

Structure of Materials

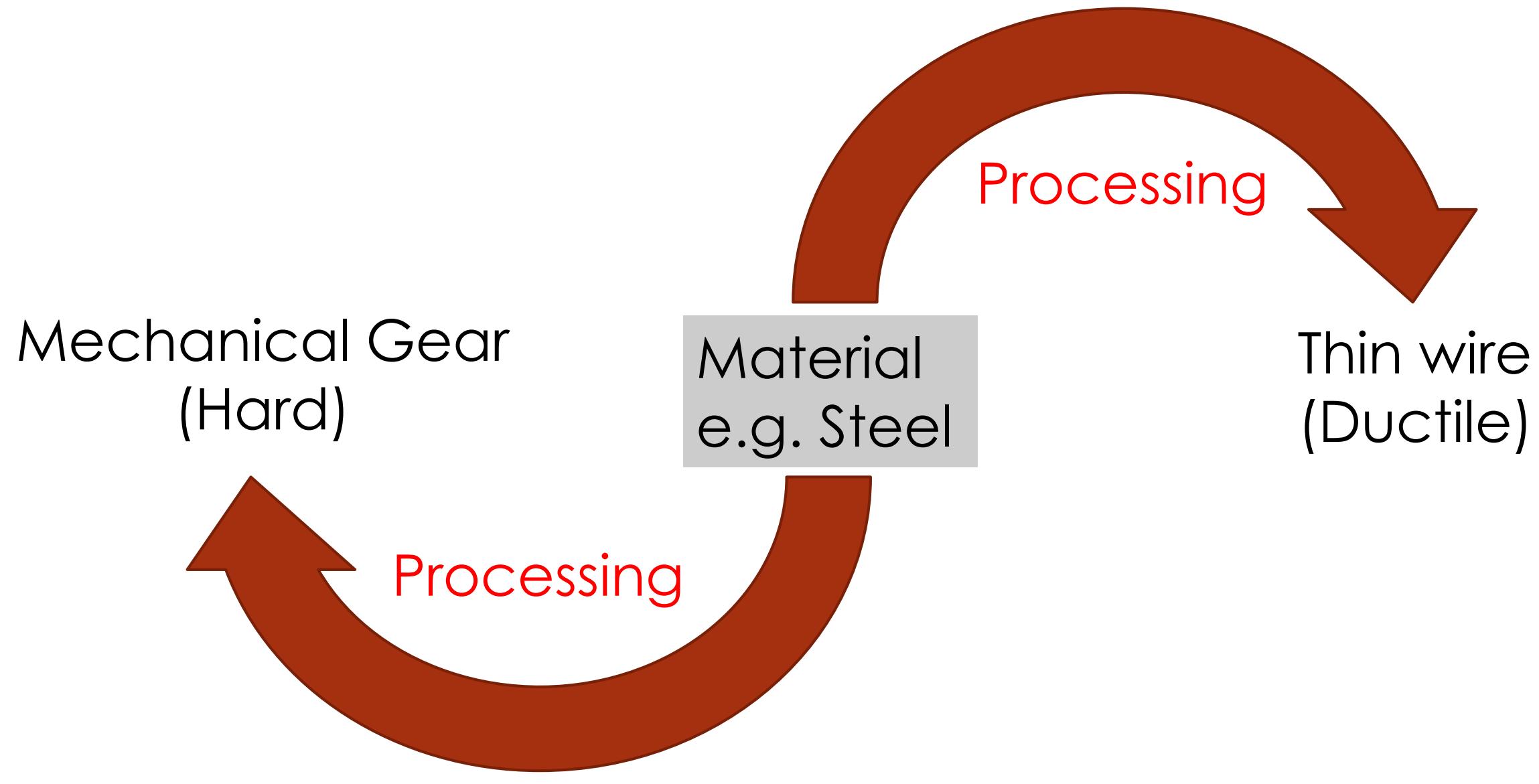
Thapar Institute of Engineering & Technology
(Deemed to be University)
Bhadson Road, Patiala, Punjab, Pin-147004
Contact No. : +91-175-2393201
Email : info@thapar.edu



THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

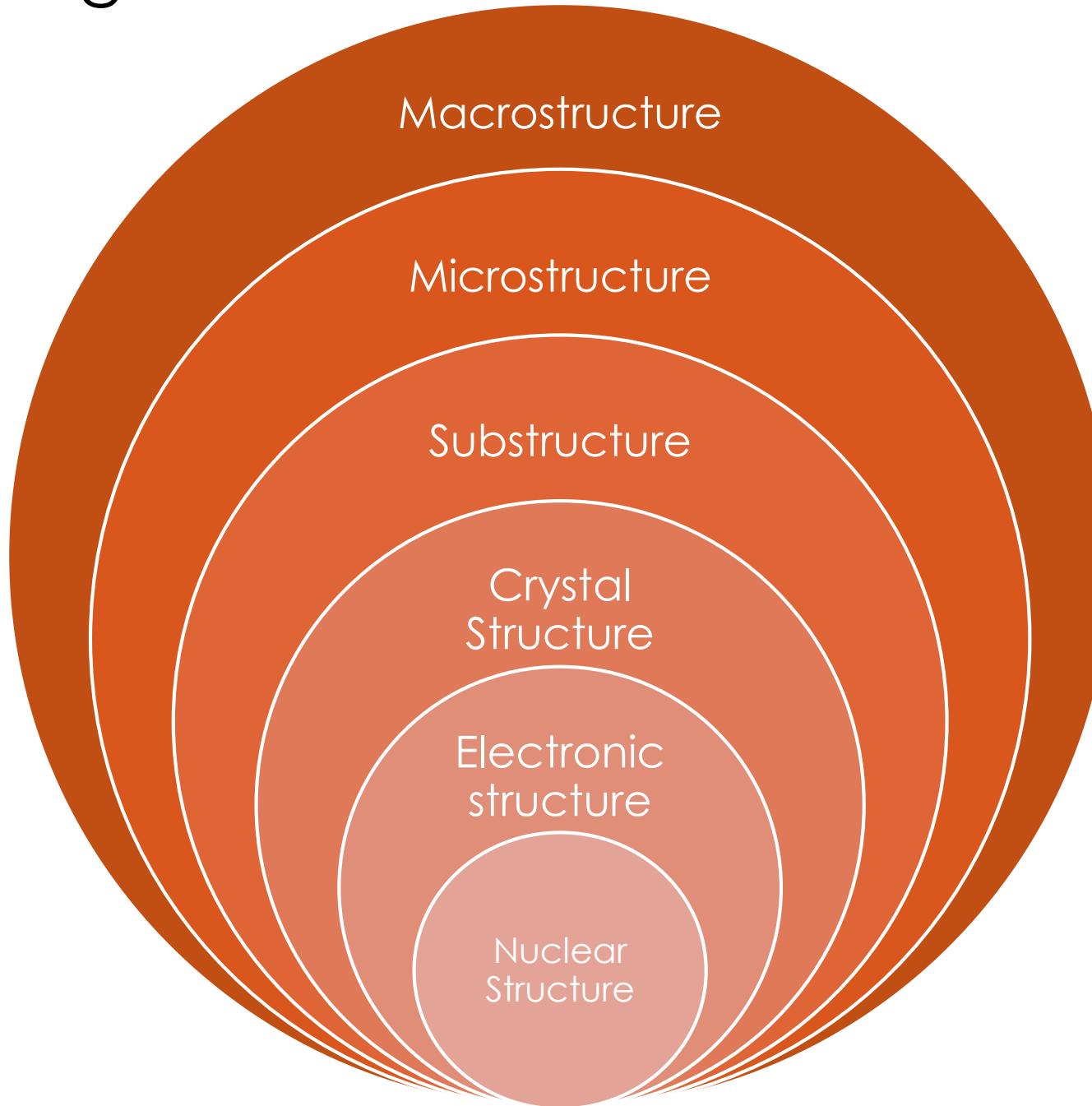
Materials design approach

- Processing of material is very important to get desired properties.
- Properties are depend on the structure of the material.



Levels of Structure

From smallest to largest



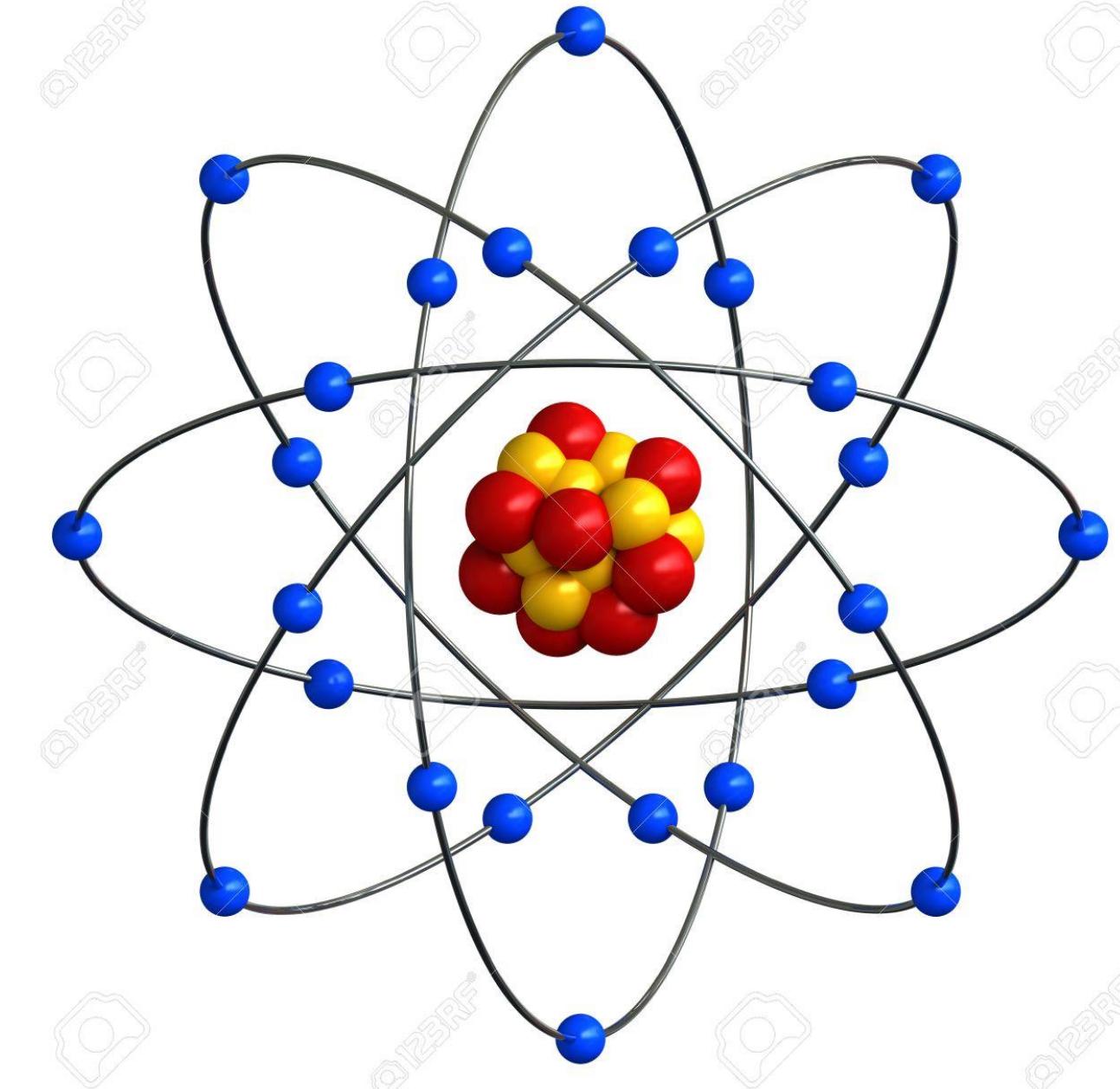
Nuclear and Electronic Structure

Nuclear level in an atom

Nucleus spin, magnetic properties:
NMR, Mossbauer studies

Electronic levels in an atom

Electronic band gap, transition
levels: UV-VIS, FTIR



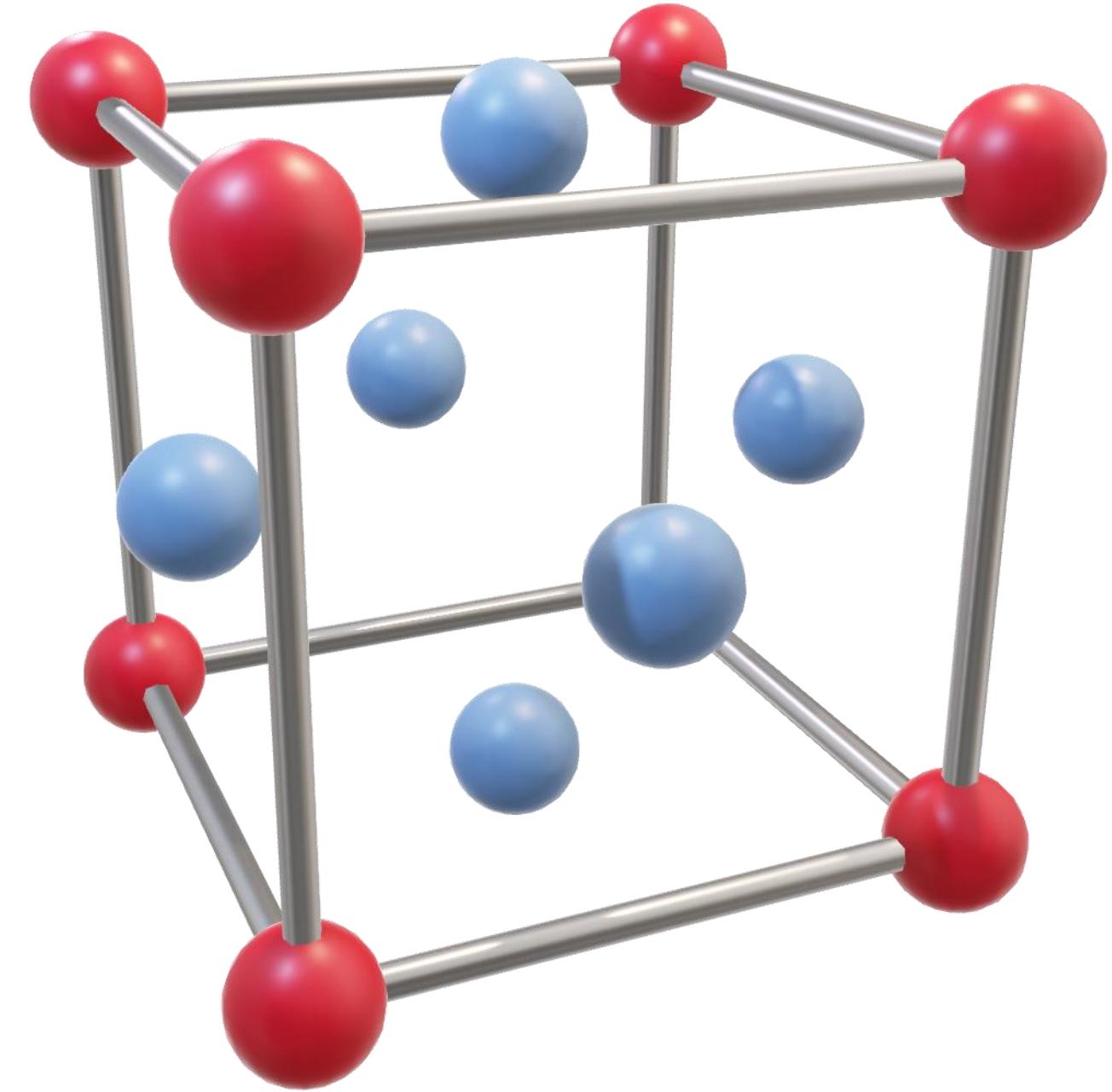
Crystal Structure

Arrangement of atoms in solid material

X-ray diffraction

Neutron diffraction

Electron diffraction



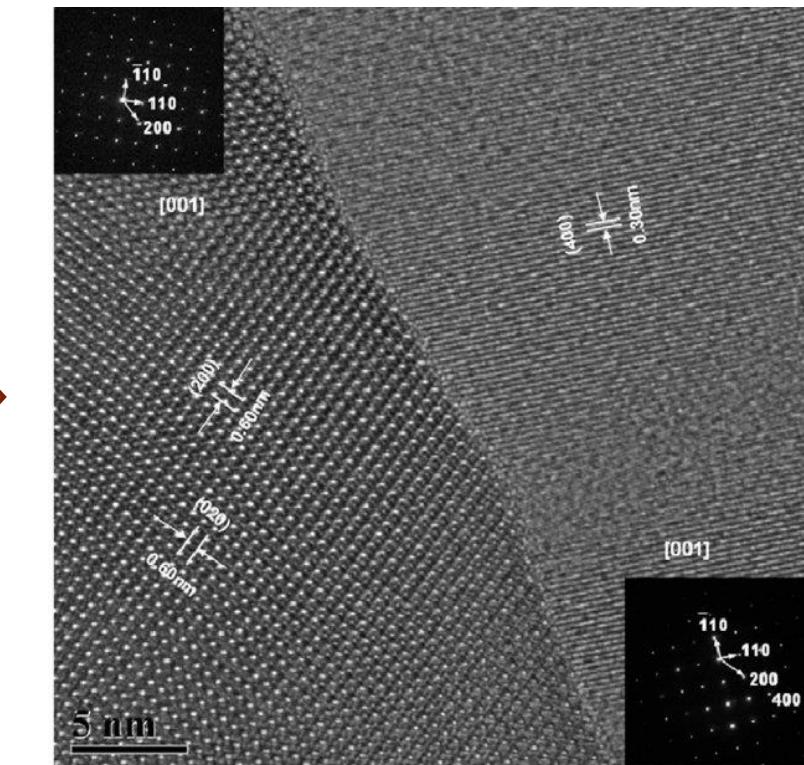
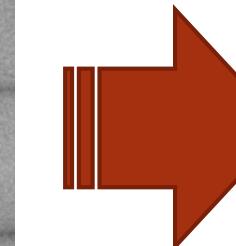
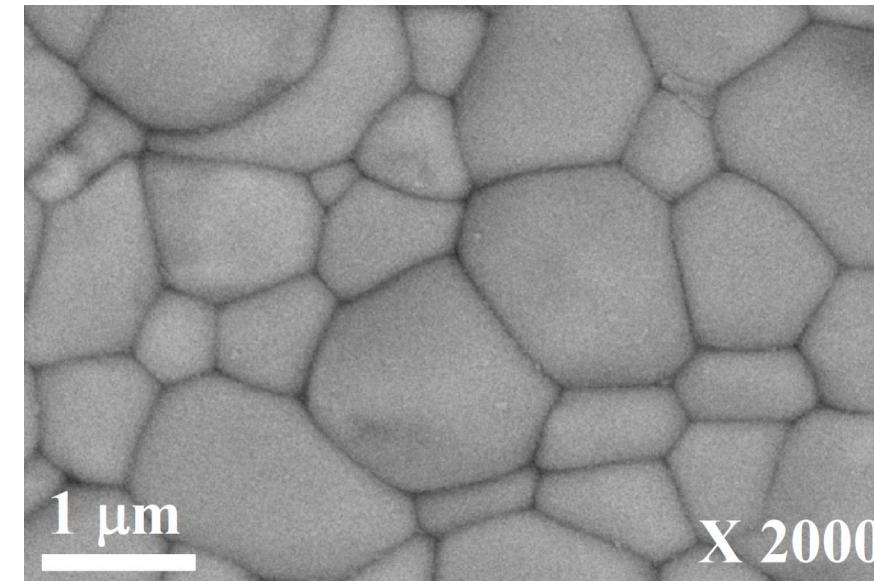
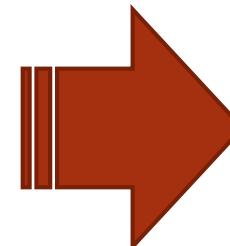
Remember

- Magnification: Action of magnifying something. It refers to enlarging the apparent size and not the physical size.
- Resolution: Ability to distinguish between two different points separately

Scanning Electron Microscopy

Magnification: $10^5 \times$

Resolution: $2 \times 10^{-9} \text{ m}$



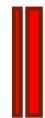
Transmission Electron Microscopy

Magnification: $10^7 \times$

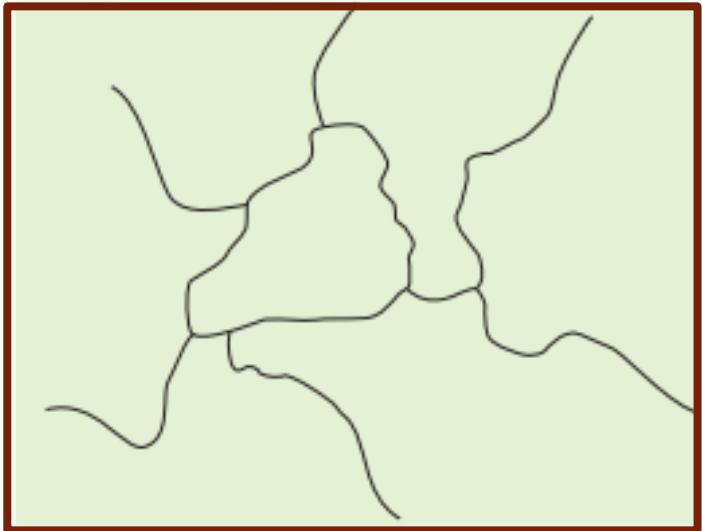
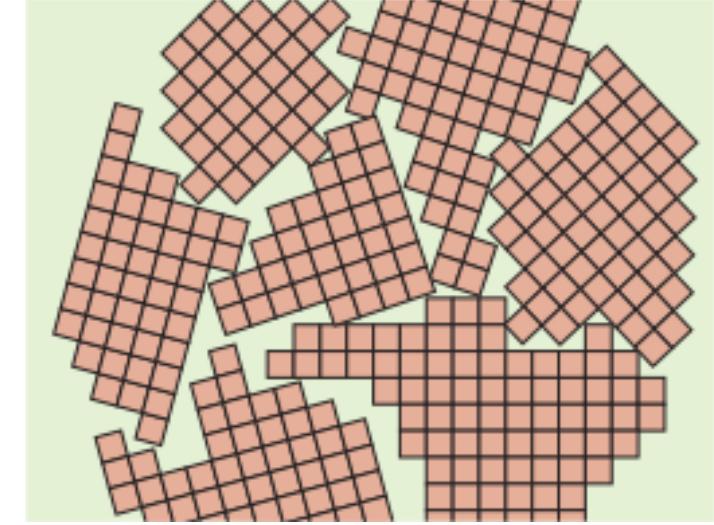
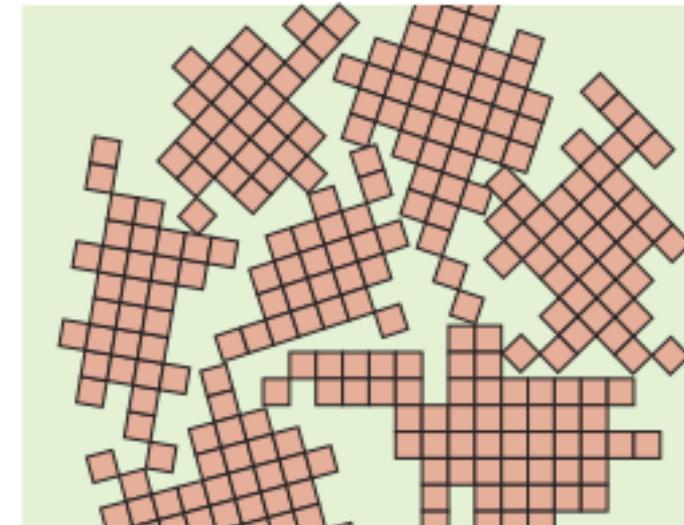
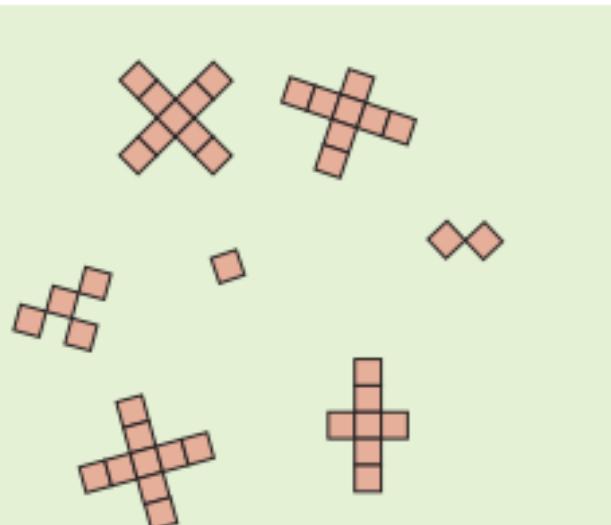
Resolution: 10^{-10} m

How grains are formed?

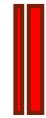
Melting



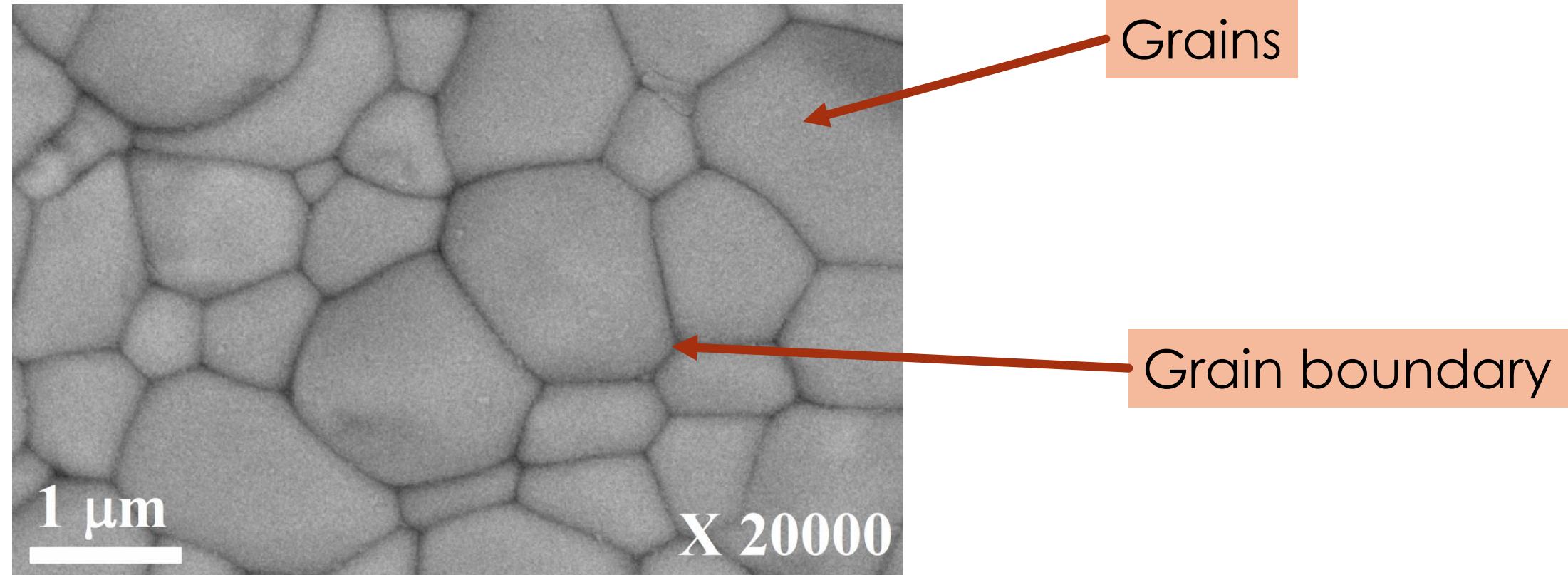
Solidification



Unit cells

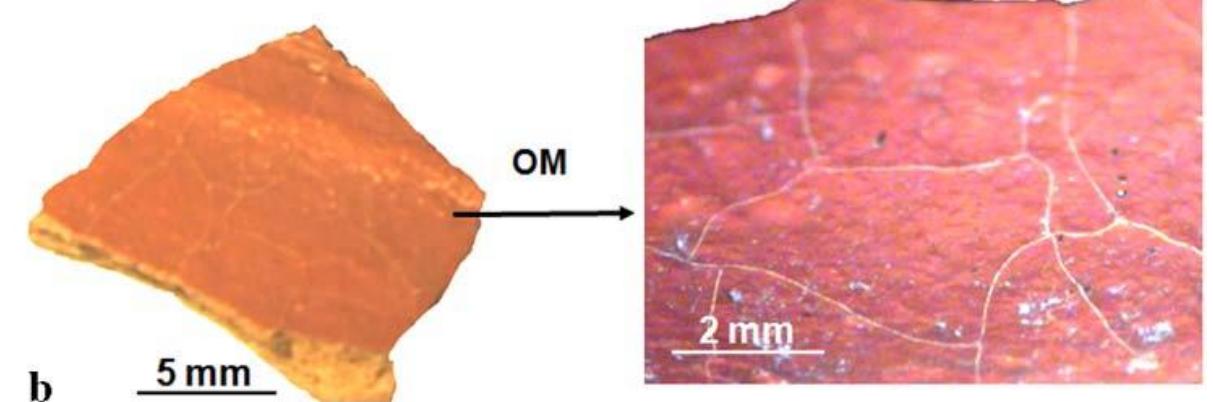
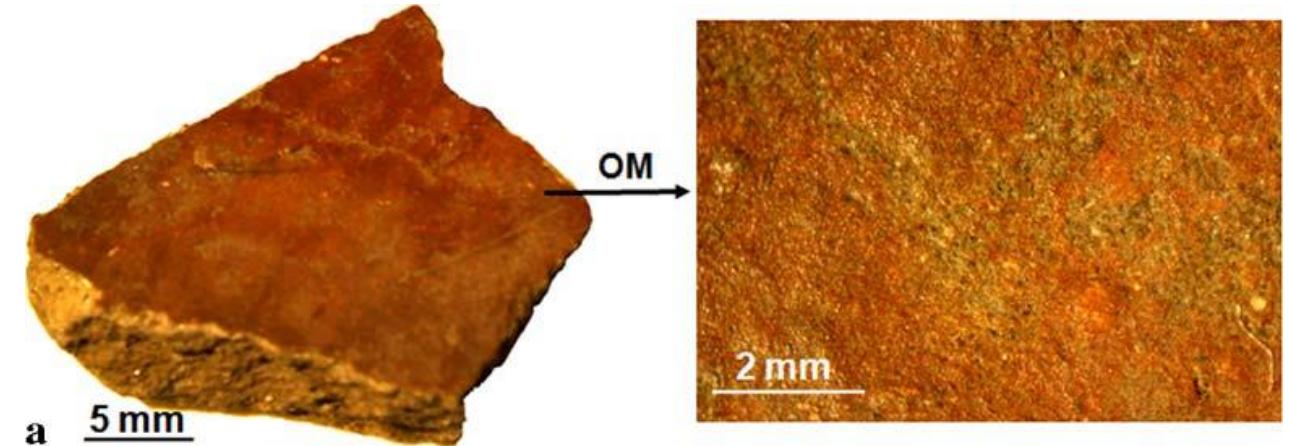


Grains



Each grain is a single crystallite (Atoms are arranged periodically).
Grain boundaries are amorphous in nature.

Observation with the aid of optical microscope



Optical Microscope

Magnification: 1500 X

Resolution: 10^{-7} m

Macrostructure

Everything that can be seen by naked eyes

Magnification: 50 x

Resolution: 10^{-4} m



Summary

1. Structure is the internal arrangement of atoms.
2. Nuclear structure is the smallest level in the structure.
3. Macrostructure is the largest level and can be observed by naked eyes.
4. We can change the property of any material by changing its structure.

Assignments

1. Name the different mechanical, thermal, electrical, magnetic, chemical, optical and physical properties of materials.
2. Mention different technological properties of metals and alloys and explain them.
3. Give five examples and applications of each of metal, alloy, ceramic, polymer, composite and electronic materials.
4. Differentiate between grain and grain boundary. Find some good micrographs showing grain and grain boundary clearly.
5. Identify the type(s) of bonding(s) present in the following materials: Graphite, Bakelite, Glass, SiC, CdS, AgCl, MgO, Al_2O_3 , Clay, Germanium, Brass, ZnO and also give their respective applications.
6. What is the difference between macrostructure, microstructure and substructure of the material?

Assignments

7. Find at least two optical microscope and SEM images of pure metals, alloys and composite materials.
8. What is the difference between an element and compound? List five elements which are metals, non-metals and metalloids.
9. Explain the difference between an amorphous and crystalline material with suitable example. Show a microstructure of any amorphous material.
10. What are composite, ceramics and alloys? Contrast between mixture and compound.
11. What do you understand by structure sensitive and structure insensitive properties of materials? Give at least three examples of each.
12. Which technique can be used to determine the substructure and crystal structure of materials? Give their resolution powers.
13. Write down the physical, electrical, mechanical properties of at least five polymeric materials.