Ashur University College
Dental material
2nd year Prosthodontics
Technology dept.
Lect 1&2

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Dental Material

The science of dental materials involves a study of the composition and properties of materials and the way in which they interact with the environment in which they are placed.

The dentist and dental technician have a wider variety of materials at their disposal than any other profession. Rigid polymers, elastomers, metals, alloys, ceramics, inorganic salts and composite materials are all commonly encountered.

“why are we studying this field?”

1. **For the knowledge to make optimal selection of materials**
2. **To understand the behavior of the materials, use, handling, manipulation**
3. **Safety considerations of the materials.**
4. **Patient education regarding dental restoratives**
5. **Recognition of materials – proper care of restorations**
6. **Understand the professional literature**

History of dental materials:

- dating as early as 500 B.C. – Present :
- metals – gold
- plaster and wax models
- prosthetics of bone, ivory, wax, metals
- porcelains – late 1700’s
- amalgam – early 1800’s
- acrylics – 1940’s
- adhesive dentistry – 1970’s - present

Ancient Egyptian bridge

- **gold wire used to hold pontic crowns.**



Oral environment

- **very demanding.**
- **There can be**
- **1. Temperature variations.**
- **2. pH variations.**
- **3. Variations in masticatory forces.**

Temperature variations

- **normal temperature of oral cavity (32℃ to 37℃).**
- **On intake of a cold/hot food or drink temperature range increases (0℃ to 70℃).**

PH variations

- **pH of saliva is neutral (7.0)**
- **on intake of acidic fruit juices or alkaline medicaments, ph, may vary from 2.0 to 11.0 .**

Variations in masticatory forces

Muscles of mastication apply forces to the dentition.

Masticatory forces vary from tooth to tooth.

Average force applied by the tooth increases from anterior to posteriors. Tooth average force (N) second molar 800 first molar 390 premolars 288 canines 208 incisors 155.

Characteristics of ideal materials:

It should be

1. **biocompatible – non-toxic, non-irritating, non-allergenic.**
2. **mechanically stable and durable – strong, resistant to fracture.**
3. **resistant to corrosion – does not deteriorate over time.**
4. **dimensionally stable – little change by temperature and solvents.**

Characteristics of ideal materials (cont.):

5) **Minimal conduction – insulates against thermal/electrical change.**
6) **esthetic – looks like oral tissue.**
7) **easy to manipulate – minimal/reasonable effort and time needed**
8) **adheres to tissues –retains onto, and seals, tooth structure.**

Characteristics of ideal materials:

9. **tasteless and odorless – not unpleasant to patient.**
10. **cleanable/repairable – easily maintained or fixed.**
11. **cost-effective – affordability vs. Benefits/disadvantages.**

Standards for dental materials

- **American Dental Association (ADA)**
- **Food and Drug Administration (FDA)**
- **International Standards Organization (ISO)**
- **International Dental Federation (FDI)**

***FDI and ISO establish standards for DM on an international level.**

Classification of dental materials

All dental materials fall under 4 main groups:

1. **Polymers.**
2. **Metals.**
3. **Ceramics.**
4. **Composites.**
5. **Inorganic salts.**

Materials used in dentistry

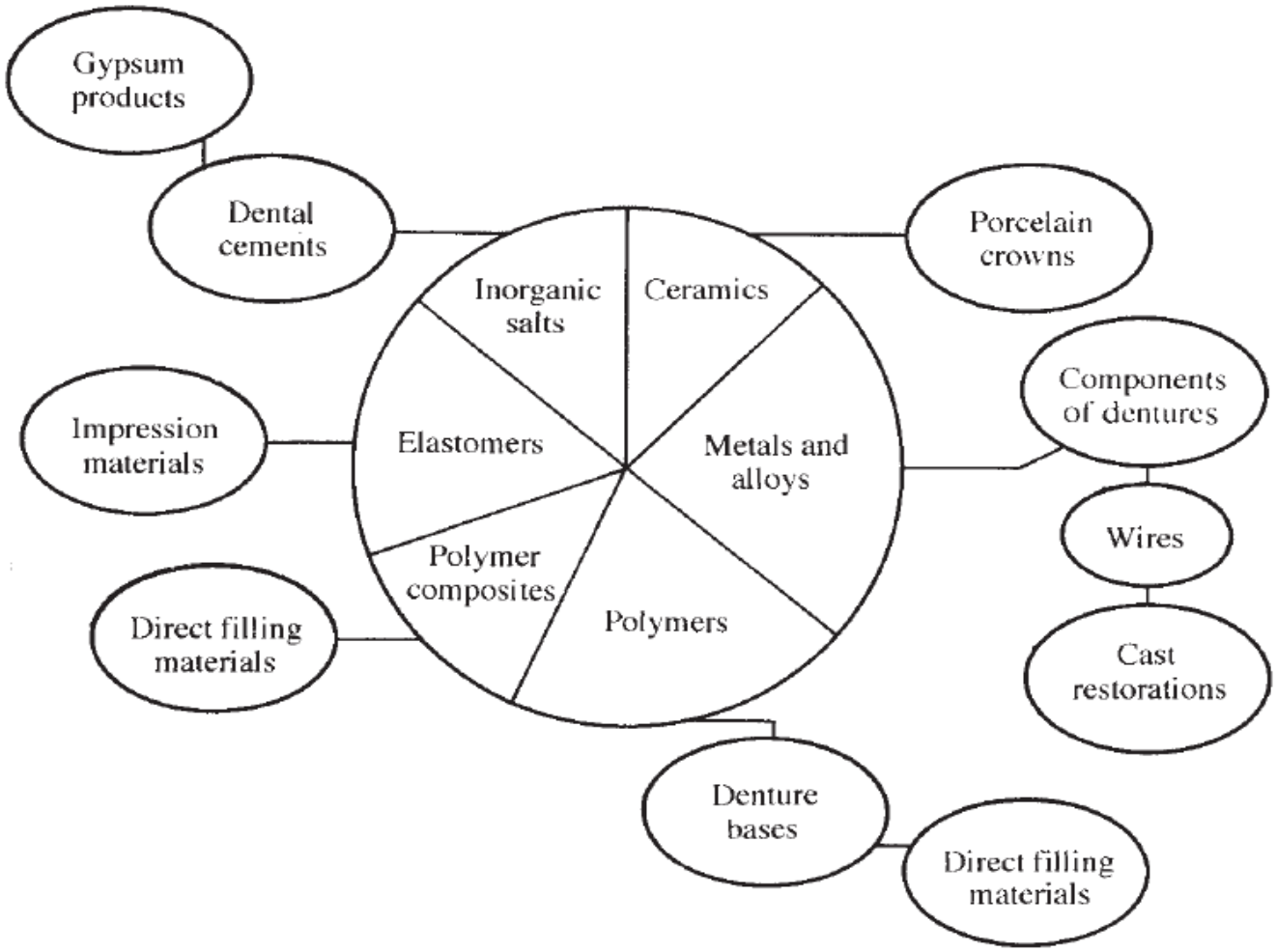


Fig. 1.1 Diagram indicating the wide variety of materials used in dentistry and some of their applications.

Dental materials may be used in three phases for dental treatment.

1. **Prevention.**
2. **Restoration.**
3. **Rehabilitation.**

Prevention

a-Materials of brushing and flossing.

b-Fluoride therapy.

c-Fissure sealants.



Restoration

a-Filling materials (temporary filling, silver filling, tooth colored filling, gold inlay, ceramic inlay).

b-Materials have soothing and promote healing of the pulp (calcium hydroxide).

c-Root canal treatment (solutions used to clean the canal, materials which fill the canal like gutta percha, silver cone, and sealing paste)

d-Crown and onlay.

e-Post and core.

f-Cements.

g-Model of teeth to fabricate restorations (gypsum products).

h-Impression materials.

Amalgam filling



Composite filling.



Rehabilitation

a-Artificial teeth (acrylic, porcelain).

b-Implant (titanium screw).

c-Fixed partial denture materials.

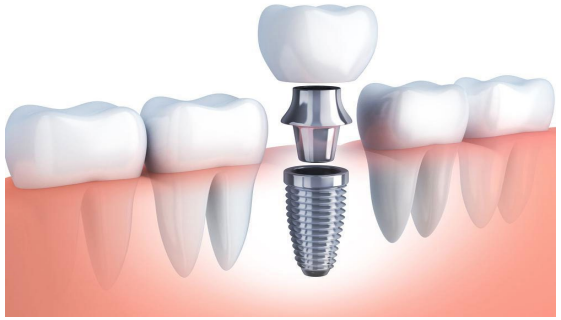
d-Cements.

e-Removable partial denture materials (metal framework and plastic (acrylic)denture base, or made entirely of plastic).





Fixed bridge



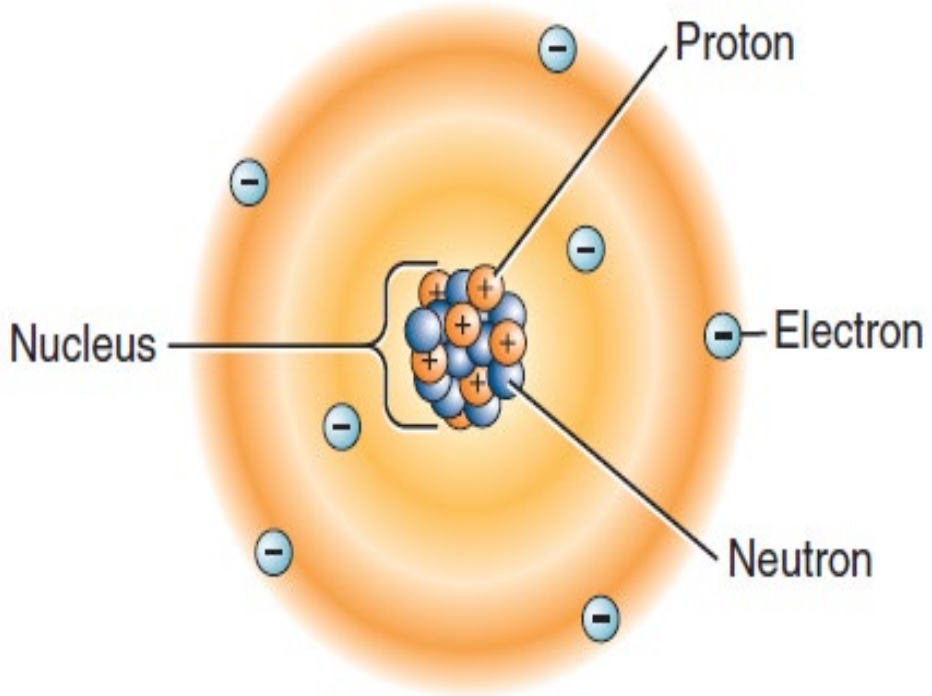
Dental implant



Removable partial denture(RPD)

The structure of matter

All mater composed of atoms. An atoms may be considered to consist of nucleus, containing protons and neutrons, surrounded by electrons.



INTERATOMIC BONDS

The forces of attraction between atoms or molecules may be divided into:

- **Primary bonds**
- **Secondary bonds.**

Primary Bonds

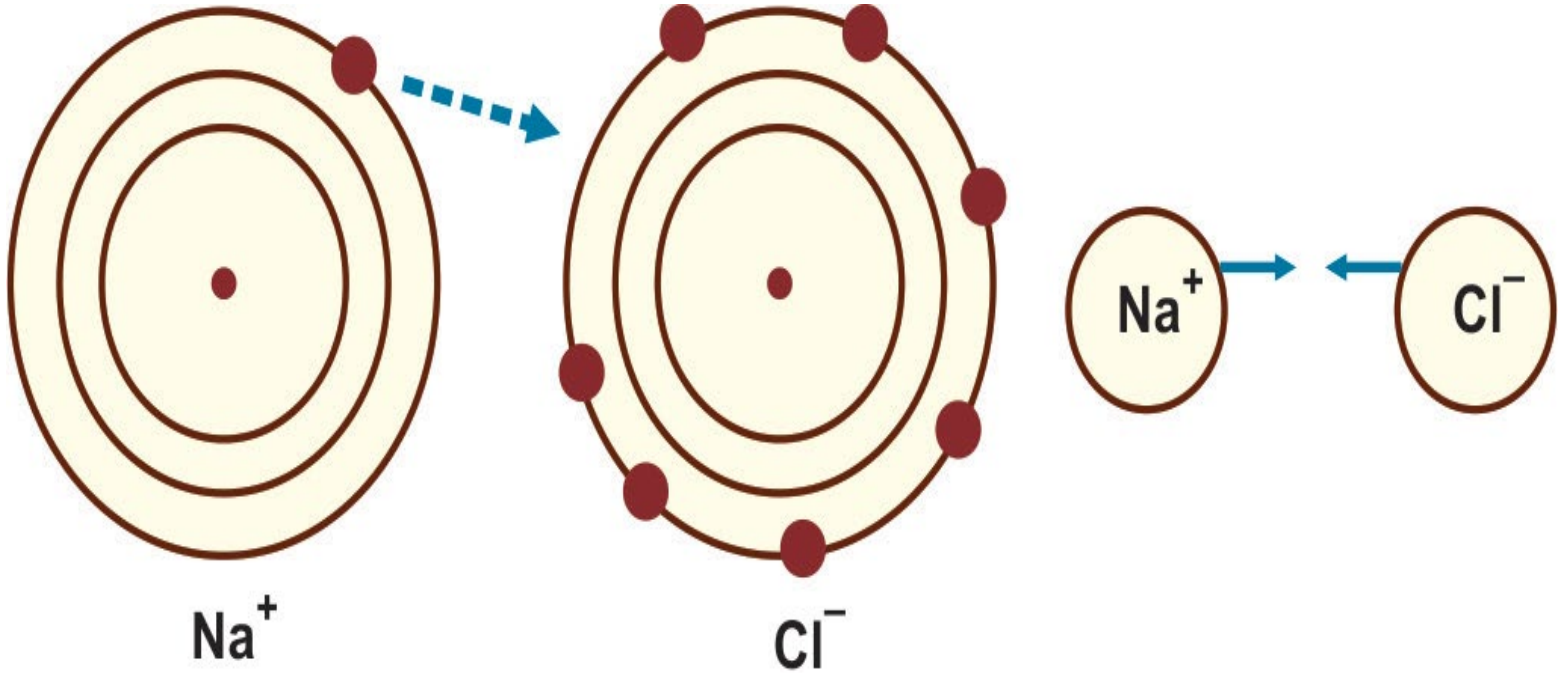
They may be of three types:

- **Ionic**
- **Covalent**
- **Metallic.**

Ionic Bond

It occurs as a result of mutual attraction of positive and negative charges.

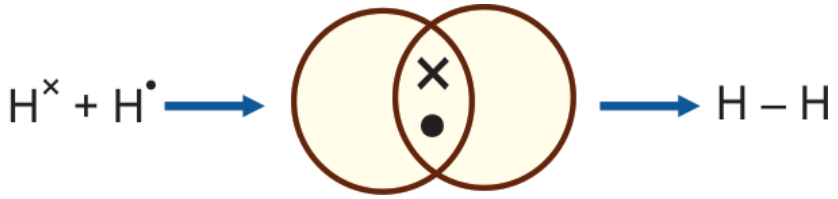
For example, NaCl.

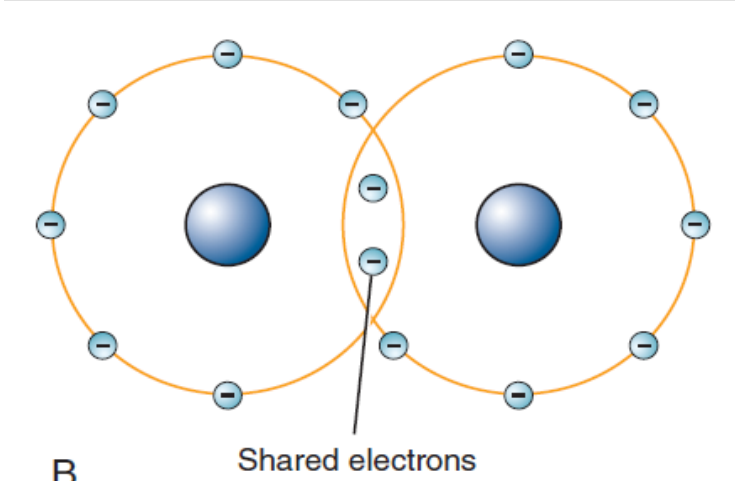


Covalent Bonds

In many chemical compounds, two valence electrons are shared by adjacent atoms sharing electrons, the two atoms are held together by covalent bonds to form a molecule that is sufficiently stable, and electrically neutral in a definite arrangement.

For example: H2 molecule, in this single outer most electron in each hydrogen atom is shared with that of other.

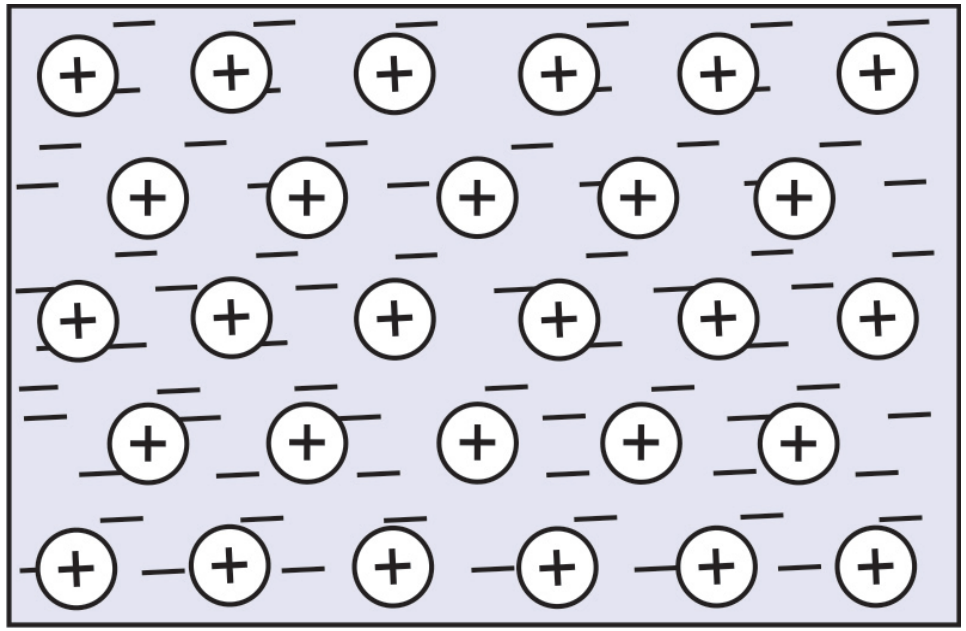




Covalent bond, characterized by electron sharing and very precise bond orientations.

Metallic Bond

The valence electrons from each metallic atom form an electron cloud. The positive ions formed by the loss of electrons and the electron cloud itself produce strong forces of attraction bonding the metal together .

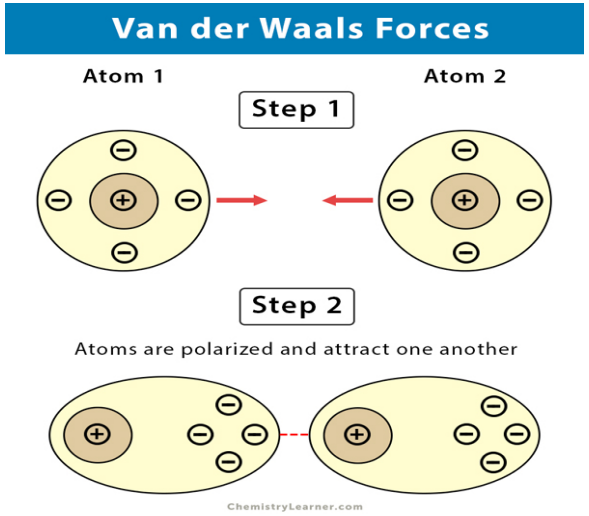


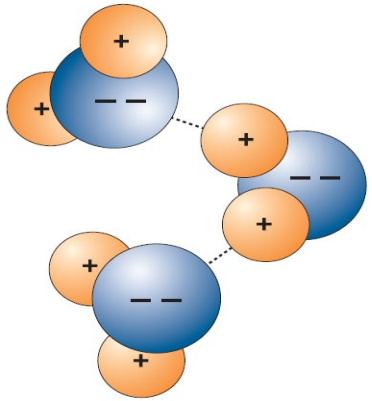
Metallic bond, characterized by electron sharing and formation of a “cloud” of electrons that bonds to the positively charged nucleus in a lattice.

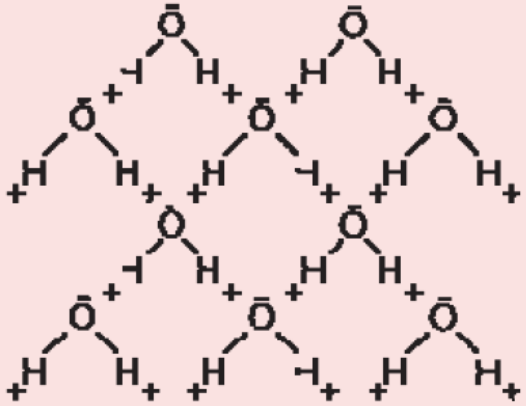
Secondary Bonds

van der Waals Forces and hydrogen bond are examples of secondary bonds and considered as physical forces.

In contrast with primary bonds, secondary bonds do not share electrons. Instead, charge variations among atomic groups of the molecule induce dipole forces that attract adjacent molecules or parts of a large molecule.

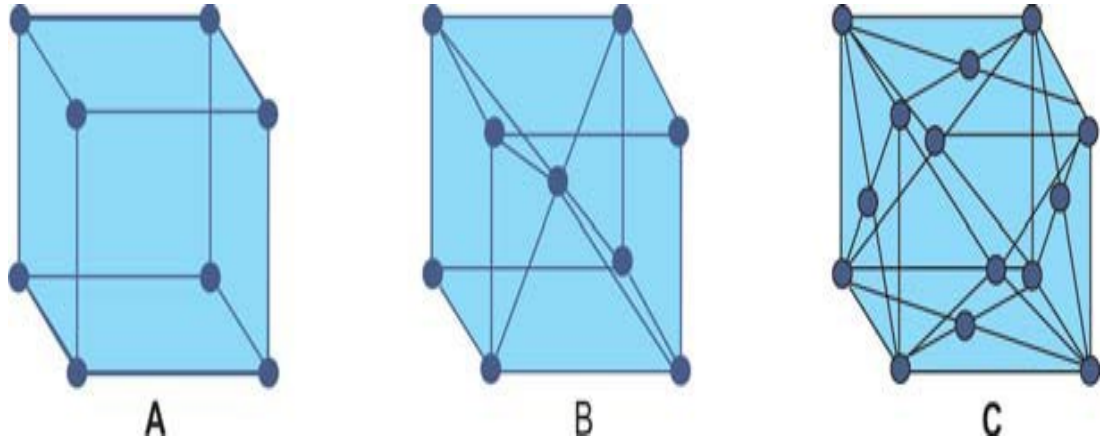






Crystalline solid structure

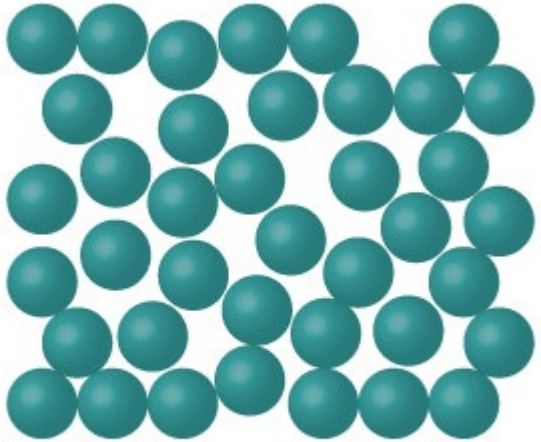
Space lattice or crystal can be defined as any arrangement of atoms in space such that every atom is situated similar to every atom. Space lattice may be the result of primary or secondary bonds. **The simplest and most regular lattice is a cubic.**



A. **Simple cubic lattice, atoms at each corner of the cube.**
B. **Body centered cubic, atoms at each corners of the cube and one in the center.**
C. **Face centered cubic, atoms at each of the eight corners and one in the center of each of the six faces but none in the center of the cube.**

Amorphous solid structure:

Amorphous means (without form). Glasses and most of polymers may be considered under this category. In such a material there is no long range repeating structure, but merely a random arrangement of atoms or group of atoms.



Amorphous

