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Sources:
Outline

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- Experimental setup & measurements
- Results
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Motivation for the paper

- More detailed study of the behavior of low stacking fault energy (SFE) FCC metals (SFE < 20 mJ/m²) that was observed in a previous paper.
- Study the effect of grain size on deformation twinning in FCC metals.
Low SFE FCC metals exhibited a four stage strain hardening behavior

\((\sigma - \sigma_0)/G\) used as a measure of dislocation density
Previous Results

- Twin initiation occurred at approximately the same value for two materials (MP35N and 70/30 brass) with different stacking fault energies.

- Noted in other studies that the twin initiation stress decreases with increasing grain size.
Assertions

Two microstructual variables that influence twinning stress are:

- **Dislocation density** → Some critical dislocation density required for twin initiation at onset of Stage B and twin-twin interactions at onset of Stage D.
- **Homogeneous slip length** → Region of a grain where there is homogeneity of slip (characterized by parallel slip markings in the grain)
- **Criterion for twin initiation in low SFE polycrystalline FCC metals:**

\[
\frac{(\sigma_{tw} - \sigma_0)}{G} = C \left( \frac{d}{b} \right)^A
\]

C = 0.0004 & A = -0.89
Historic View of the Problem

- Venables (1964) model suggests parabolic relation between stress and SFE.
- Problem: Alloys used different solute concentrations → different solid solution strengthening for each
- Author’s claim: Using \((\sigma - \sigma_0)/G\) accounts for different solid solution strengthening
Experimental Reasoning

- Decouple the effects of grain size and stacking fault energy to study individual effects.
- For SFE effects: For nearly constant grain size, use compression test data and microscopy studies to determine SFE influence on twinning.
- For grain size effects: Use compression test data (for a single SFE material) of a range of grain sizes.
Experimental Procedures & Results

- Room temperature compression tests
- Strain rate: 0.001 s\(^{-1}\)
- Sample size: 7-10 mm diameter, 10-15 mm long
- Strain hardening computed from data expressed in Figure 2

Fig. 2—True stress–true strain curves measured in simple compression for fcc metals with average grain sizes in the range of 30 to 40 μm.
Results--Effects of SFE

- Low SFE metals exhibit 4-stage strain hardening behavior
- Graph shows evidence of a critical dislocation density at 0.003 and at 0.013
Results--Effects of Grain Size

- Grain size does contribute to the strain hardening behavior
- Indicates twin initiation stress is less for coarse grain materials
- Curves similar for other materials
Discussion

- Homogenous slip length determined by studying homogenous deformation zones (HDZ) length
Increasing stain decreases the HDZ length.

This decrease in HDZ for low SFE is relatively small.

Authors attribute deformation twinning in low SFE FCC metals to the small change in HDZ.
Criterion for Twinning

- For small change in slip length, large change in strain hardening $\rightarrow$ twinning.
- Line serves as dividing regions where twinning will occur.
Conclusions

- Low SFE polycrystalline FCC metals exhibit a 4-stage strain hardening.
- Critical dislocation density is required for nucleation of deformation twins.
- Dislocation density and average homogeneous slip are the microstructural variables controlling deformation twinning.
- Twining is indirectly affected by low SFE→ promotes strain hardening and reduces grain breakup.