3.40 Sept 30th Lecture Highlights

- Cross-slip
- Applied stress:
  - Stress axis & slip systems
- Dislocation Locking Interactions
  - Intersections
  - Combinations
- Partial Dislocations
Cross-slip

- Overcome an obstacle in primary slip plane
  - Screw dislocation: no uniquely defined slip plane
  - Transfer to intersecting slip plane with same \( \mathbf{b} \)
  - Returns to initial slip plane (double cross slip)
  - Conservative: length of dislocation line unchanged

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W. Hosford. Mechanical behavior of materials. Cambridge. 2005

Courtesy of Krystyn Van Vliet. Used with permission.

Please also see Fig. 10.8 in Hosford, William F. Mechanical Behavior of Materials. New York, NY: Cambridge University Press, 2005.

S Baker. MS&E 402 course notes 2006. Cornell University

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Effects of Stress

Reorientation of stress axis

- Tension: \( s \) towards slip direction \( b \)
- Compression: \( s \) towards slip plane \( n \)

Changes Schmid factors:
Activates new slip systems

FCC \(<110>\{111\} \) slip system
Tension applied

T. Courtney. Mechanical behavior of materials. 2000

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Please see Fig. 5.31 in Reed-Hill and Abbaschian, Physical Metallurgy Principles. Boston, MA: PWS Publishing, 1994.
Dislocation Intersections

• Dislocation acquires a step
  • Equal in direction and magnitude to intersecting dislocations burgers vector
    • Exception: $b \parallel$ dislocation line: Nothing happens
  • May have different character and glide plane than original dislocation

http://www.bss.phy.cam.ac.uk/~amd3/teaching/A_Donald/Crystalline_solids_2.htm

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Steps in Dislocations

- Edge dislocations
- Step normal to slip plane
- Changes glide plane
- Pinning point (glissile)
- Step in slip plane
- Constant glide plane
- Mobile (sessile)

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http://www.tf.uni-kiel.de/matwis/amat/def_en/index.html
Steps in Dislocations - Visual

Screw Dislocation:
- Kink
- Jog

Edge Dislocation:
- Kink
- Jog

Figure by MIT OpenCourseWare

web.nchu.edu.tw/~jyuan/handout/3_3%20Dislocation.pdf

Courtesy of A. M. Donald. Used with permission.
Lomer Lock: Combination

- 2 Dislocations on primary slip planes combine
  \[
  \frac{a^2}{2} + \frac{a^2}{2} > \frac{a^2}{2}
  \]

- new dislocation:
  - \textbf{b} primary slip direction
  - \textbf{n} non-primary slip plane

- Dislocation becomes immobile “locked”

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Partial Dislocations

Partial dislocation

Single dislocation $\rightarrow$ 2 partials & stacking fault

$E_{\text{disloc}} \approx \mu b^2/2$

$\frac{E_{\text{partials}}}{E_{\text{Perfect}}} = \frac{a^2/6 + a^2/6}{2} = \frac{2}{3}$

Courtesy of Sam Allen and Krystyn Van Vliet. Used with permission.

Please also see Fig. 9.20 and 9.25 in Hosford, William F. *Mechanical Behavior of Materials*. New York, NY: Cambridge University Press, 2005.

Partial Dislocations

Dislocations repel
Stacking fault resists

- Stacking Fault Energy $\gamma_{SF}$ (mJ/m$^2$)
- Ag: 22   Cu: 78   Ni: 128
- Low $\gamma_{SF} = $ large separation
- Hinders partial recombination
  - Limits cross-slip
  - Easier work hardening

Partial dislocation

$\gamma_{SF} \Delta x \propto \frac{\mu b^2}{\gamma_{SF}}$

$\tau = \frac{\mu b}{2\pi}\Delta x (screw) \frac{\mu b}{2\pi(1-\nu)\Delta x} (edge)$

Courtesy of Sam Allen and Krystyn Van Vliet. Used with permission.
Please also see Fig. 9.25 in Hosford, William F. Mechanical Behavior of Materials.

A. Putnis. Introduction to mineral sciences. Cambridge Univ. Press. 1992
Thompson’s Tetrahedron

- Notation for all slip planes, directions, and partials.
  - Example: FCC
- Triangles are slip planes
  - \{111\}
- Edges are slip directions
  - \langle110\rangle
- Blue arrows:
  - Partial dislocations

http://www.tf.uni-kiel.de/matwis/amat/def_en/kap_5/illustr/i5_4_5.html
Thompson’s Tetrahedron

- Example:
- Triang
- Edges:
- Blue area:
- Part

http://www.tf.uni-kiel.de/matwis/amat/def_en/kap_5/illustr/i5_4_5.html

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Questions?

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Please see Cham, Jorge. "Unemployment vs. Graduate Stipends."
Piled Higher & Deeper, August 21, 2009.
View from below
Glide plane

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Please see Fig. 5.8b in Hull, D., and D. J. Bacon.

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