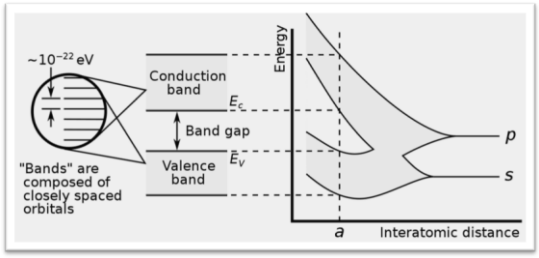
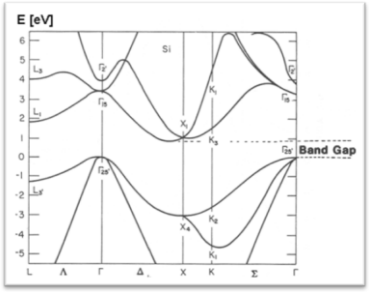
- https://www.koreatech.ac.kr/kor/Main.do

What is semiconductor?

Bandgap



E-k diagram



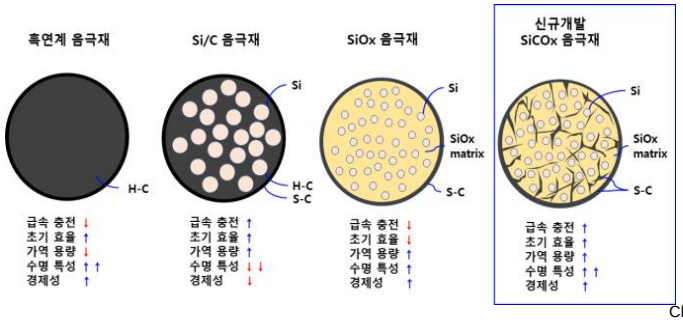
기술 개발 내용 (음극 소재 개발)

◦ SiOx계 음극소재 개발

(1) SiOx 매트릭스의 일부를 소프트 카본으로 치환하여 율속특성과 초기효율을 향상시키고,

(2) 카본의 균일분산을 통해 부피팽창을 저감하여 수명특성을 향상시키며, 고가의 CVD공정을 탈피하여

(3) 저가 탄소 전구체와 나노탄소물질을 함께코팅/탄화함으로써 충전속도와 수명특성을 향상



COURSE SCHEDULE

	Topics
1	General Intro, Atomic bonding
2	Structures of Metals & Ceramics 1
3	Quantum mechanics
4	Hydrogen atom
5	Electronic structure of atoms
6	Hydride bonding
7	**Wave function of crystals**

Materials Science & Engineering

Course Objective...

Introduce fundamental concepts in Materials Science & Engineering

You will learn about:

- material structures
- how structure dictates properties
- how processing can change structure

This course will help you to:

- use materials properly
- realize new design opportunities with materials

COURSE MATERIALS (with text)

Required text:

- *Fundamentals of Materials Science and Engineering,* W.D. Callister, Jr. and D.G. Rethwisch, 5th edition, Wiley

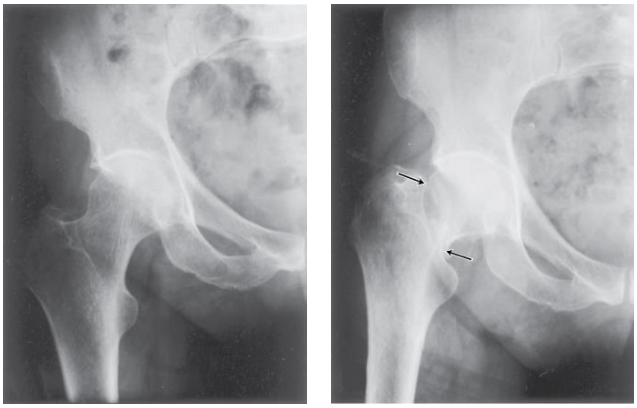
Chapter 1 - Introduction

- What is materials science?
- Why should we know about it?

- Materials drive our society
  - Stone Age
  - Bronze Age
  - Iron Age
  - Now?
    - Silicon Age?
    - Polymer Age?

Example – Hip Implant

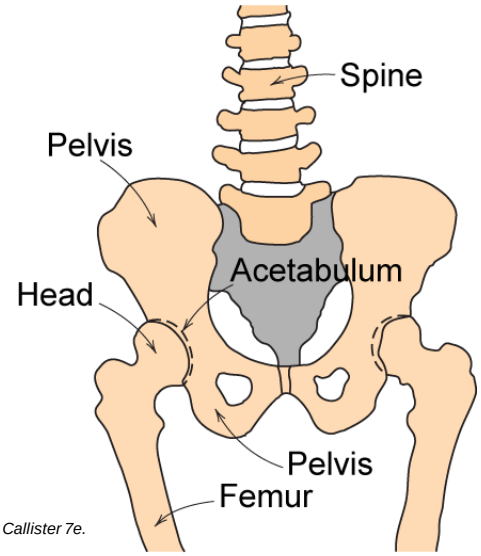
- With age or certain illnesses joints deteriorate. Particularly those with large loads (such as hip).



Adapted from Fig. 22.25, *Callister 7e.*

Example – Hip Implant

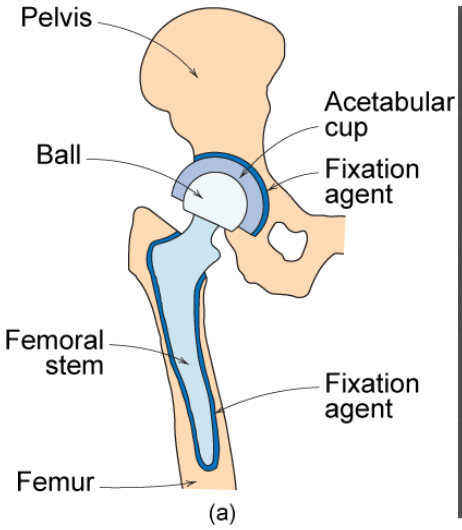
- Requirements
  - mechanical strength (many cycles)
  - good lubricity
  - biocompatibility



Adapted from Fig. 22.24, *Callister 7e.*

Pelvis: 골반
Acetabulum: 관골구
Femur: 대퇴골

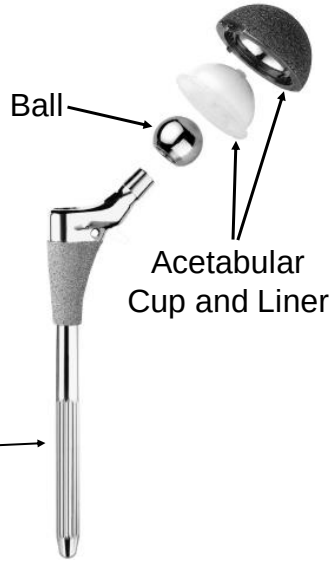
Example – Hip Implant



Adapted from Fig. 22.26, *Callister 7e.*

Hip Implant

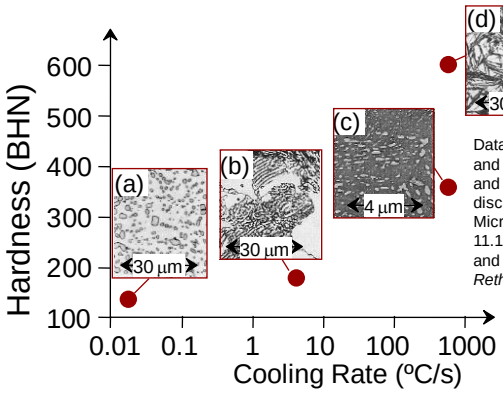
- Key problems to overcome
  - fixation agent to hold acetabular cup
  - cup lubrication material
  - femoral stem – fixing agent
  - must avoid any debris in cup



Adapted from chapter-opening photograph, Chapter 22, *Callister 7e.*

Structure, Processing, & Properties

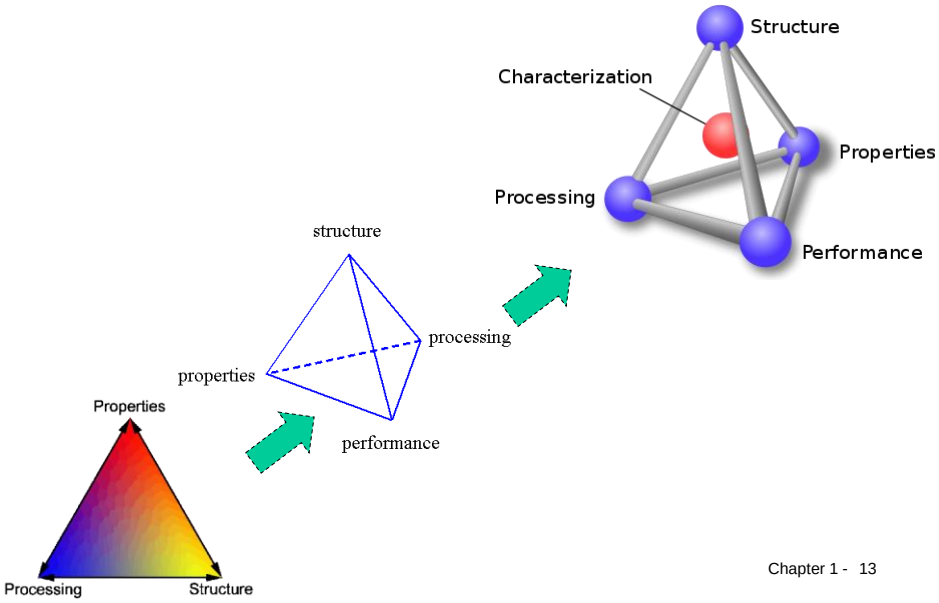
- Properties depend on structure
  ex: hardness vs structure of steel



Data obtained from Figs. 11.31(a) and 11.33 with 4 wt% C composition, and from Fig. 14.8 and associated discussion, *Callister & Rethwisch 4e*. Micrographs adapted from (a) Fig. 11.19; (b) Fig. 10.34;(c) Fig. 11.34; and (d) Fig. 11.22, *Callister & Rethwisch 4e*.

- Structure can be changed by processing
  ex: structure vs cooling rate of steel

Structure, Processing, & Properties



Types of Materials

- Metals:
  - Strong, ductile
  - High thermal & electrical conductivity
  - Opaque, reflective.
- Polymers/plastics: Covalent bonding → sharing of e's
  - Soft, ductile, low strength, low density
  - Thermal & electrical insulators
  - Optically translucent or transparent.
- Ceramics: ionic bonding (refractory) – compounds of metallic & non-metallic elements (oxides, carbides, nitrides, sulfides)
  - Brittle, glassy, elastic
  - Non-conducting (insulators)

The Materials Selection Process

1. Pick Application ⟶ Determine required Properties

   Properties: mechanical, electrical, thermal, magnetic, optical, deteriorative.

2. Properties ⟶ Identify candidate Material(s)

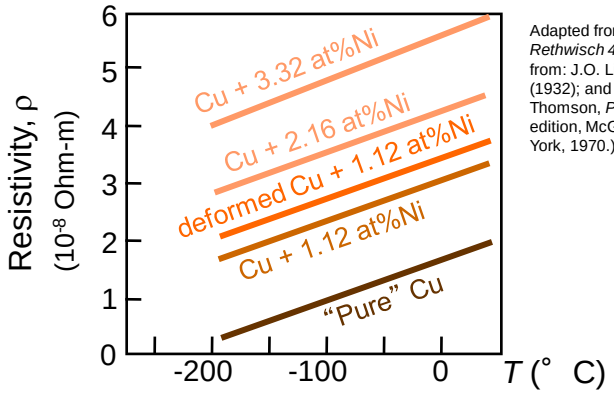
   Material: structure, composition.

3. Material ⟶ Identify required Processing

   Processing: changes *structure* and overall *shape*
   ex: casting, sintering, vapor deposition, doping
   forming, joining, annealing.

ELECTRICAL

- Electrical Resistivity of Copper:

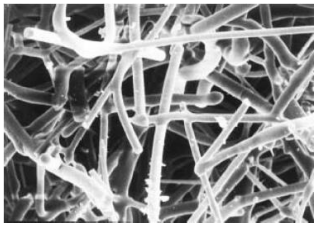


Adapted from Fig. 12.8, *Callister & Rethwisch 4e.* (Fig. 12.8 adapted from: J.O. Linde, *Ann Physik* **5**, 219 (1932); and C.A. Wert and R.M. Thomson, *Physics of Solids*, 2nd edition, McGraw-Hill Company, New York, 1970.)

- Adding "impurity" atoms to Cu increases resistivity.
- Deforming Cu increases resistivity.

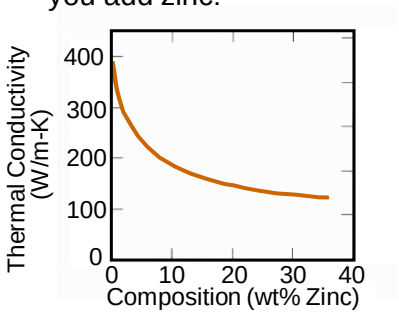
THERMAL

- Space Shuttle Tiles:
  -- Silica fiber insulation offers low heat conduction.



Adapted from Fig. 19.4W, *Callister 6e.* (Courtesy of Lockheed Aerospace Ceramics Systems, Sunnyvale, CA) (Note: "W" denotes fig. is on CD-ROM.)

- Thermal Conductivity of Copper:
  -- It decreases when you add zinc!



Adapted from Fig. 17.4, *Callister & Rethwisch 4e.* (Fig. 17.4 is adapted from *Metals Handbook: Properties and Selection: Nonferrous alloys and Pure Metals*, Vol. 2, 9th ed., H. Baker, (Managing Editor), American Society for Metals, 1979, p. 315.)

MAGNETIC

- Magnetic Storage:
  -- Recording medium is magnetized by recording head.

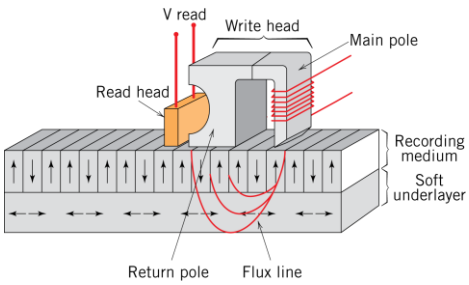
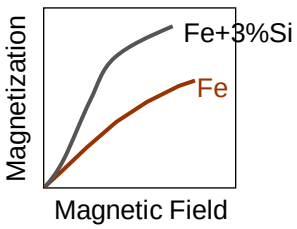


Fig. 18.23, *Callister & Rethwisch 4e.*

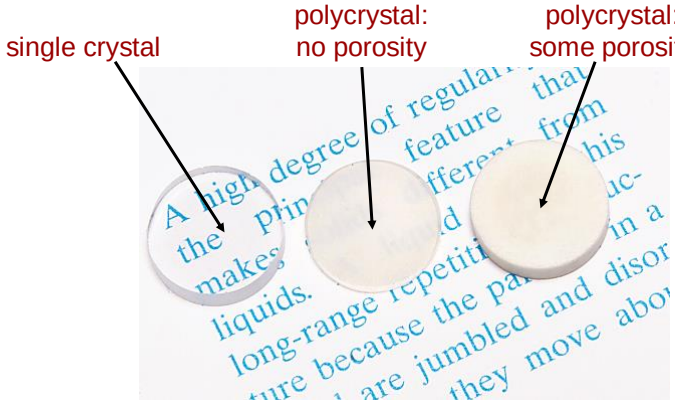
- Magnetic Permeability vs. Composition:
  -- Adding 3 atomic % Si makes Fe a better recording medium!



Adapted from C.R. Barrett, W.D. Nix, and A.S. Tetelman, *The Principles of Engineering Materials*, Fig. 1-7(a), p. 9, 1973. Electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, New Jersey.

OPTICAL

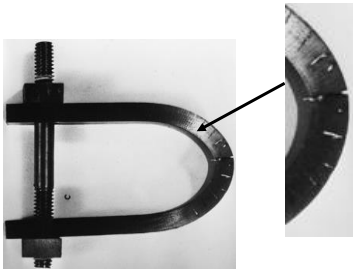
- Transmittance:
  -- Aluminum oxide may be transparent, translucent, or opaque depending on the material's structure (i.e., single crystal vs. polycrystal, and degree of porosity).



Adapted from Fig. 1.2, *Callister & Rethwisch 4e.* (Specimen preparation, P.A. Lessing; photo by S. Tanner.)

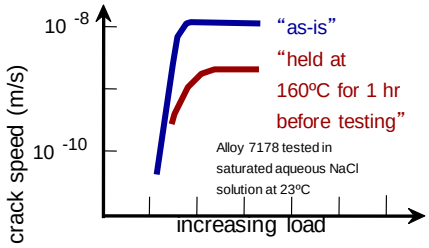
DETERIORATIVE

- Stress & Saltwater...
  -- causes cracks!



Adapted from Fig. 16.21, *Callister & Rethwisch 4e.* (from *Marine Corrosion, Causes, and Prevention*, John Wiley and Sons, Inc., 1975.)

- Heat treatment: slows crack speed in salt water!



Adapted from Fig. 11.20(b), R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials" (4th ed.), p. 505, John Wiley and Sons, 1996. (Original source: Markus O. Speidel, Brown Boveri Co.)

SUMMARY

Course Goals:

- Use the right material for the job.
- Understand the relation between properties, structure, and processing.
- Recognize new design opportunities offered by materials selection.

Select one of the following modern items and determines its specific properties, materials, processes.

- **Cell phone**
- **Digital camera batteries**
- **Cell phone display**
- **Solar cells**
- **Wind turbine blades**
- **Automobile bodies**
- **Sports equipment**