

**EMA 3010 – Introduction to Materials
Fall 2003**

MWF, Period 5 (11:45am-12:35pm)

Class room: MCCA G186

Instructor:

Dr. Fereshteh Ebrahimi

Materials Science and Engineering Department

180 Rhines Hall

Tel #: 846-3791

Email: febra@mse.ufl.edu

Office Hours:

Mondays and Thursdays

from 2pm to 4pm

(or by appointment)

Teaching Assistant:

Ms. Nichole Whitney

Materials Science and Engineering Department

165 Rhines Hall

Tel #: 846-3323

or 846-3794 (during the office hours)

Email: nwhitney@ufl.edu

Office Hours:

Wednesdays and Fridays

from 2pm to 4pm

Text Book:

Materials Science and Engineering: An Introduction, W. D. Callister, Jr., **6th Edition**, John Wiley and Sons, 2003.

Conduct

- Correct behavior in class is always important but even more so in a large class such as this. **Making noise, talking, reading the paper, leaving your cell phone on, leaving early or arriving late can be very distracting.** If your cell phone rings during class it will be confiscated for the remainder of the class period.
- Attendance in class is important. Material covered in class will follow the book closely in some areas and will deviate from them in others. **Those not in class for any reason are responsible for the material covered and the homework assigned.**
- Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

Assignments

Homework

There will be a total of six homework assignments. Each homework is due a week after it has been assigned. The homework should be handed to the TA in the beginning of the class. **No late homework will be accepted!** The average homework grade will be based on the best five homework grades (the worst grade will be dropped).

Group Projects

There will be a total of three group projects. On the first day of the class you will be assigned into a group. The group listing will also be announced on the WebCT. The only way to change your group assignment is to find a person in your desired group who is willing to switch place with you. Such a change should be brought to the attention of your TA. Every member will evaluate the participation of the other members in her/his group for each project. This evaluation will be confidential. If a person receives more than three negative evaluations by her/his group members, she/he will not receive only 50% of the grade. For more than five negative evaluations, the person will receive 0% of the grade.

Exams

There are four examinations. The dates and the percent grade for each exam are given below. The place of examinations will be determined at a later date.

| | | |
|---------------|---------------------------------------|-------------|
| Exam 1 | Monday, September 22nd, 7:00pm-9:00pm | 25% |
| Exam 2 | Monday, October 20th, 7:00pm-9:00pm | 30% |
| Exam 3 | Wednesday, Nov.19th, 7:00pm-9:00pm | 30% |
| Exam 4 | Thursday December 18, 3pm-5pm | 15% |
| | | ----- |
| | Total | 100% |

Grades

| | |
|----------------|-------|
| Homework | 15% |
| Group Projects | 10% |
| Exams | 75% |
| | ----- |
| Total | 100% |

Letter grades will be assigned as follows:

90 = A; 85-89 = B+; 80-84 = B; 75-79 = C+; 70-74 = C; 65-69 = D+; 60-64 = D; 59 = E

There will be **no curving** of grades!

Objectives

The objectives of this course are:

- To learn the atomic, molecular, crystal, nano-, micro- and macro-structure of various materials.
- To become familiar with the mechanical and physical properties of materials and their relationship with the structure of materials.
- To gain knowledge of the fabrication techniques and applications of materials.

Structure of Materials

Materials are...

engineered structures...not blackboxes!

Structure...has many dimensions...

| Structural feature | Dimension (m) |
|--------------------------|---------------------|
| atomic bonding | $< 10^{-10}$ |
| missing/extra atoms | 10^{-10} |
| crystals (ordered atoms) | $10^{-8} - 10^{-1}$ |
| second phase particles | $10^{-8} - 10^{-4}$ |
| crystal texturing | $> 10^{-6}$ |

The Materials Selection Process

1. Pick **Application** → Determine required **Properties**

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

2. **Properties** → Identify candidate **Material(s)**

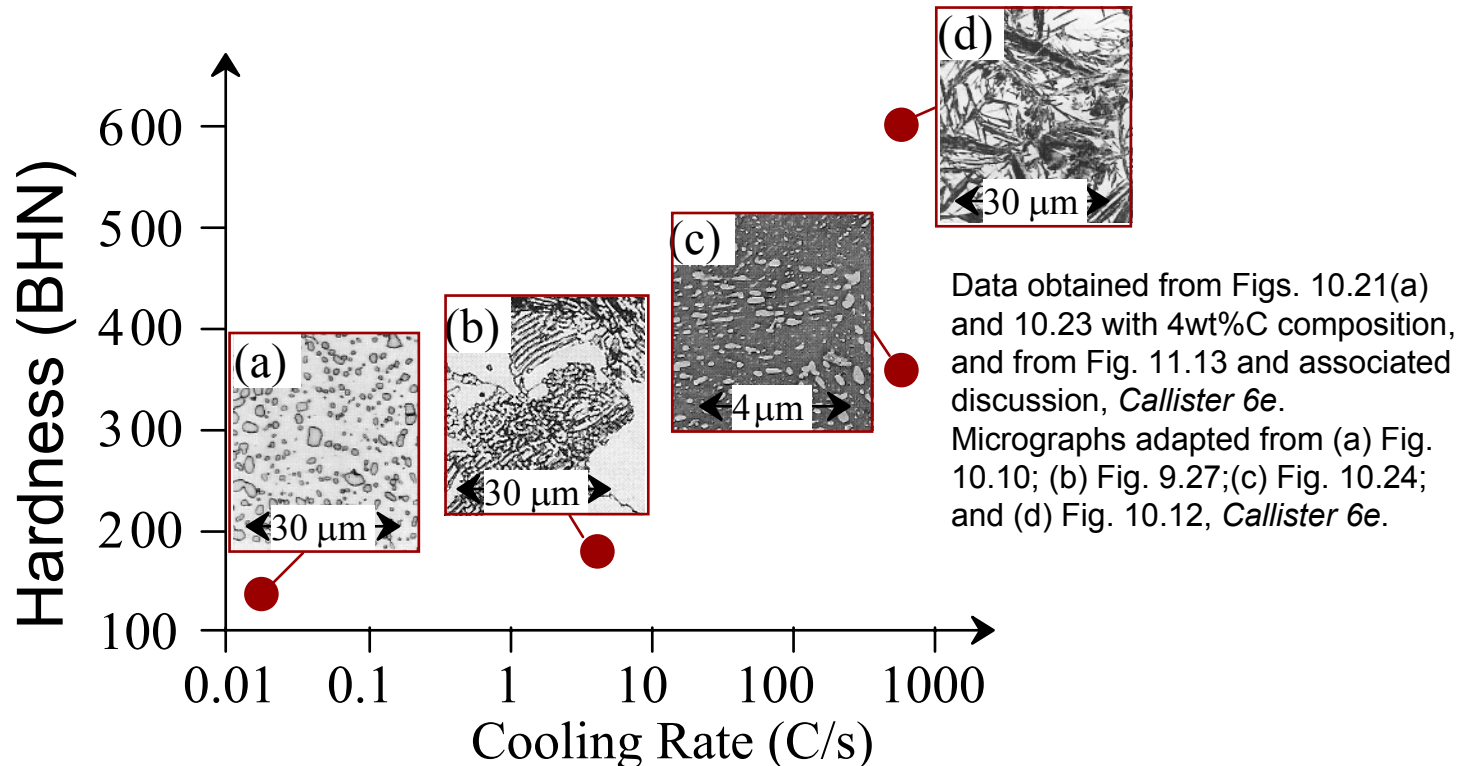
Material: structure, composition.

3. **Material** → Identify required **Processing**

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

Mechanical Properties

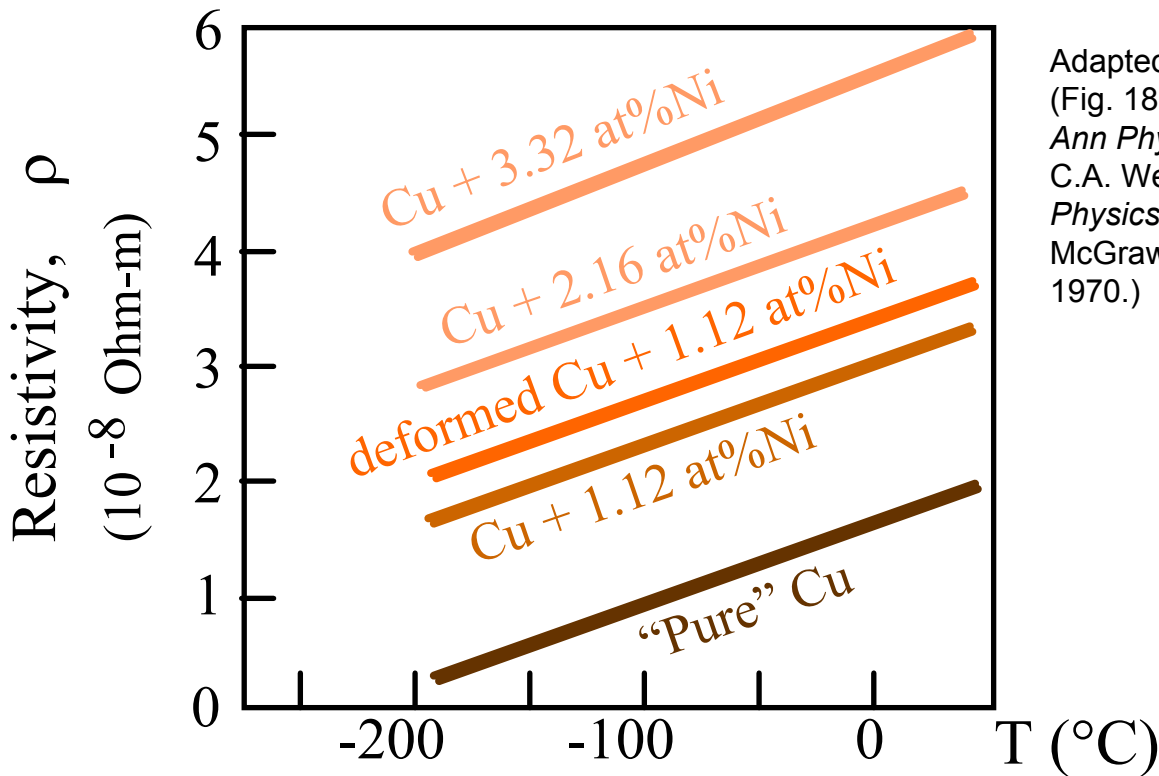
- **Properties** depend on **structure**
ex: hardness vs structure of steel



- **Processing** can change **structure**
ex: structure vs cooling rate of steel

ELECTRICAL

- Electrical Resistivity of Copper:



Adapted from Fig. 18.8, *Callister 6e*.
(Fig. 18.8 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.)

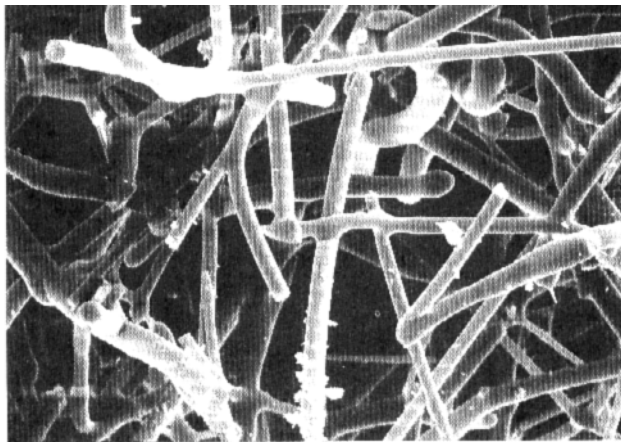
- Adding "impurity" atoms to Cu increases resistivity.
- Deforming Cu increases resistivity.

THERMAL

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



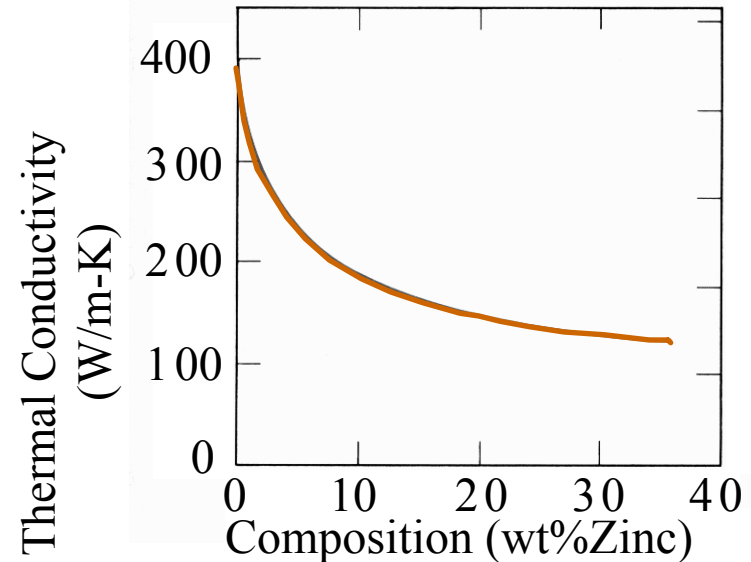
Fig. 19.0, *Callister 6e*.
(Courtesy of Lockheed Missiles and Space Company, Inc.)



← 100 μm →

Adapted from Fig. 19.4W, *Callister 6e*. (Courtesy of Lockheed Aerospace Ceramics Systems, Sunnyvale, CA)

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



Adapted from Fig. 19.4, *Callister 6e*. (Fig. 19.4 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.)

Schedule

| Subject | Reading Assignment | # Sessions | Homework Assignments |
|---|---|------------|--------------------------|
| 1. Introduction | Chapter 1 | 1 | - |
| 2. Structure of Materials | | | |
| 2.1. Atomic Structure and Bonding | Chapter 2 | 1 | Project 1 |
| 2.2. Structure of Metals and Ceramics Dr. Susan Sinnott will teach this section. | Chapter 3, 12-1 through 12-4 | 3 | |
| | | | HW #1 |
| | | | |
| 2.3. Imperfections | Chapter 4 12-5 | 2 | Project 1 is due! |
| | | | HW #1 is due! |
| 2.4. Diffusion | Chapter 5, 12-6 | 2 | HW #2 |
| | | | |
| 2.5. Structure of Polymers | Chapter 14 | 2 | |
| | | | HW #2 is due! |
| Exam 1 | | | |

Schedule

| 3. Mechanical Properties | | | |
|---|---|---|-------------------|
| 3.1. Tensile and Creep Testing | 6-1 thru 6-8, 15-1 thru 15-8, 8-14, 8-15 | 4 | |
| | | | HW #3 |
| | | | Project 2 |
| | | | |
| 3.2. Hardness and Flexural Testing | 6-10, 12-9 | 1 | HW #3 is due! |
| 3.3. Fracture and Fatigue | 8-1 thru 8-13, 12-8, 15-5 | 3 | HW #4 |
| | | | Project 2 is due! |
| | | | |
| 3.4. Deformation Mechanisms | 7-1 thru 7-10, 15-7 thru 15-9, 12-10, 12-11 | 4 | HW#4 is due! |
| | | | |
| | | | |
| | | | |
| Exam 2 | | | |

Schedule

| 4. Processing and Application | | | |
|--|---|----------|--------------------------|
| 4.1. Fabrication of Metals | 11-4 thru 11-6, 7-11 thru 7-13 | 2 | |
| 4.2. Phase Diagrams | 9-1 thru 9-15 | 2 | HW #5 |
| 4.3. Kinetics of Phase Transformation | Chapter 10 | 3 | HW #5 is due! |
| 4.4. Fabrication and Processing Ceramics | Chapter 13 | 2 | Project 3 |
| 4.5. Fabrication and Processing of Polymers | 15-10 thru 15-24 | 3 | Project 3 is due! |
| Exam3 | | | |

Schedule

| 5. Physical Properties | | | |
|-------------------------------|---------------------------|---|----------------------|
| 5.1. Corrosion | 17-1, 17-2, 17-7, 17-9 | 2 | |
| | | | HW #6 |
| 5.2. Electrical Properties | 18-1 thru 18-12 | 3 | |
| | | | |
| | | | HW #6 is due! |
| 5.3. Magnetic Properties | 20-1 thru 20-7 | 2 | |
| | | | |
| Exam 4 | | | |

Communication

The information regarding this course will be disseminated via WebCT (www.webct.ufl.edu). All announcements, class handouts and homework assignments will be given on WebCT. Also the grades will be posted on this site.