

INTRODUCTION TO CERAMICS, GLASS AND REFRACTORIES

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9) COMPOSITES

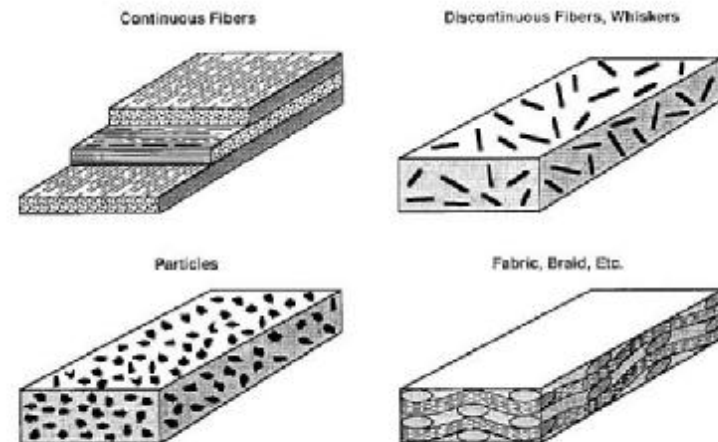
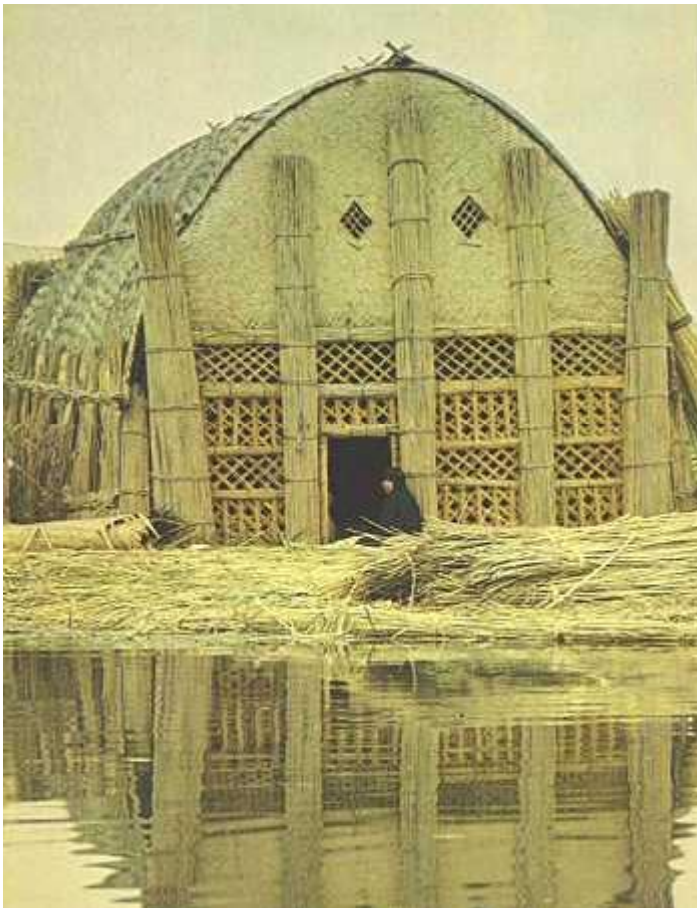


Figure 1 Reinforcement forms.

Composite material is a material composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents.

Composites are combinations of two or more materials in which one of the materials, called the **reinforcing phase**, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the **matrix phase**. The reinforcing material and the matrix material can be metal, ceramic, or polymer. The dispersed phase is usually stronger than the matrix, therefore it is called reinforcing phase.

Examples of some current application of composites include the diesel piston, brake-shoes and pads, tires and aircraft in which 100% of the structural components are composites.



Classification of Composites

Based on Matrix Material

Metal Matrix Composites **MMC** are composed of a metallic matrix (aluminium, magnesium, iron, cobalt, copper) and a dispersed ceramic (oxides, carbides) or metallic (lead, tungsten, molybdenum) phase.

Ceramic Matrix Composites **CMC** are composed of a ceramic matrix and embedded fibers or Whiskers of other ceramic material (dispersed phase).

Polymer Matrix Composites **PMC** are composed of a matrix from thermoset (Unsaturated Polyester (UP), Epoxy (EP)) or thermoplastic (Polycarbonate (PC), Polyvinylchloride, Nylon Polyesterene) and embedded glass, carbon, steel or Kevlar fibers (dispersed phase).

Based on Reinforcing Material

Fiber Composites

1. Short-fiber or Whiskers reinforced composites. consist of a matrix reinforced by a dispersed phase in form of discontinuous fibers (length $< 100 \times$ diameter) or Whiskers (Length less than 15μ and diameter of less than 1μ)
 - A. Composites with random orientation of fibers.
 - B. Composites with preferred orientation of fibers.
2. Long-fiber reinforced composites. Long-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of continuous fibers.
 - A. Unidirectional orientation of fibers.
 - B. Bidirectional orientation of fibers (woven).

Particulate Composites

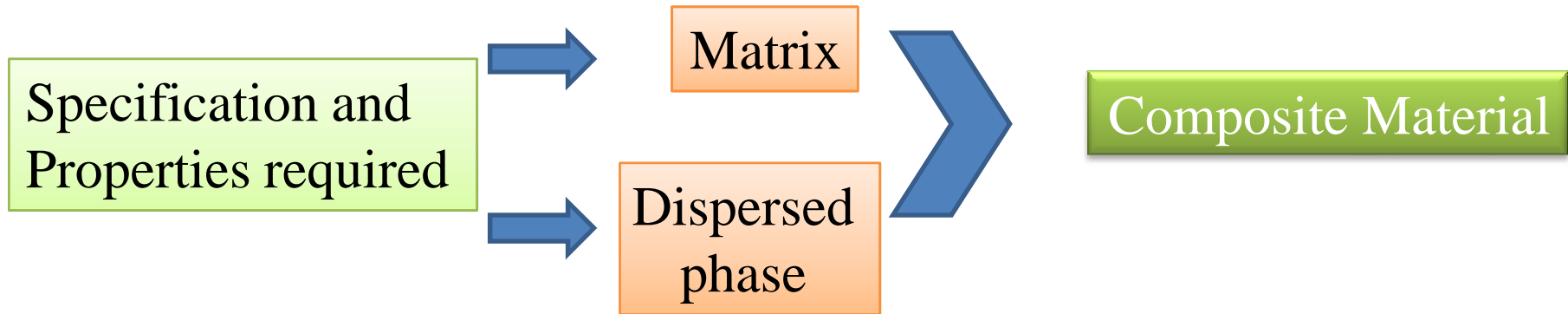
Particulate Composites consist of a matrix reinforced by a dispersed phase in form of particles.

1. Composites with random orientation of particles.
 2. Composites with preferred orientation of particles.
- Dispersed phase of these materials consists of two-dimensional flat platelets (flakes), laid parallel to each other.

Laminate Composites

When a fiber reinforced composite consists of several layers with different fiber orientations, it is called multilayer (angle-ply) composite.

Design with composites



Possible Advantages

- Light weight
- High strength
- High Hardness
- High Toughness
- High corrosion resistance
- High impact resistance
- Durability