







Discontinuous deformation of FCC high and medium entropy alloys at close to 0 K

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Goals



To understand discontinuous deformation at close 0 K

- Deformation mechanisms
- Serration characteristics





A. S. Tirunilai et al., Journal of Materials Research, Volume 33, 2018, (3287-3300)

Possible causes



TWIP and/or TRIPSingle crystals

Mechanical origin

Karlsruhe Institute of Technology



V.V Pustovalov, Low temperature Physics, Volume 34, 2008, (683-723)

Thermomechanical origin invalidation

No effect from cooling medium

No effect from sample dimensions





Possible causes



Thermomechanical origin
 Localized thermal softening

TWIP and/or TRIPSingle crystals

Mechanical origin

V.V Pustovalov, Low temperature Physics, Volume 34, 2008, (683-723)



TWIP invalidation



Deformation is severely serrated

A. S. Tirunilai et al., Materials Science and Engineering A, Volume 783, 2020 , (art. no. 139290)

TRIP invalidation





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7 21.04.2021 Discontinuous deformation of FCC high and medium entropy alloys at close to 0 K

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Mechanical origin





Dislocations pile-up \rightarrow Stress rise

Mechanical origin

- LC lock formation rate
- Cross-slip energy
- Dislocation mobility
- Dislocation pile-up characteristics

Lower temperature is favorable for dislocation pile-ups and unfavorable for cross-slip

Z. Pu et al., Philosophical Magazine, Volume 101, Issue 2, 2020, (154-178)
A. S. Tirunilai et al., Acta Materialia, Volume 200, 2020, (980-991)
S. Huang et al., Scripta Materialia, Volume 108, 2015, (44-47)
M.S Duesbery et al., Acta Metallurgica et Materialia, Volume 40, Issue 1, 1992, (149-158)





Serration behavior at different temperatures



- Higher temperature \rightarrow continuous deformation (cross-slip possible)
- Lower temperature \rightarrow cross-slip restricted \rightarrow serrated deformation
- Even lower temperatures \rightarrow cross-slip more difficult \rightarrow serrations intensify



Microstructural correlations

- Lower SFE does not imply more intense serrations
- Serrations are indicative of planarity of slip
- Serration trends are indicative of microstructural features like microbands

N. L. Okamoto et al., Scientific reports 6, 2016, (Article no. 35863) G. Laplanche et al., Acta Materialia, Volume 128, 2017, (292-303)







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13 21.04.2021 Discontinuous deformation of FCC high and medium entropy alloys at close to 0 K