SE 104
STRUCTURAL MATERIALS

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Scope of this course

- Prerequisites:

  Introduction to Structures and Design (SE1)

  Statics (*SE101A or equivalent*)

  Solid Mechanics (*SE110A or equivalent*)

- What I expect:

  By the end of the quarter (*actually, shortly after the midterm*), *you should understand structural properties of materials, and know how to choose materials according to functional requirements.*

- What you should expect:

  Homework, Midterm, Final

Course Details

- Instructor: Prof. Yu Qiao
  Office: SME 442G
  Office Hours
  Phone: 858-534-3388
- Course Website –
  http://mmrl.ucsd.edu/Courses/SE104/
- TA
  Office Hours
  Homework

Course Details

- Text Book: Ashby's book (required)
- Material: Handouts
  Covered in class
  Homework assignments
  Text book
- **Reference Book** (suggested):
  - D. R. H. Jones, Michael F. Ashby, Engineering Materials 2: An Introduction to Microstructures and Processing, 4th Edition, Butterworth-Heinemann (2012)
  - Sidney Mindess, J. Francis Young, David Darwin, *Concrete*, 2nd Edition, Pearson (2002)
  - Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, *Mechanical Measurements*, 6th Edition, Pearson (2006)

Course Structure

- Homework Assignments (10%)
- Class Participation (10%)
- Midterm (35%)
  Final (45%)
- Students who get the average score will receive "B" (or "B+", depending on the class performance); the interval between adjacent levels is 0.3 to 0.5 sigma

Course Details

- From the 2nd week, popup questions will be given "randomly", as a part of the classroom discussion
- *iClicker* is required
- Full participation in all the popup questions = 10 points
- >70% correct answers → bonus points: 2
  100% correct answers → bonus points: 3

Course Structure

Midterm:

Closed-book, closed-notes
1 (and only 1) cheat sheet:
letter sized, one-sided

Final:

Comprehensive
Closed-book, closed-notes
2 cheat sheets: letter sized, one-sided

For the Lab Sessions (SE 104L)

- Students must download hand-outs *prior to* each lab/class; must understand the lab instruction *before* the lab begins.
- Team work: lab preparation, lab, lab report (group discussion, literature research, writing, proofreading – unified lab report, etc.)
- Correction factor
- Grading
- UCSD email

Lab Sessions

- Safety –by the Lab Manager
- Lab preparation
- In the first lab, you need to form the team for the rest of the quarter. There will be log-in sheets for each lab section.
- Academic integraity

Citations in Lab Reports

- Citations must be given throughout the text, wherever other people's work is referred to.
- A complete list of references must be given at the end of the lab report
- The references for images (including cover images), figures, tables, data, etc. must be specific.
- If the reference is a book, give the page number.
- Failure in giving references appropriately can lead to investigation of plagiarism.

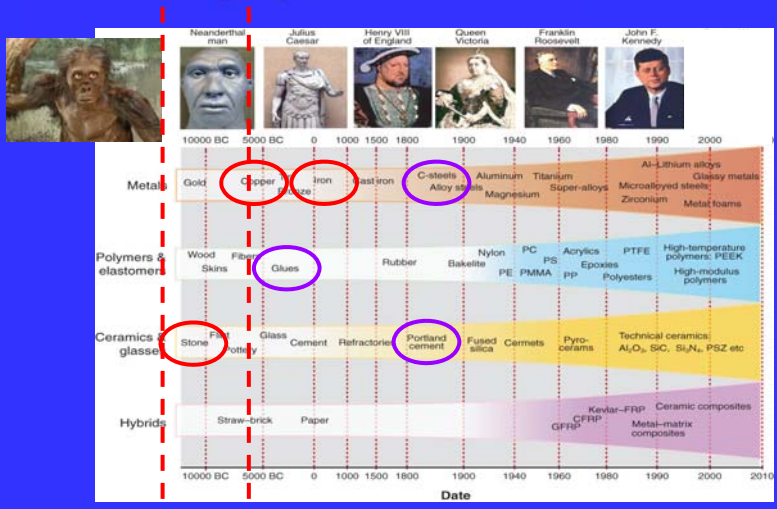
Engineering materials

Materials

- Relating to, derived from, or consisting of matter
- Relating to, or concerned with, physical rather than spiritual or intellectual things
- The elements, constituents, or substances of which something is composed, or can be made

-Websters New Collegiate Dictionary

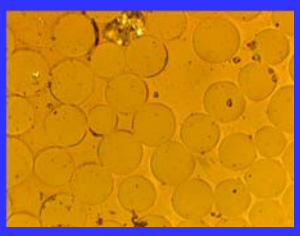
History of Materials

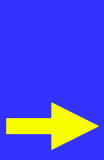


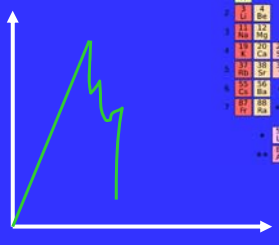
Colored zones indicate man-made materials

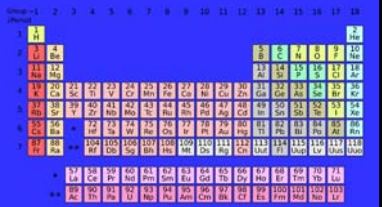
Science & Engineering

- Materials Science:
  - Discipline involving the investigation of fundamental relationships between structure and properties of materials & development of new materials
  - Discovery, depth









Science & Engineering

- Materials Engineering:
  - Discipline involving the design and use of material on the basis of structure-property relationships
  - Invention, novelty

- Hexcel

Use different materials to increase efficiency & to meet new functional requirements

Create new things…

Common Material Properties

General	Mechanical	Thermal	Electrical
• Cost • Density	• Stiffness • Strength • Toughness	• Conductivity • Diffusivity • Heat Capacity • Expansion	• Dielectric Constant • Conductivity

Collectively measures the complexity of processing and availability

Magnetic	Optical	Chemical
• Remanence • Saturation Magnetization	• Refraction • Absorption	• Corrosion Resistance

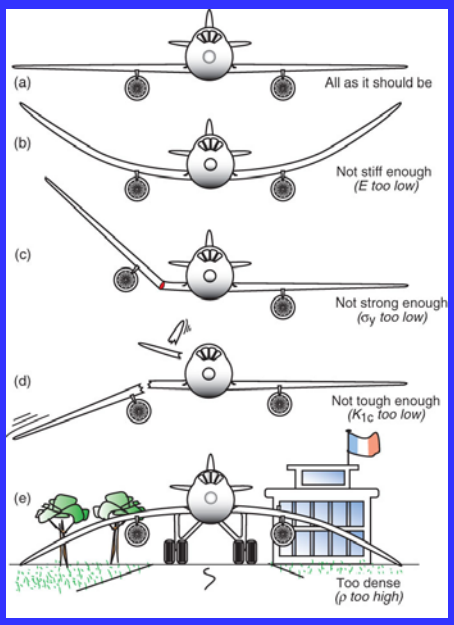


Figure 1.2

Mechanical Properties

E - elastic modulus

σ_y - yield strength

K_{1c} - fracture toughness

Mechanical Properties

3dprinthq.com

Stiff vs. flexible

A plastic strip exhibits a large deflection (without damage) under bending forces:

Stiffness of the structure →

Stiffness of the materials that carry the load

Mechanical Properties

Strong vs. weak

An iPhone 6 is permanently bent (damaged):

Strength of the structure →

Strength of the material at the damaged area

Mechanical Properties

Tough vs. brittle

An iPhone 6 is fractured (final failure happens):

Toughness of the structure →

Toughness of the material at the cracking area

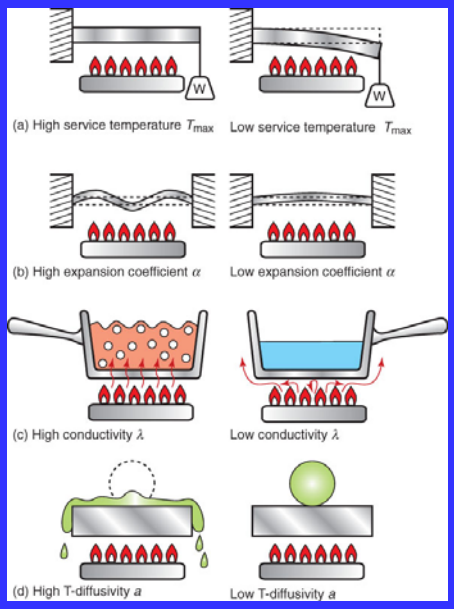


Figure 1.3

Thermal Properties

T_{max} – limiting temperature for engineering applications

C_p – heat capacity

λ - conductivity

diffusivity $\propto \lambda/C_p$

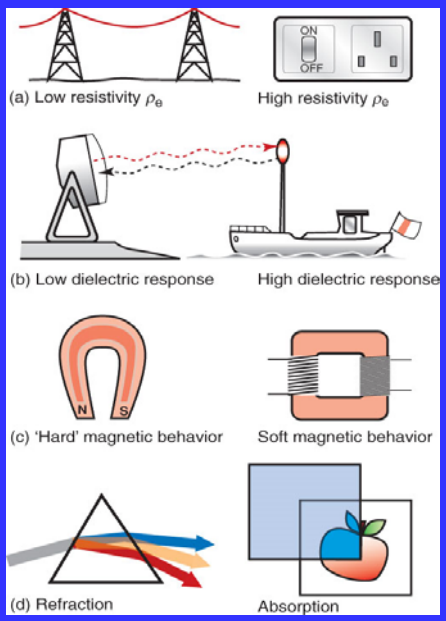


Figure 1.4

Electrical, Magnetic, and Optical Properties

ε_D – dielectric constant

'hard' magnet - permanently magnetized

'soft' magnet – can be magnetized and demagnetized

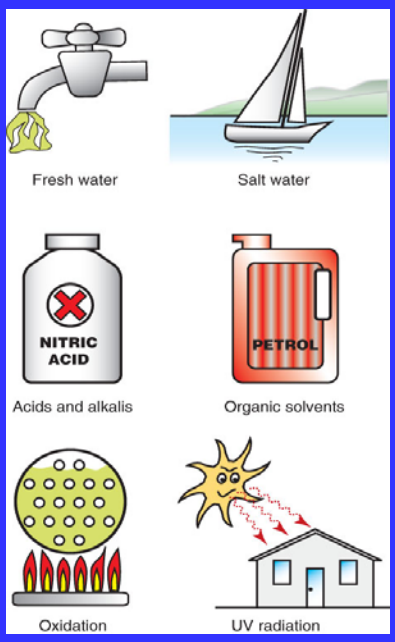


Figure 1.5

Chemical Properties

Intrinsic resistance of a material in a given environment

Scale of measurement:
1 (very bad) – 5 (very good)

Structure and Properties

Processing → Structure → Properties → Performance

Mechanical
Electrical
Thermal
Magnetic
Optical
Deteriorative

Design-limiting Properties

Properties that determine the suitability of a material based on design requirements

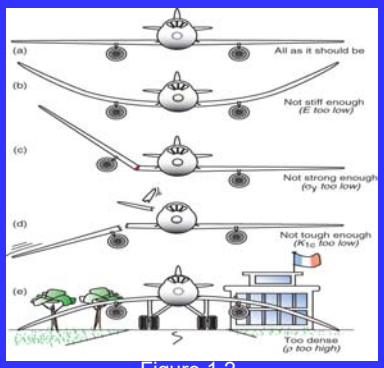


Figure 1.2

For the plane, strength, stiffness and toughness are design limiting – if any of the three are too low, the plane will not fly