Introduction to Properties of Metals

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What Are Metals?

• Generally in the central part of periodic chart
• Can we can identify metals by their properties?
  – Take 3 minutes and make a list of metals that you use every day
Metal Properties

• Properties are how metals behave
• Make a list of the properties of the metals on your list:
  – Example: Iron--Hard
Basic Properties

• Density
  – Mass per unit volume
  – “Basic” because density does not change for a specific element

• Modulus of elasticity
  – Resistance to being deformed elastically (no permanent deformation)
  – High modulus makes a material stiff
  – “Basic” because modulus is always the same for each specific element
Mechanical Properties

• Mechanical properties include
  – Strength
    • Force the material can withstand per unit area
    • Strength is related to hardness, also a mechanical prop.
  – Ductility
    • How much the material will stretch before failure
  – Failure
  – Fatigue
    • Failure after cyclic loading
More Properties

• Electrical
  – Conductivity, resistivity

• Optical
  – Color
  – Reflectance, Transparency

• Magnetic
  – Ferromagnetism
  – Paramagnetism
Which of these properties is MOST characteristic of metals?
Metal Properties Depend on

• Structure
  – Crystal structure
  – Microstructure (grain structure)

• Processing
  – Mechanical (rolling, stretching, extruding)
  – Chemical (alloying, reactions)
  – Physical (casting, thin-film deposition)
  – Annealing and Heat Treating
Metal Alloys

• Alloys are mixtures of 2 or more elements
• Steel: Iron + Carbon
• Brass: Copper + Zinc
• Bronze: Copper + Tin

• Many alloys possible
  – Each alloy may have different properties!
Alloy example

• Paper clips
  – Plain carbon steel (Fe + C)
• Drawn into wires and bent to shape
• Strength of paper clip is not important—just so it holds paper together!
  – Properties of the paper clip are less important, so they often have uncontrolled impurities
  – This makes properties variable from clip to clip
Paper Clip Experiment

- Open paper clip into S shape
- Bend back and forth to failure
- Count number of bends

One cycle = Bend up to 90° and back down
Conclusions

• Properties are important
  – Metals are used for many applications
  – Properties dictate what material to use for a specific application.

• Properties depend on structure and on processing/production.
  – Paper clip experiment is one example of variation
  – More on this in subsequent units
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