Al-Mustaqbal University

Collage of Engineering

Prosthetics and Orthotics Engineering

First Stage

PHYSICS OF MATERIALS

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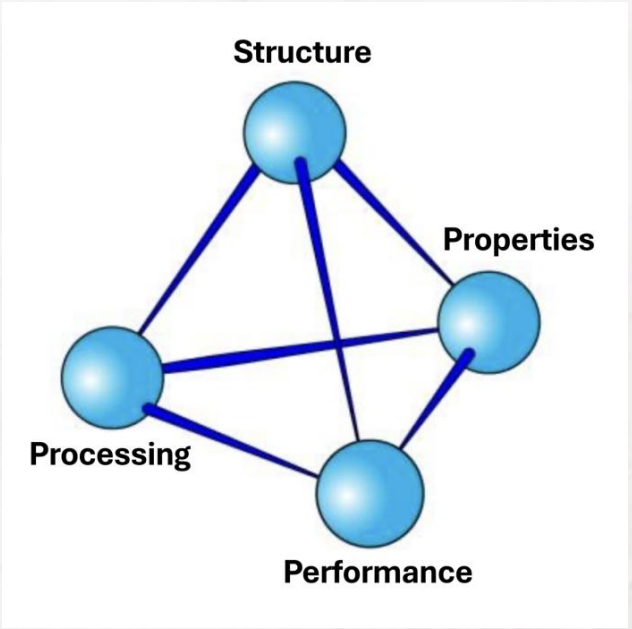
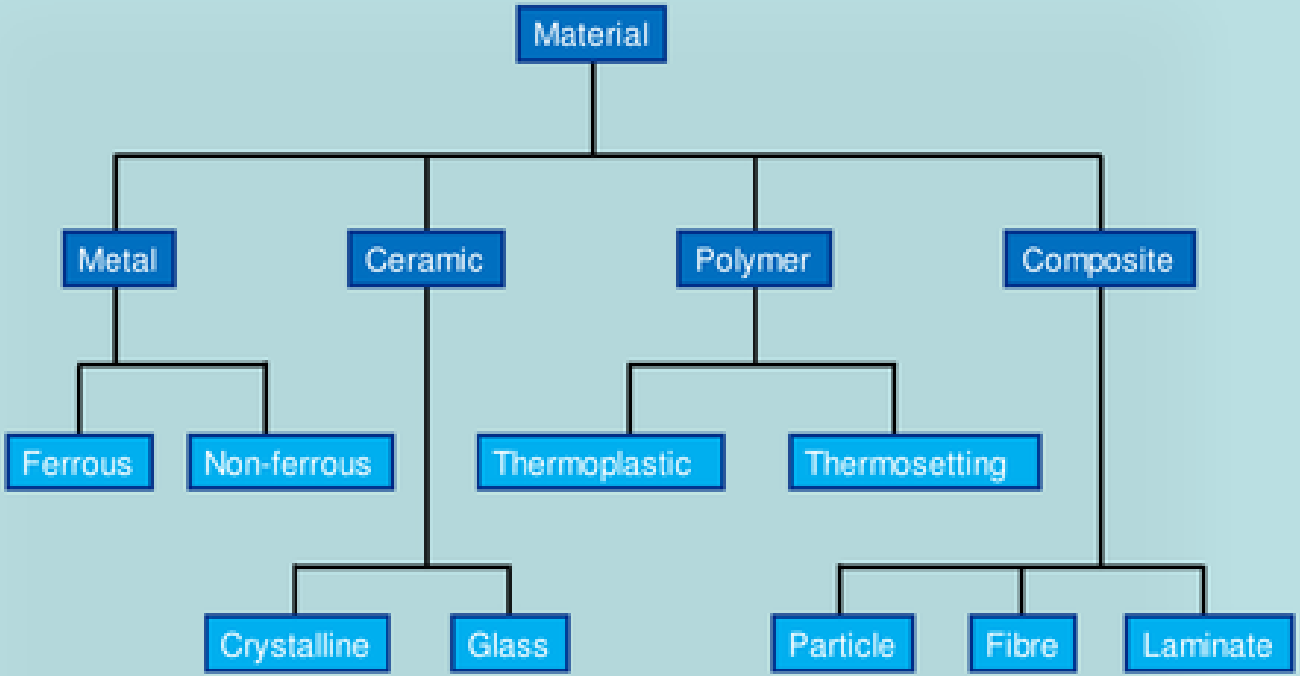


Classification of Materials



Classification of Materials

Solid materials are categorized into three main types based on their chemical makeup and atomic structure:

- Metals
- Ceramics
- Polymers

Most materials fall into one of these categories.

There are also **composites**, which are combinations of two or more of these material types.

Metals:

- Composed of one or more metallic elements (e.g., iron, aluminum, copper) and sometimes small amounts of nonmetallic elements (e.g., carbon, oxygen).

- Atoms are bonded together in a crystalline structure.

Characteristics:

- Stiff, strong, and resistant to fracture.

- Ductile (can deform without breaking).

- High thermal and electrical conductivity.

- High density and weight.

- Low porosity compared to ceramics.

Metals:

Categories:

Ferrous Metals:

Contain iron.

Examples: Steel, wrought iron, cast iron.

Typically, magnetic.

Nonferrous Metals:

Do not contain iron.

Examples: Aluminum, copper, brass.

Typically, non-magnetic.

Less prone to corrosion due to protective oxide layer.

Ceramics:

- Compounds of metallic and nonmetallic elements.

- Commonly oxides, nitrides, and carbides.

- **Examples:** Aluminum oxide (Al2O3), silicon carbide (SiC), porcelain, cement, and glass.

Atomic Arrangement:

Atoms can be arranged in crystal, semi-crystal, or amorphous (non-crystalline) structures.

Ceramics:

Characteristics:

- Lightweight
- Hard but brittle
- Stiff
- Moderately strong
- Not tough
- Good insulator
- Poor heat conductor
- Heat resistant
- Handles temperature changes
- Corrosion resistant

Polymers:

Polymer: A large molecule made up of many repeating units called monomers, joined by covalent bonds.

Monomer: The small, repeating unit that makes up a polymer.

Polymerization: The chemical process where monomers combine to form a polymer with a high molecular weight.

In essence, polymers are big molecules made up of smaller repeating units (monomers), and the process of forming these large molecules is called polymerization.

Classification of Polymers:

Based on Source

Natural Polymers: Found in nature (plants and animals). Examples: proteins, resins, rubber.

Semi-Synthetic Polymers: Modified natural polymers. Examples: starch, silicones.

Synthetic Polymers: Made in labs through polymerization. Examples: nylon, polyethylene, synthetic rubber, PVC, Teflon.

Classification of Polymers:

Based on Structure

Linear Polymers: Long, straight chains. High density and strength. Examples: polyethylene, PVC, nylon.

Branched Polymers: Long chains with side chains. Lower density and strength. Example: polypropylene.

Cross-Linked Polymers: 3D network structures. Hard, rigid, brittle. Example: rubber.

Ladder Polymers: Two linear polymers linked like a ladder. More rigid.

Classification of Polymers:

Based on Structure

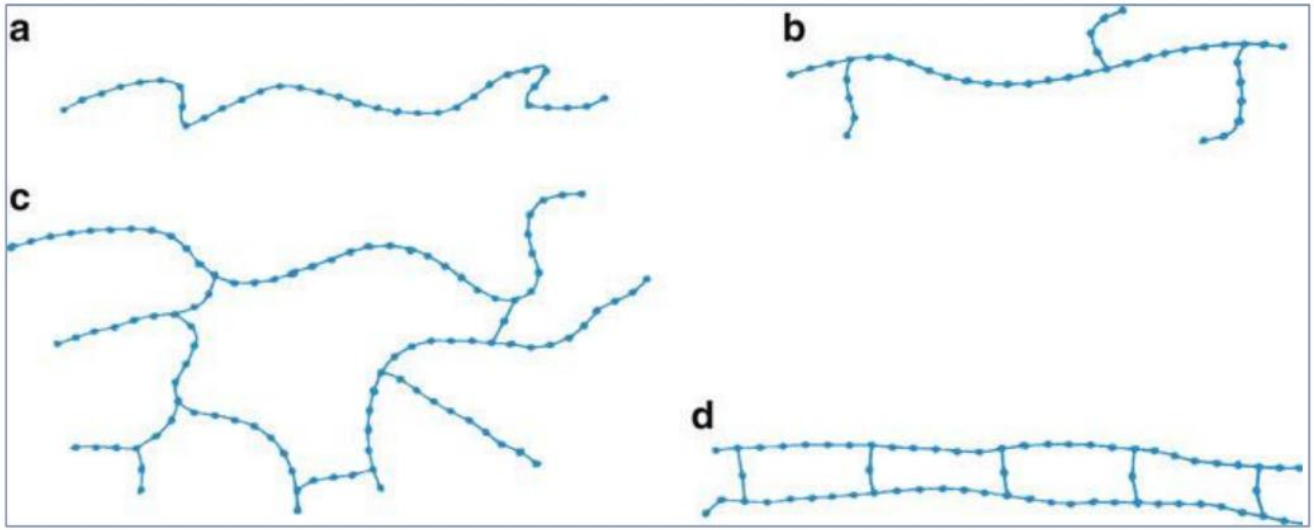


Fig.1 Different molecular chain configurations: (a) linear, (b) branched, (c) cross-linked,(d) ladder

Classification of Polymers:

Based on Molecular Forces

Thermoplastic Polymers:

- Intermediate intermolecular forces
- Soften on heating, harden on cooling
- Linear or branched, can be recycled
- Examples: Polyethylene

Thermosetting Polymers:

- Hard and infusible on heating
- Cannot be softened or remolded
- Cross-linked or heavily branched, not recyclable
- Example: Silicone


Thank
you