.2$)

Crystal Plasticity FEM Simulation ($\mu = 0.1$)

Crystal Plasticity FEM Simulation ($\mu = 0.2$)
COMPARISON OF FEM AND CPFEM

Continuum FEM Simulation

Cristal Plasticity FEM Simulation

von Mises strain

8% height reduction

\( \mu = 0.2 \)
Heterogeneity in accumulated plastic strain (90% from mean)

Grain scale heterogeneity is determined by two factors:

1. Macroscopic boundary conditions (geometry, friction)

2. Local crystal kinematics

“Micromechanical and macromechanical effect in grain scale polycrystal plasticity experimentation and simulation”,