Classification of Engineering materials:

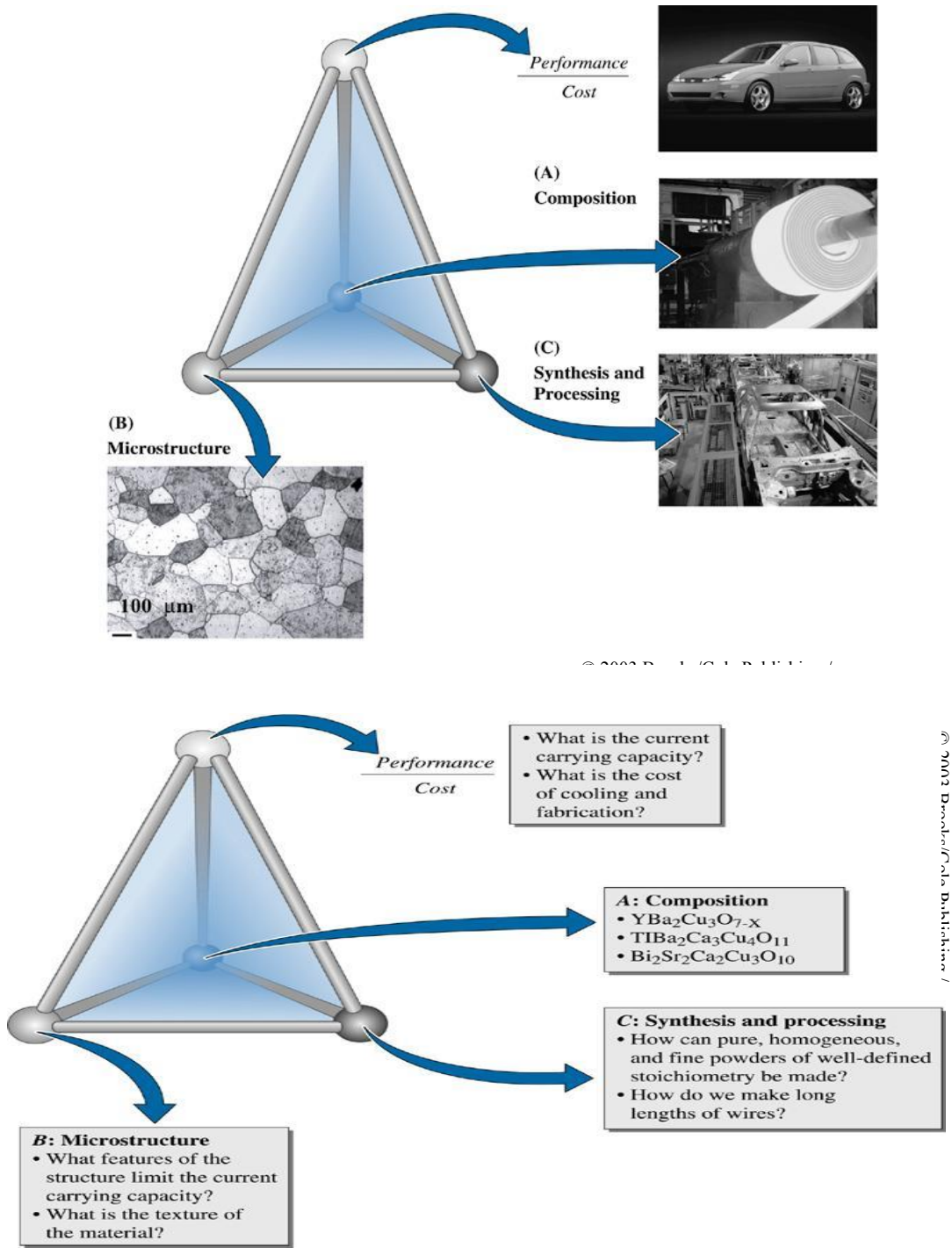


Figure 1.1 Application of the tetrahedron of materials science and engineering to ceramic superconductors. Note that the microstructure-synthesis and processing-composition are all interconnected and affect the performance-to-cost ratio

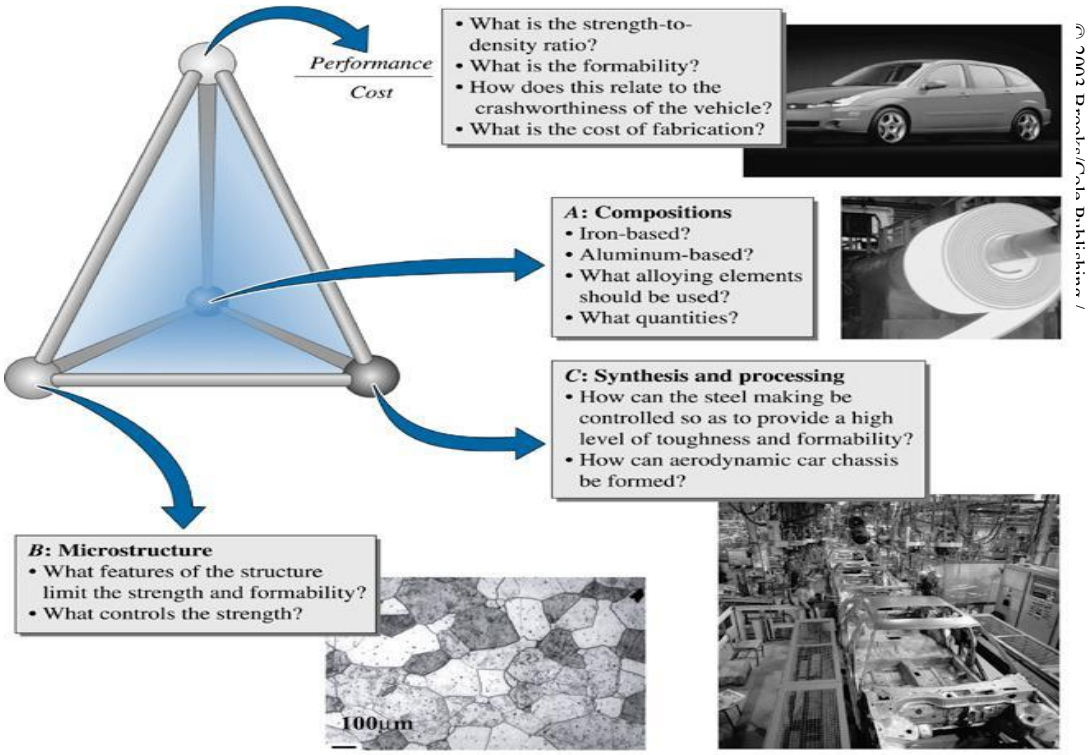


Figure 1.2 Application of the tetrahedron of materials science and engineering to sheet steels for automotive chassis. Note that the microstructure-synthesis and processing-composition are all interconnected and affect the performance-to-cost ratio

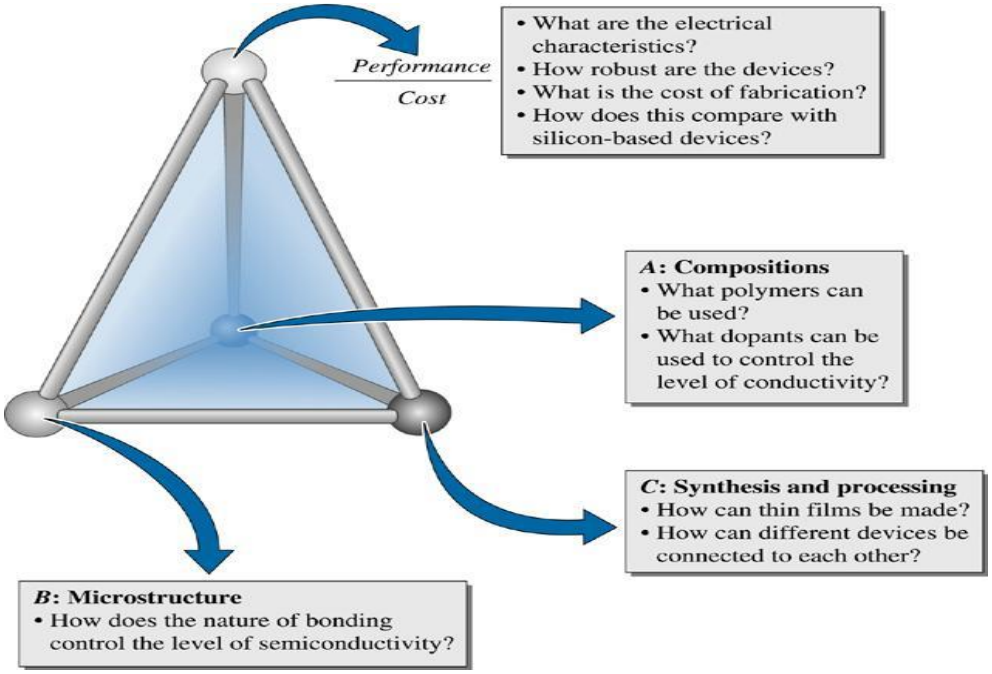


Figure 1.3 Application of the tetrahedron of materials science and engineering to semiconducting polymers for microelectronics.

General Classification of Engineering Materials

1- Metals and Alloys
2- Ceramics, Glasses,and Glass-ceramics
3- Polymers (plastics), Thermoplastics and Thermosets
4- Semiconductors
5- Composite Materials

Table 1.1 Representative examples, applications, and properties for each category of materials

material	Example of Applications	Properties
1-Metals and Alloys		
Gray cast iron	Automobile engine blocks	Castable, machinable, vibration dampings
2- Ceramics and Glasses		
SiO_2-Na_2O-CaO	Window glass	Optically transparent, thermally insulating
3- Polymers		
Polyethylene	Food packaging	Easily formed into thin, flexible, airtight film
4- Semiconductors		
Silicon	Transistors and integrated circuits	Unique electrical behavior
5- Composites Tungsten carbide -cobalt (WC-Co)	Carbide cutting tools for machinig	High hardness, good shock resistance

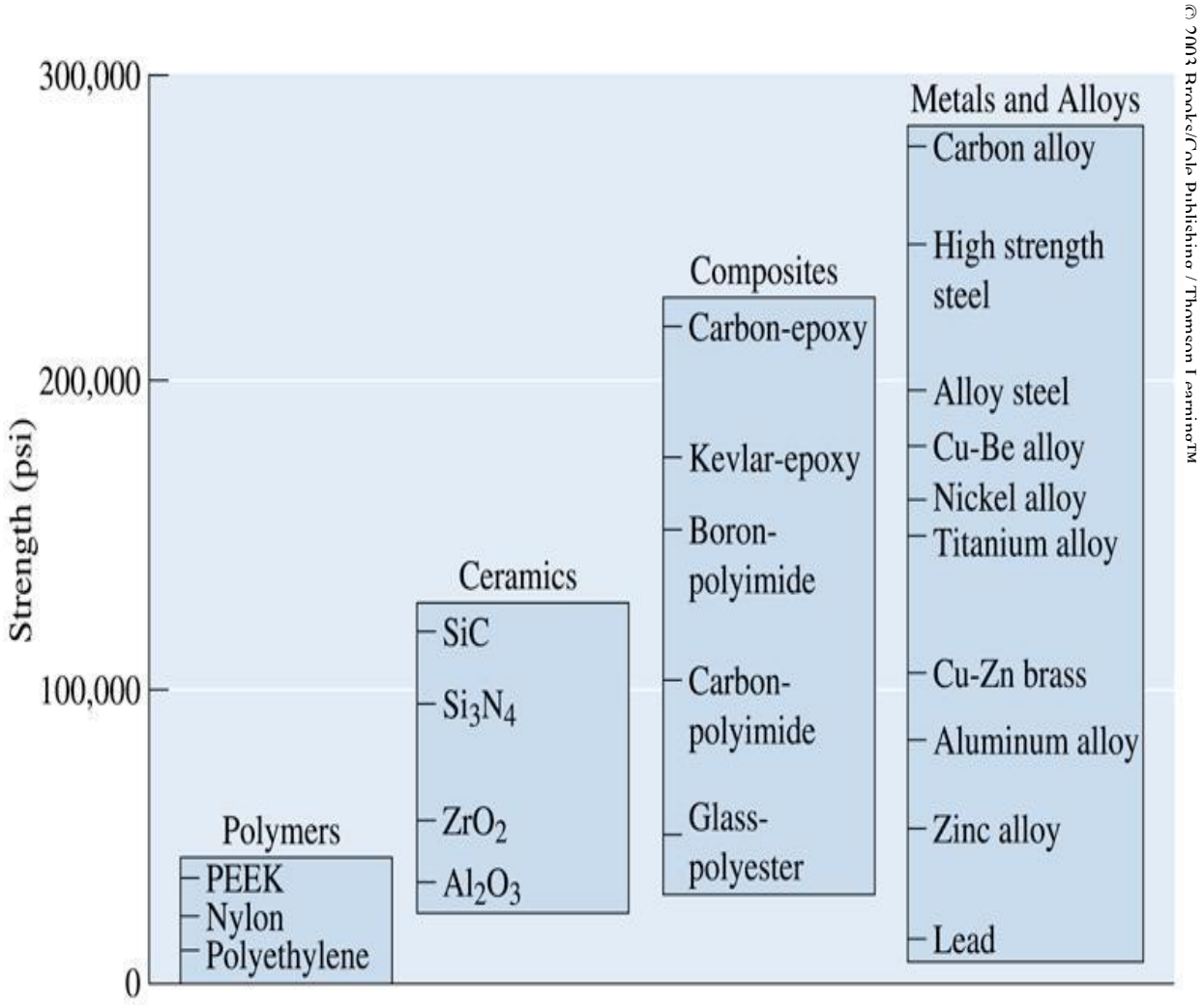
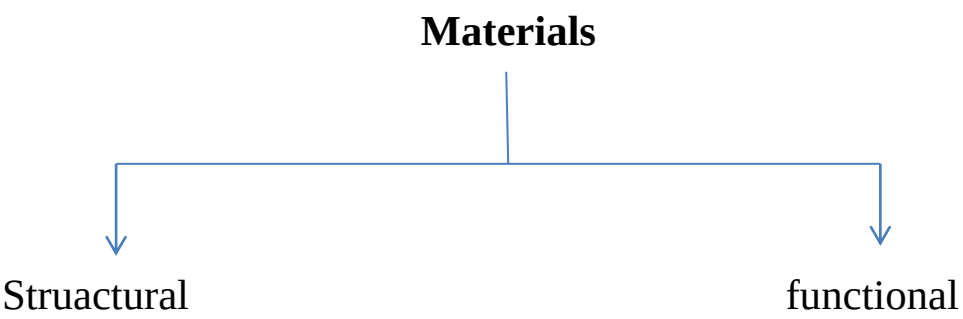


Figure 1.4 Representative strengths of various categories of materials

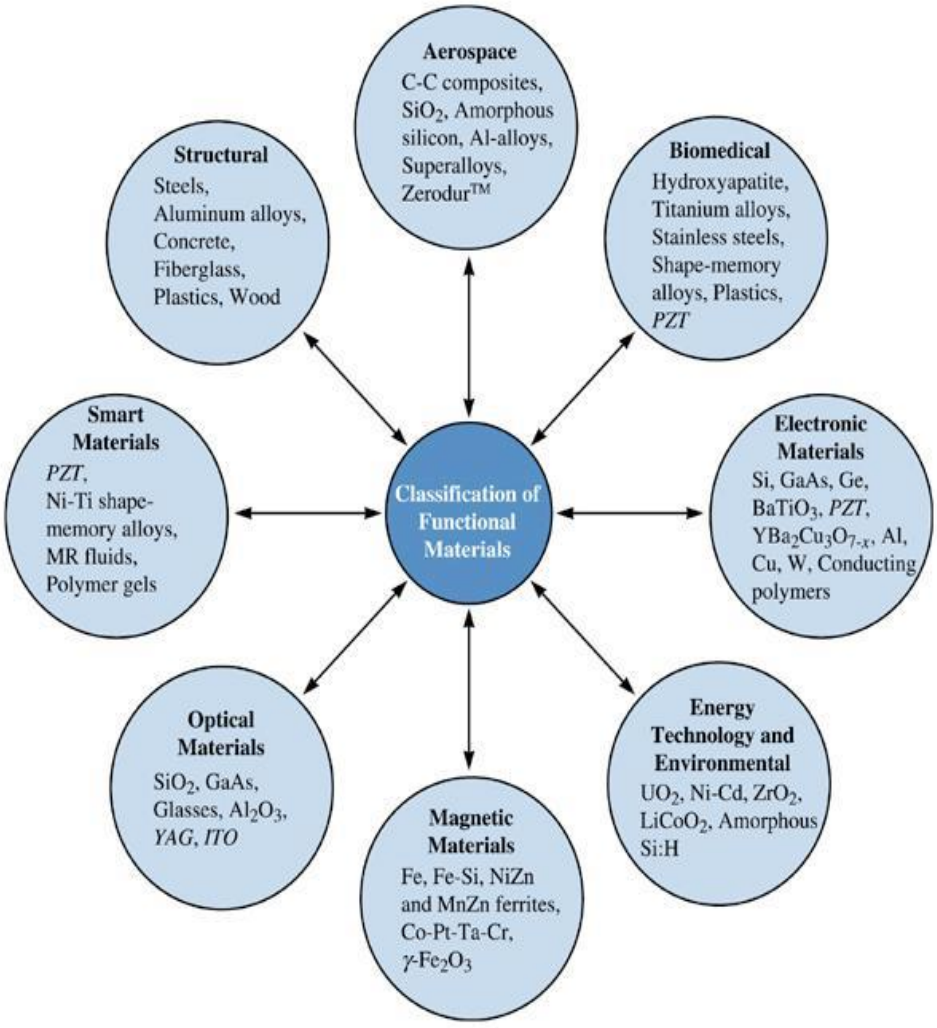
There are <u>three</u> general classification for materials

The one as follows

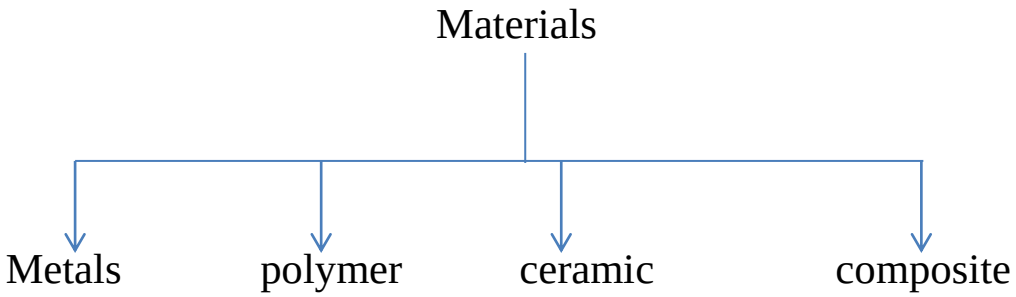


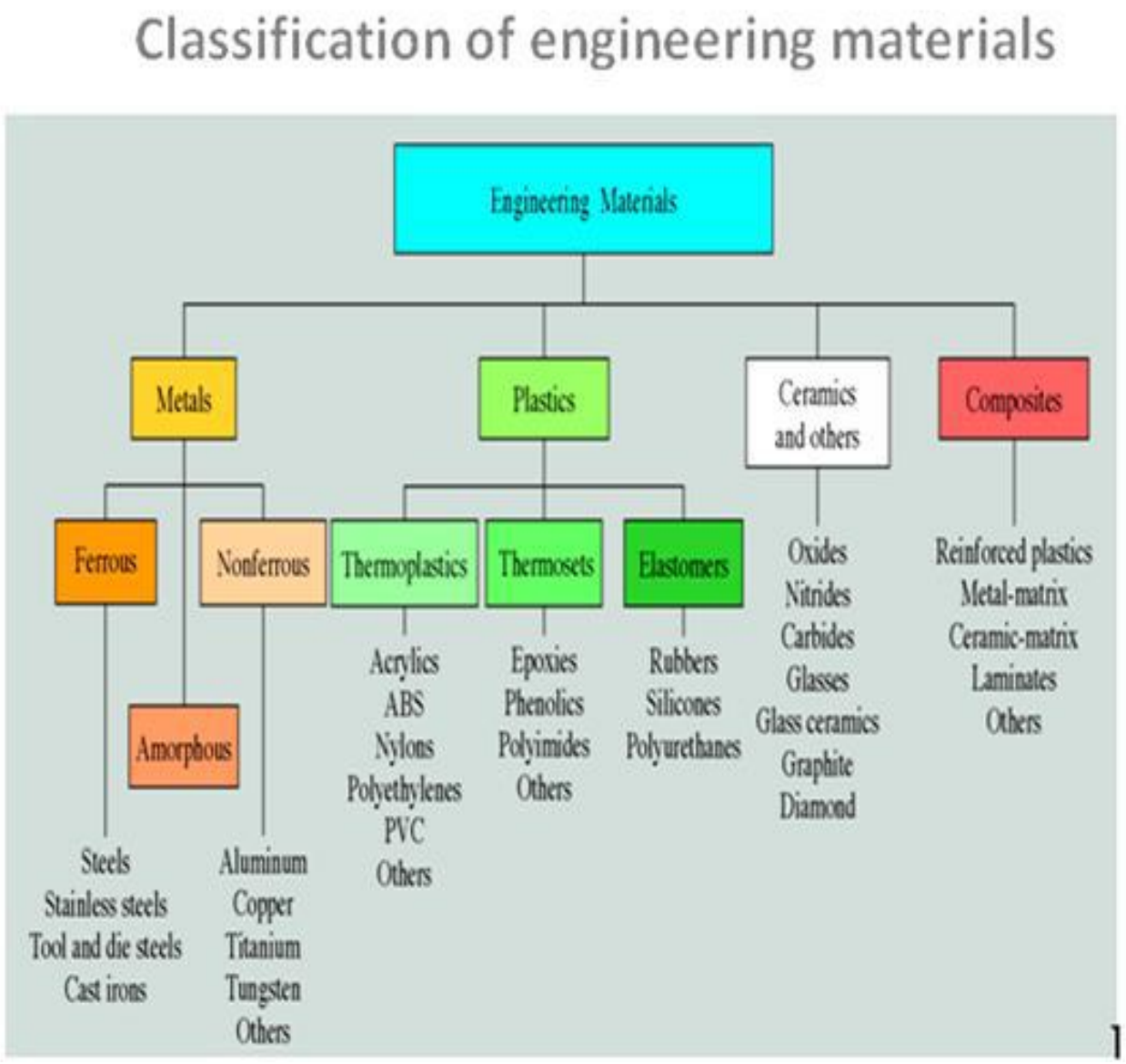
Functional Classification of Materials

1- Aerospace
2- Biomedical
3- Electronic Materials
4- Energy Technology and Environmental Technology
5- Magnetic Materials
6- Photonic or Optical Materials
7- Smart Materials
8- Structural Materials

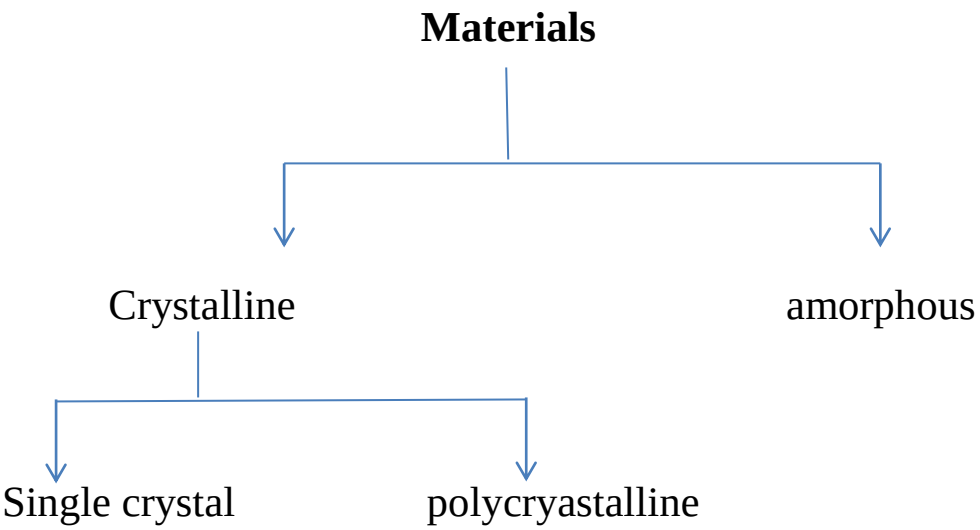


The second as follows





The third as follows



Almost every substance known to man has found its way into the engineering workshop at some time or other. The most convenient way to study the properties and uses of engineering materials is to classify them
into 'families' as shown in figure below (1) :

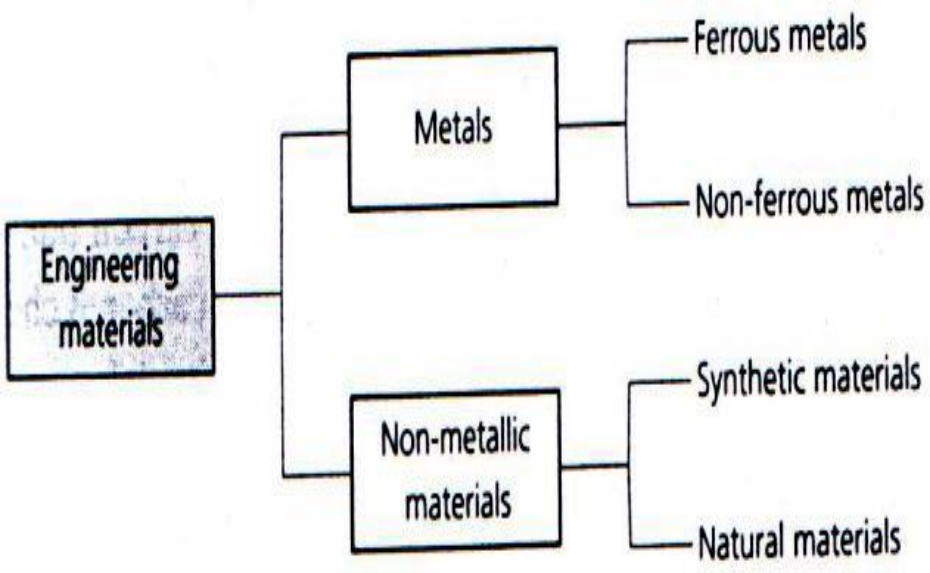
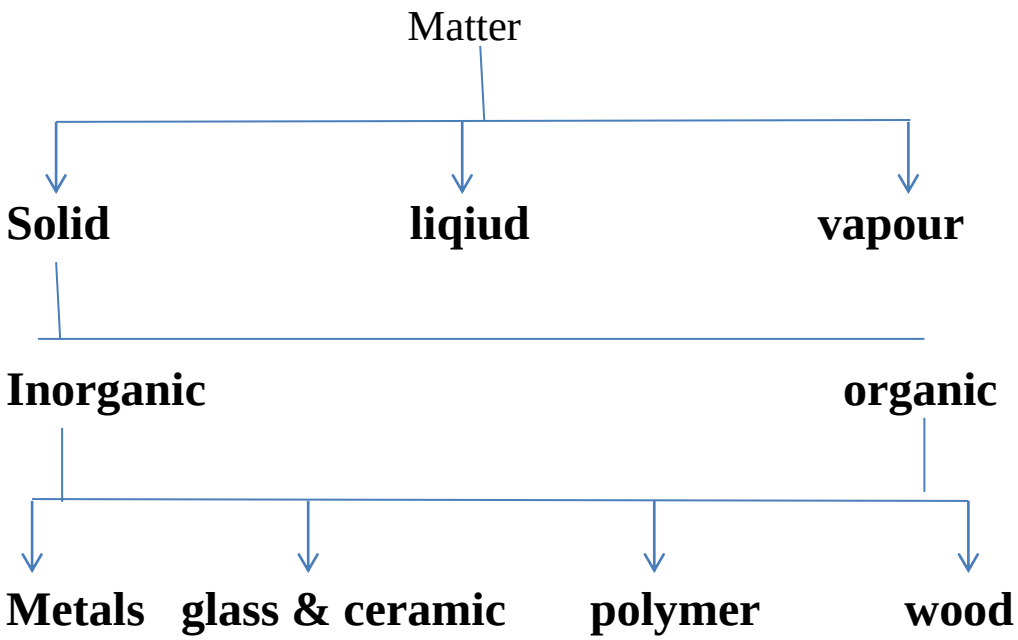


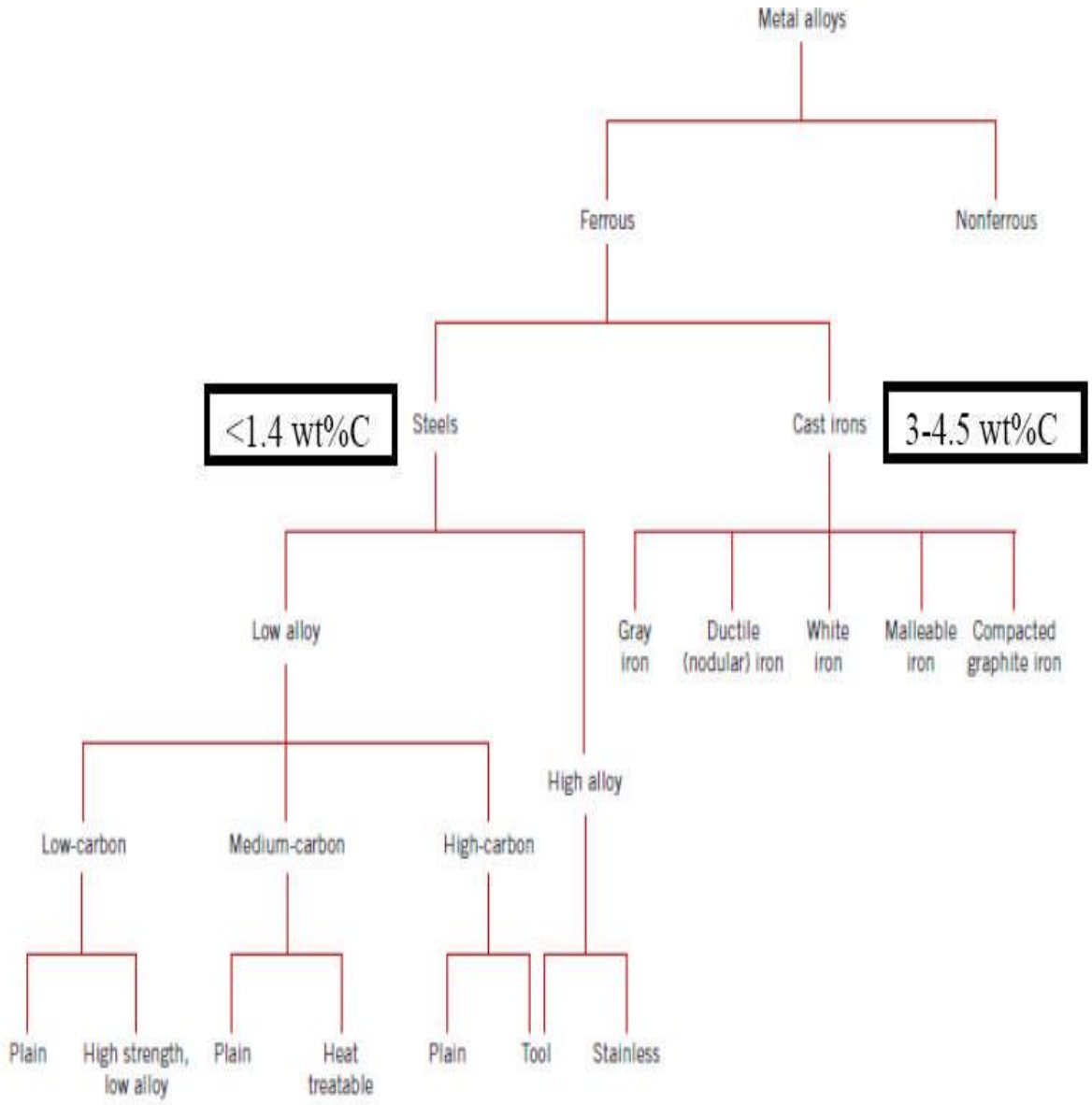
FIG (1) classification of engineering materials.

the physical classificatiom of materials acording to state of matter as follws



Physical classification of materials by state.

1 - Metals



1.1 Ferrous metals

- These are metals and alloys containing a high proportion of the element iron.

- They are the strongest materials available and are used for applications where high strength is required at relatively low cost and where weight is not of primary importance.

As an example of ferrous metals such as : bridge building, the structure of large buildings, railway lines, locomotives and

rolling stock and the bodies and highly stressed engine parts of road vehicles.

- The ferrous metals themselves can also be classified into "families', and these are shown in figure (2). •

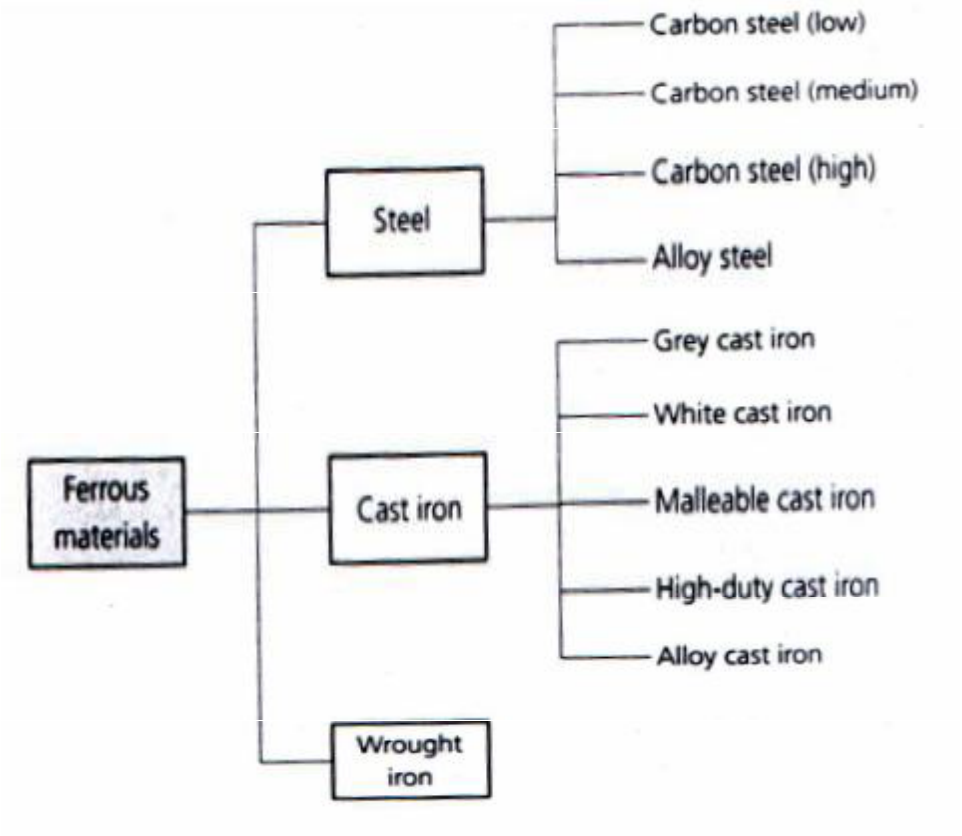


Fig (2) Classification of ferrous metals.

1.2 Non – ferrous metals

- These materials refer to the remaining metals known to mankind. The pure metals are rarely used as structural materials as they lack mechanical strength.

- They are used where their special properties such as corrosion resistance, electrical conductivity and thermal conductivity are required. Copper and aluminum are used

as electrical conductors and, together with sheet zinc and sheet lead, are use as roofing materials.

- They are mainly used with other metals to improve their strength.

Some widely used non-ferrous metals and alloys are classified as shown in figure (3).

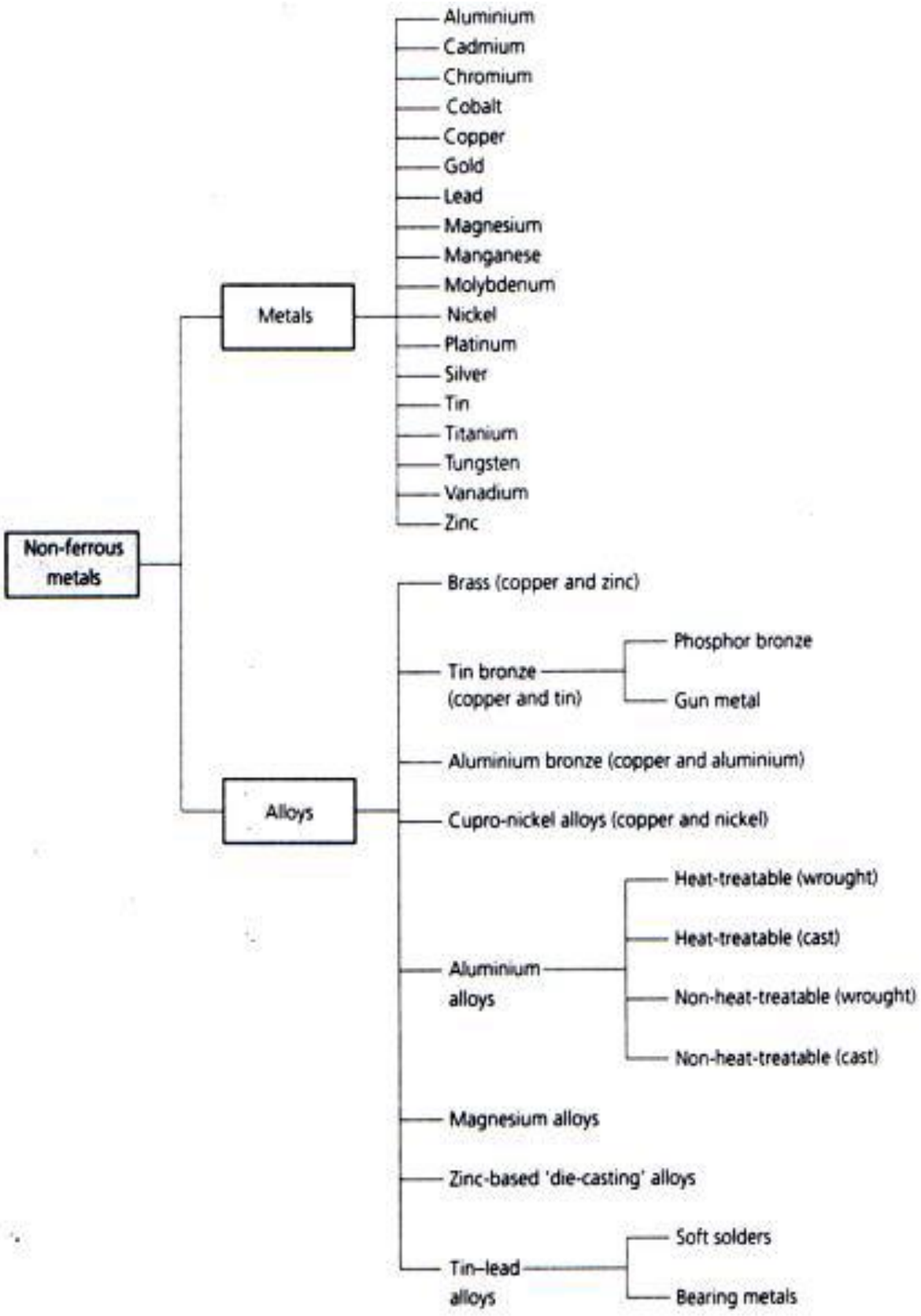


Fig (3) Classification of non-ferrous metals and alloys.

2. Non – metallic materials

2.1 Non – metallic (synthetic materials)

These are non – metallic materials that do not exist in nature, although they are manufactured from natural substances such as oil, coal and clay. Some typical examples are classified as shown in fig (4).

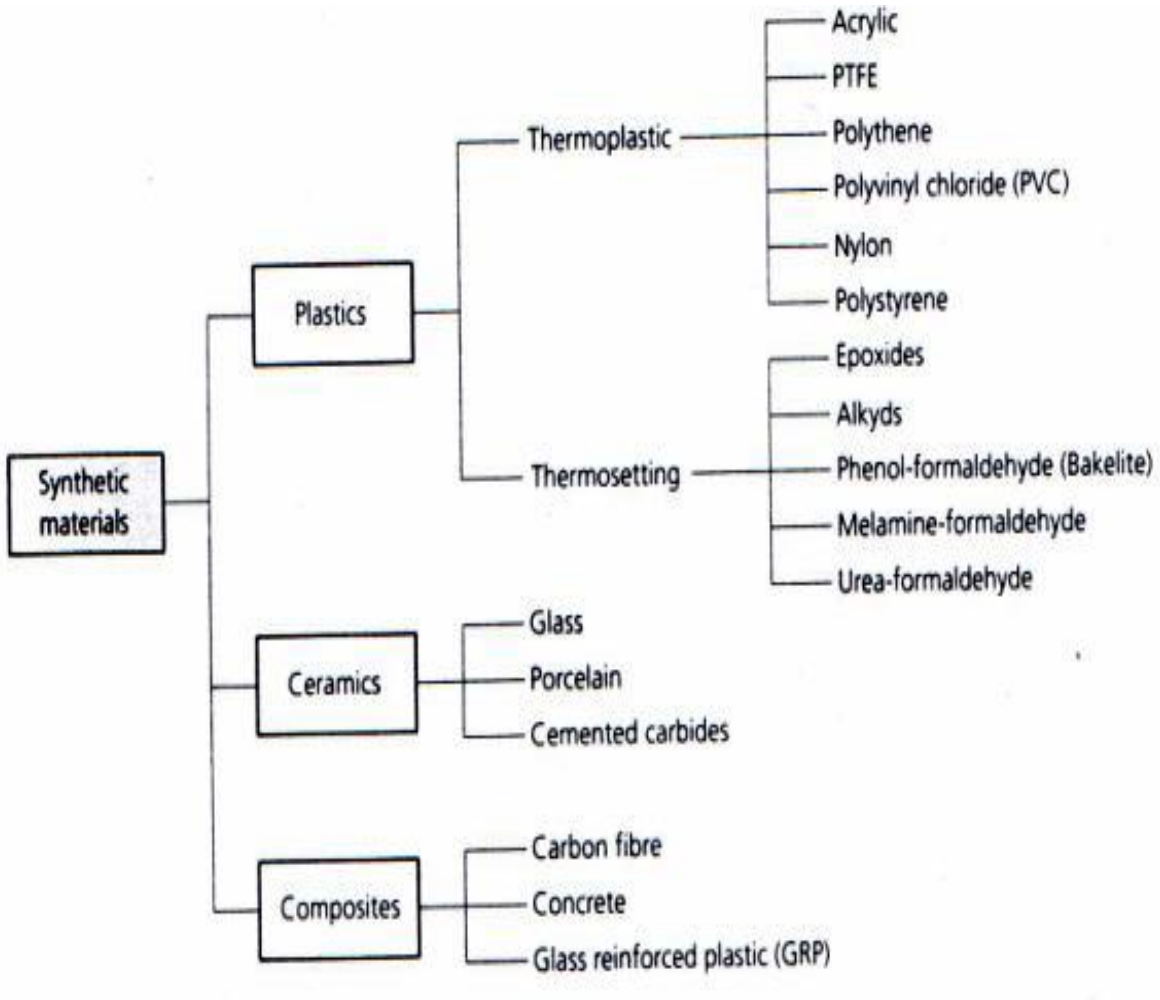


fig (4) classification of synthetic materials.

They combine good corrosion resistance with ease of manufacture by moulding to shape and relatively low cost.

Synthetic adhesives are also being used for the joining of metallic components even in highly stressed applications.

2.2 Non – metallic (Natural materials)

Such materials are so diverse that only a few can be listed here to give a basic introduction to some typical applications.

Wood:

This is naturally occurring fibrous composite material used for the manufacture of casting patterns.

Rubber :

This is used for hydraulic and compressed air hoses and oil seals. Naturally occurring latex is too soft for most engineering uses but it is used widely for vehicle tyres when it is compounded with carbon black.

Glass :

This is a hardwearing, abrasion-resistant material with excellent weathering properties. It is used for electrical insulators, laboratory equipment, optical components in measuring instruments, in the form of fibers, is used to reinforce plastics. It is made by melting together the naturally occurring materials : silica (sand), limestone (calcium carbonate) and soda (sodium carbonate).

Emery :

This is a widely used abrasive and is a naturally occurring aluminum oxide. Nowadays it is produced synthetically to maintain uniform quality and performance

.

Ceramic:

These are produced by baking naturally occurring clays at high temperatures after moulding to shape. They are used for high – voltage insulators and high – temperature – resistant cutting tool tips.

Diamonds:
These can be used for cutting tools for operation at high speeds for metal finishing where surface finish is greater importance. For example, internal combustion engine pistons and bearings. They are also used for dressing grinding wheels.

Oils :
Used as bearing lubricants, cutting fluids and fuels.

Silicon :
This is used as an alloying element and also for the manufacture of semiconductor devices.

These and other natural, non-metallic materials can be classified as shown in figure (6).

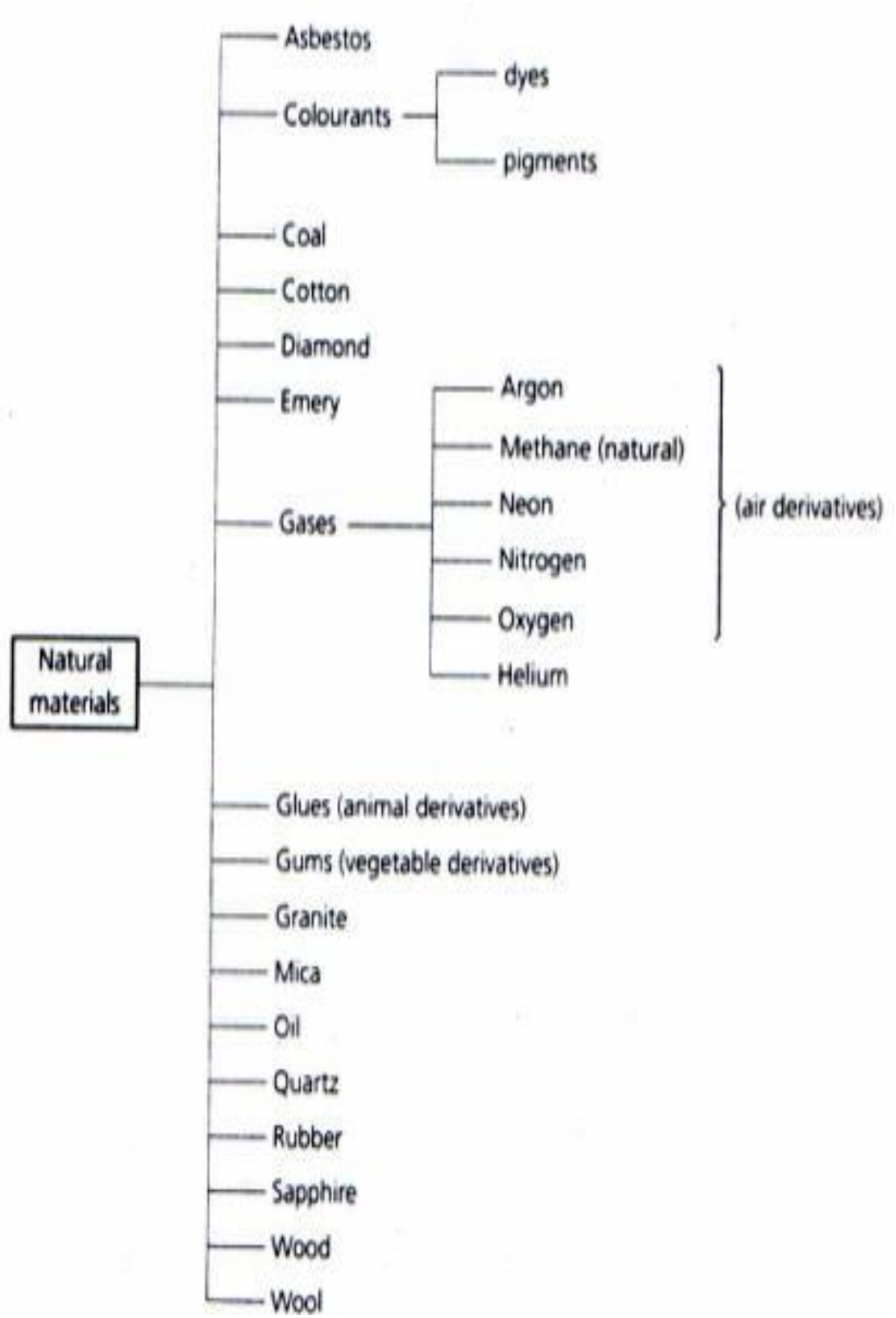


Fig (6) Classification of natural materials.

Environmental and Other Effects

Effects of following factors must be accounted for in design to ensure that components do not fail unexpectedly:

1- Temperature

2- Corrosion

3- Fatigue

4- Strain Rate

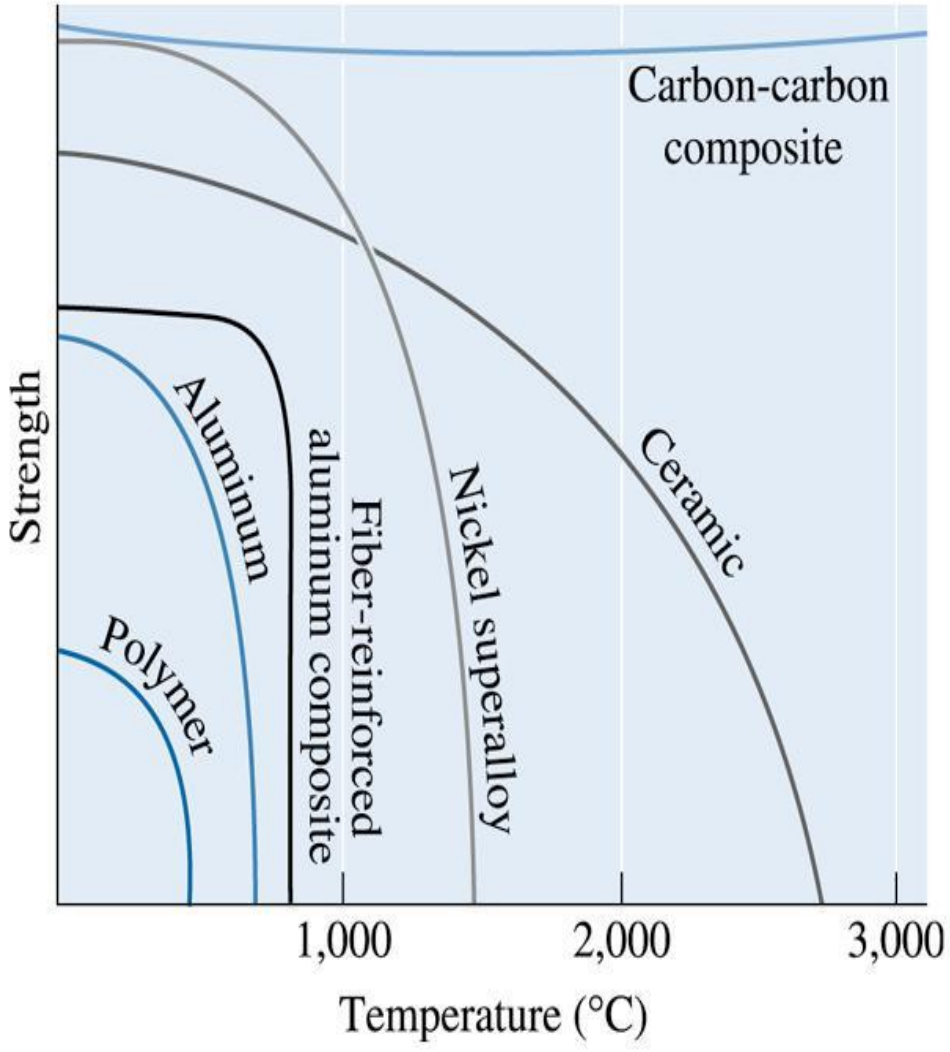


Figure 1.12 Increasing temperature normally reduces the strength of a material. Polymers are suitable only at low temperatures. Some composites, special alloys, and ceramics, have excellent properties at high temperatures