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Materials Engineering
PTT 110

SEMESTER 1 (2013/2014)
CO1:
Ability to compare types of material families (metal, polymer, ceramic, and composite) and describe material structure.
What are Materials?

- Materials may be defined as substance of which something is composed or made.
- We obtain materials from earth crust and atmosphere.

Examples :-
- Silicon and Iron constitute 27.72 and 5.00 percentage of weight of earths crust respectively.
- Nitrogen and Oxygen constitute 78.08 and 20.95 percentage of dry air by volume respectively.
Why the Study of Materials is Important?

Materials are important in engineering in different areas, they are designed:

- To support load
- To conduct electricity
- To accept or reject magnetic
- To transmit or reflect light
- To save cost
- To survive in hostile surrounding
Materials Science and Engineering

- Materials **science** deals with **basic knowledge** about the internal structure, properties and processing of materials.
- Materials **engineering** deals with the **application of knowledge** gained by materials science to convert materials to products.

![Diagram showing the relationship between Materials Science, Materials Science and Engineering, and Materials Engineering]

- **Basic Knowledge of Materials**
- **Resultant Knowledge of Structure and Properties**
- **Applied Knowledge of Materials**
Types of Materials

• Metallic Materials
  ➢ Composed of one or more metallic elements.
    ❑ Example: Iron, Copper, Aluminum.
  ➢ Metallic element may combine with nonmetallic elements.
    ❑ Example: Silicon Carbide, Iron Oxide.
  ➢ Inorganic and have crystalline structure.
  ➢ Good thermal and electric conductors.

Metals and Alloys

Ferrous
Eg: Steel, Cast Iron

Nonferrous
Eg: Copper, Aluminum
Types of Materials

• Polymeric (Plastic) Materials
  ➢ Organic giant molecules and mostly noncrystalline.
  ➢ Some are mixtures of crystalline and noncrystalline regions.
  ➢ Poor conductors of electricity and hence used as insulators.
  ➢ Strength and ductility vary greatly.
  ➢ Low densities and decomposition temperatures.

  ➢ Examples :- Poly vinyl Chloride (PVC), Polyester.
  ➢ Applications :- Appliances, DVDs, Fabrics etc.
Types of Materials

• Ceramic Materials
  ➢ Metallic and nonmetallic elements are chemically bonded together.
  ➢ Inorganic but can be either crystalline, noncrystalline or mixture of both.
  ➢ High hardness, strength and wear resistance.
  ➢ Very good insulator. Hence used for furnace lining for heat treating and melting metals.
  ➢ Also used in space shuttle to insulate it during exit and reentry into atmosphere.
  ➢ Other applications: Abrasives, construction materials, utensils etc.

  ➢ Example: - Porcelain, Glass, Silicon nitride.
Types of Materials

• Composite Materials
  ➢ Mixture of two or more materials.
  ➢ Consists of a filler material and a binding material.
  ➢ Materials only bond, will not dissolve in each other.
  ➢ Mainly two types:-
    o Fibrous: Fibers in a matrix
    o Particulate: Particles in a matrix
    o Matrix can be metals, ceramic or polymer
  ➢ Examples :-
    ❑ Fiber Glass ( Reinforcing material in a polyester or epoxy matrix)
    ❑ Concrete ( Gravels or steel rods reinforced in cement and sand)
  ➢ Applications:- Aircraft wings and engine, construction.
Types of Materials

• Electronic Materials

- Not Major by volume but very important.
- Silicon is a common electronic material.
- Its electrical characteristics are changed by adding impurities.

- *Examples:* Silicon chips, transistors
- *Applications:* Computers, Integrated Circuits, Satellites etc.
Recent Advances and Future Trends

- **Smart Materials**
  - React to environment Stimuli.
  - Change their properties by sensing external stimulus.
    - Examples: Shape memory alloys – used in the artery stents.
    - Microelectromechanical systems (MEMS) devices.
Recent Advances and Future Trends

• Nanomaterials
  ➢ Smaller than 100 nm particle size.
  ➢ Materials have special properties.
  ➢ Very hard and strong characteristics.
  ➢ Research in progress.
  ➢ Example: Carbon nanofiber reinforced plastic: very light but stronger than metals.
Case Study – Material Selection

- Problem: Select suitable material for bicycle frame and fork.

**Steel and alloys**
- Low cost but Heavy. Less Corrosion resistance

**Wood**
- Light and strong. But Cannot be shaped

**Carbon fiber Reinforced plastic**
- Very light and strong. No corrosion. Very expensive

**Aluminum alloys**
- Light, moderately Strong. Corrosion Resistance. expensive

**Ti and Mg alloys**
- Slightly better Than Al alloys. But much expensive

Cost important? Select steel
Properties important? Select CFRP