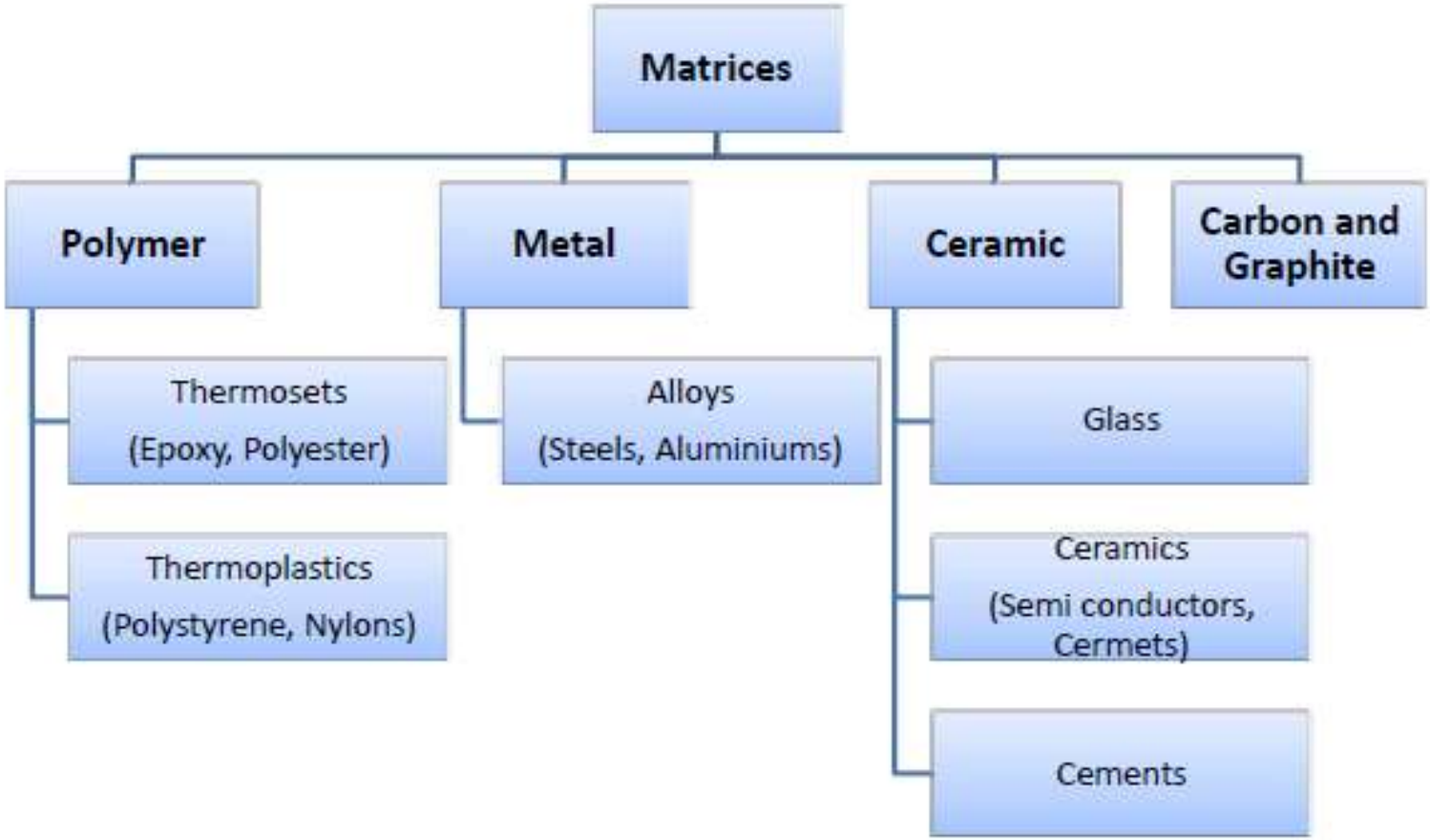
CONTENTS

INTRODUCTION

- A composite material can be defined as a combination of two or more materials (having significantly different physical or chemical properties) that results in better properties than those of the individual components.
- The constituents retain their identities in the composite; that is, they do not dissolve or otherwise merge completely into each other, although they act in concert.
- Composites are one of the most widely used materials because of their adaptability to different situations and the relative ease of combination with other materials to serve specific purposes and exhibit desirable properties.
- The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials.

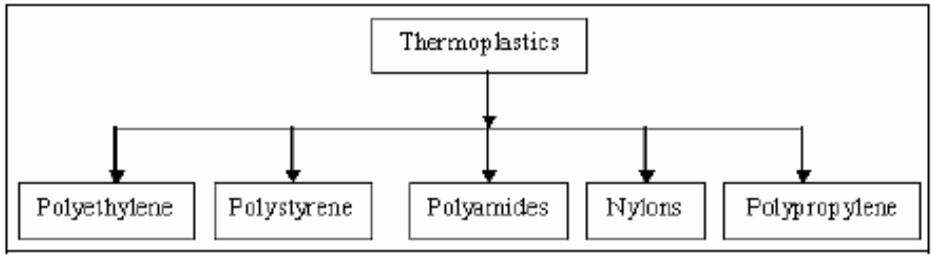
CLASSIFICATION OF COMPOSITE MATERIALS

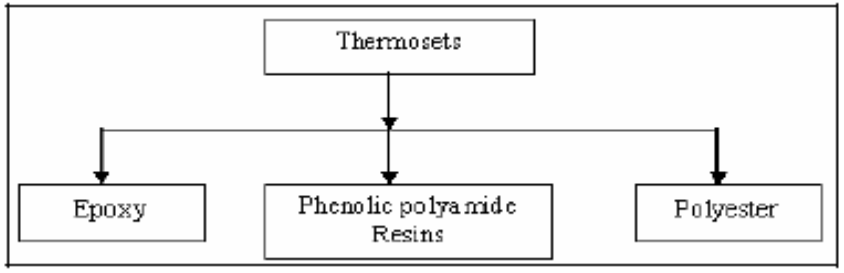
The composites are classified as mainly two constituents are matrix and a reinforcement



ORGANIC/POLYMER MATRIX COMPOSITE (PMCs)

Two main kinds of polymers are thermosets and thermoplastics





- Thermosets have qualities such as a well-bonded three dimensional molecular structure after curing. They decompose instead of melting on hardening.
- Thermoplastics have one or two dimensional molecular structure and they tend to at an elevated temperature and show exaggerated melting point. Another advantage is that the process of softening at elevated temperatures can reversed to regain its properties during cooling.

METAL MATRIX COMPOSITE (MMCs)

- Metal matrix composites are High strength, fracture toughness and stiffness are offered by metal matrices than those offered by their polymer counterparts. They can withstand elevated temperature in corrosive environment than polymer composites.
- MMCs are widely used in engineering applications where the operating temperature lies in between 250 ºC to 750 ºC.
- Matrix materials: Steel, Aluminum, Titanium, Copper, Magnesium and Super alloys.

CERAMIC MATRIX COMPOSITE (CMCs)

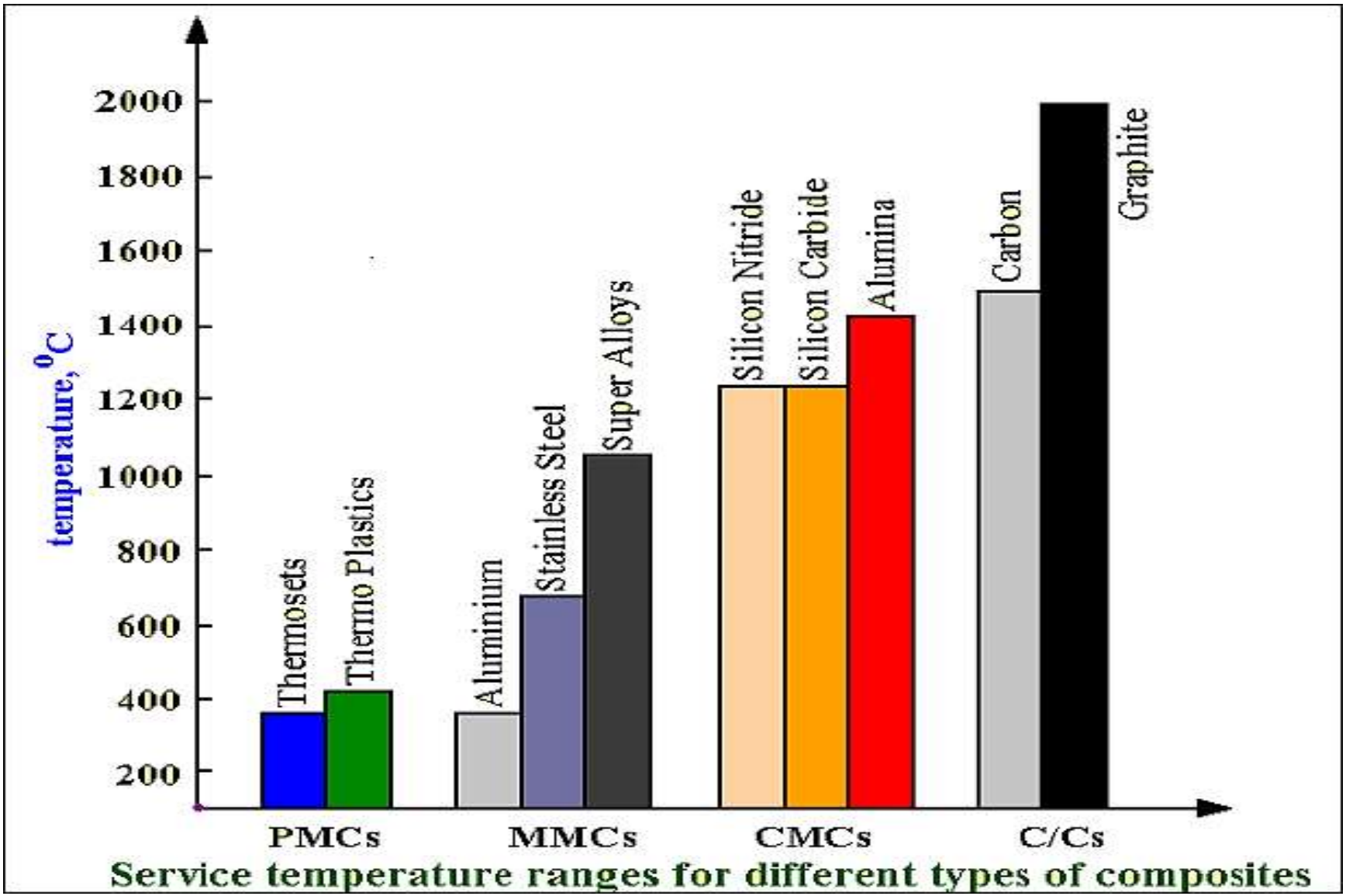
- Ceramics can be described as solid materials which exhibit very strong ionic bonding in general and in few cases covalent bonding. High melting points, good corrosion resistance, stability at elevated temperatures and high compressive strength
- CMCs are widely used in engineering applications where the operating temperature lies in between 800ºC to 1650ºC

CARBON/CARBON MATRIX COMPOSITE

- C/Cs are developed specifically for parts that must operate in extreme temperature ranges. Composed of a carbon matrix reinforced with carbon yarn fabric, 3-D woven fabric, 3-D braiding, etc.
- C/C composites meet applications ranging from rockets to aerospace because of their ability to maintain and even increase their structural properties at extreme temperatures.

Advantages:

- Extremely high temperature resistance (1930°C – 2760°C).
- Strength actually increases at higher temperatures (up to 1930°C).
- High strength and stiffness.
- Good resistance to thermal shock.



Service temperature ranges for different types of composites

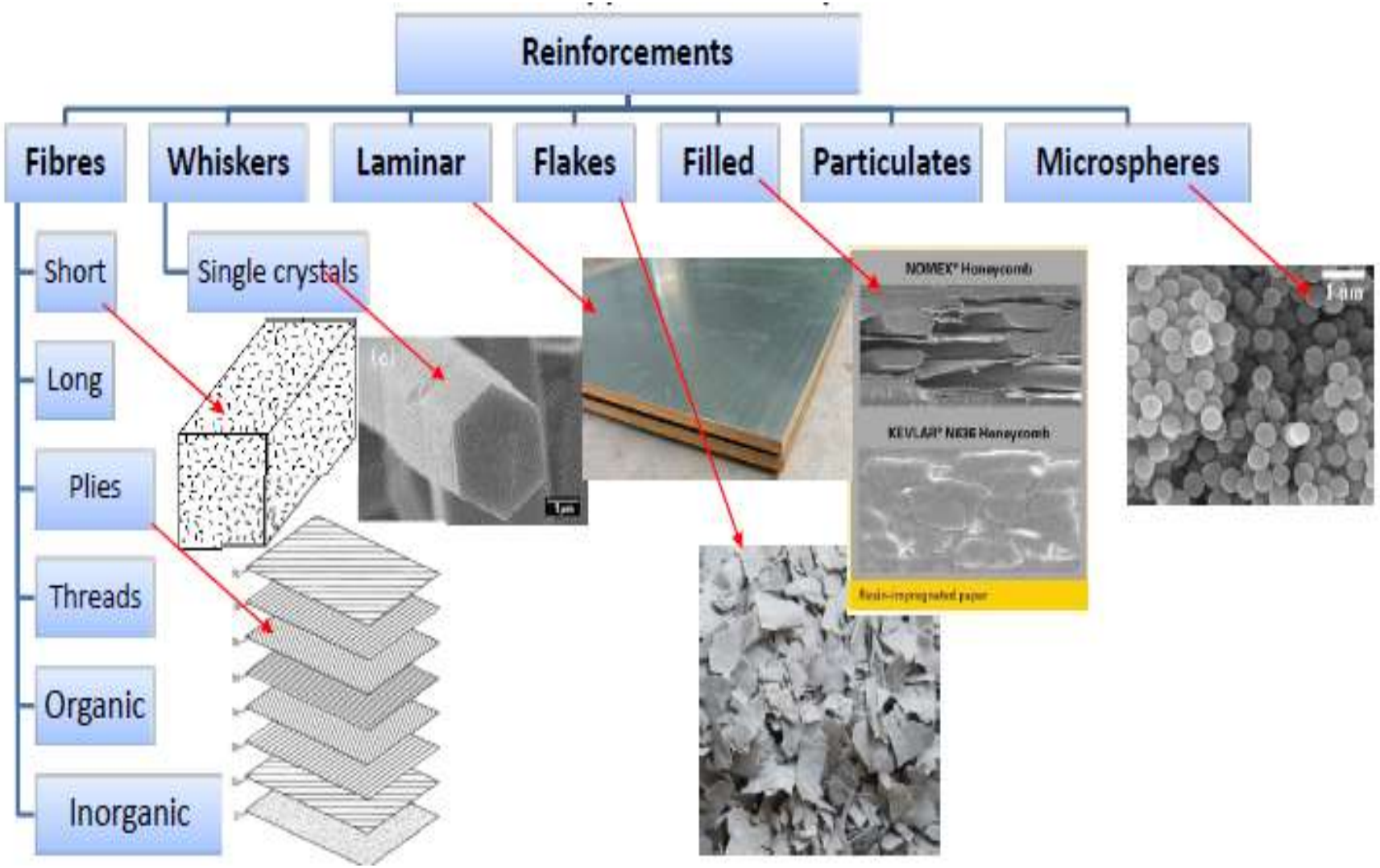
FUNCTIONS OF A MATRIX

- Holds the fibers together.
- Protects the fibers from environment.
- Distributes the loads evenly between fibers so that all fibers are subjected to the same amount of strain.
- Enhances transverse properties of a laminate.
- Improves impact and fracture resistance of a component.
- Carry inter laminar shear.

DESIRED PROPERTIES OF A MATRIX

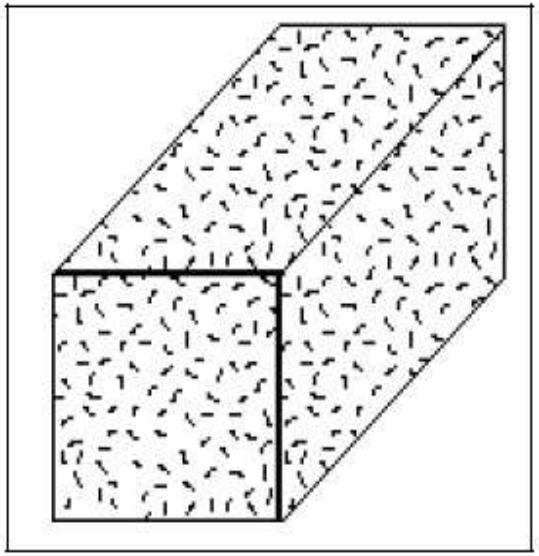
- Reduced moisture absorption.
- Low shrinkage.
- Low coefficient of thermal expansion.
- Strength at elevated temperature (depending on application).
- Low temperature capability (depending on application).
- Excellent chemical resistance (depending on application).

CLASSIFICATION OF COMPOSITE MATERIALS

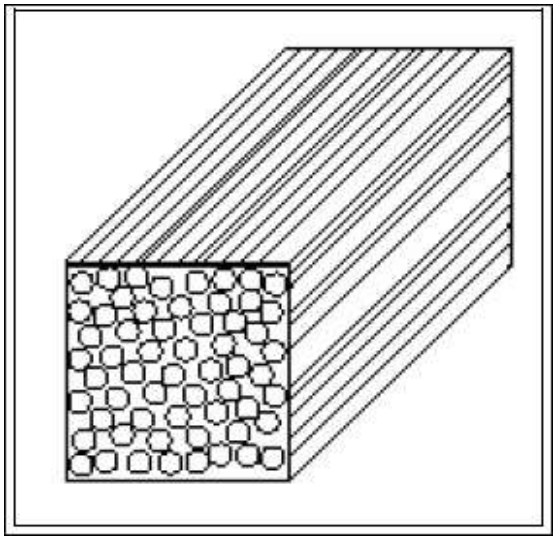


FIBER REINFORCED COMPOSITES

Fibers are the important class of reinforcements, as they satisfy the desired conditions and transfer strength to the matrix constituent influencing and enhancing their properties as desired.



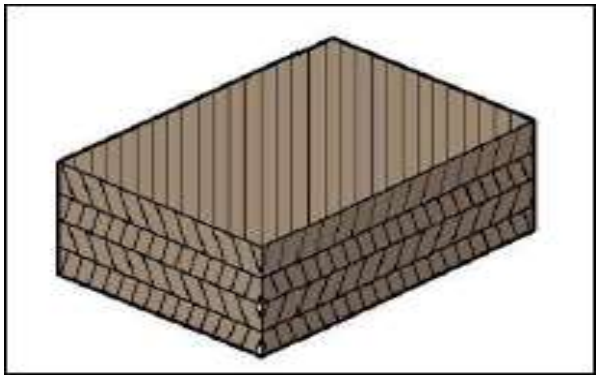
Random fiber (short fiber) reinforced composites



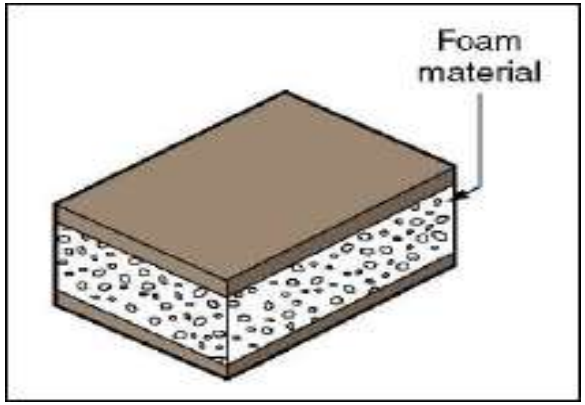
Continuous fiber (long fiber) reinforced composites

LAMINAR COMPOSITES

Laminar composites are found in as many combinations as the number of materials. They can be described as materials comprising of layers of materials bonded together. These may be of several layers of two or more metal materials occurring alternately or in a determined order more than once, and in as many numbers as required for a specific purpose.



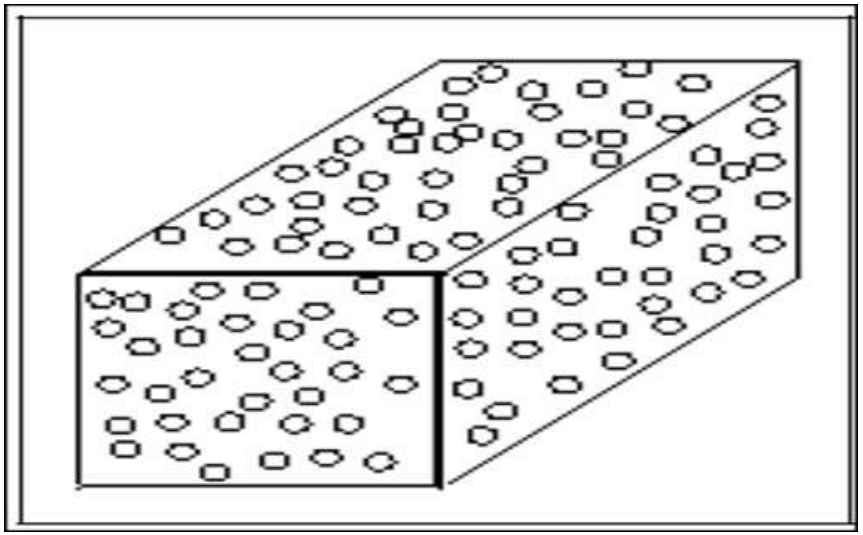
Laminar Composite



Sandwich Composite

PARTICULATE REINFORCED COMPOSITES

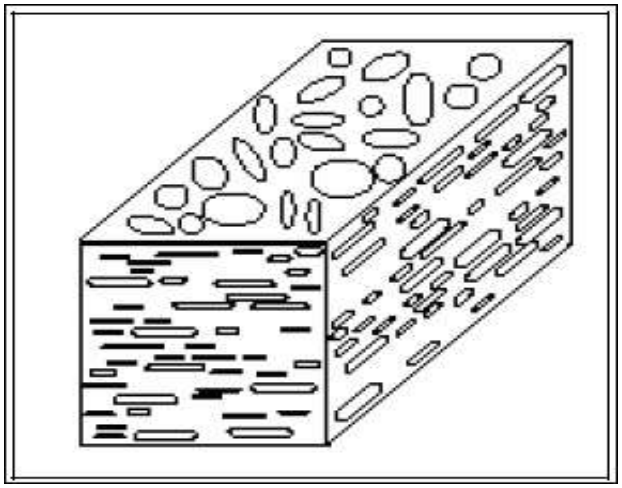
Microstructures of metal and ceramics composites, which show particles of one phase strewn in the other, are known as particle reinforced composites. Square, triangular and round shapes of reinforcement are known, but the dimensions of all their sides are observed to be more or less equal. The size and volume concentration of the dispersed distinguishes it from dispersion hardened materials.



Particulate reinforced composites

FLAKE COMPOSITES

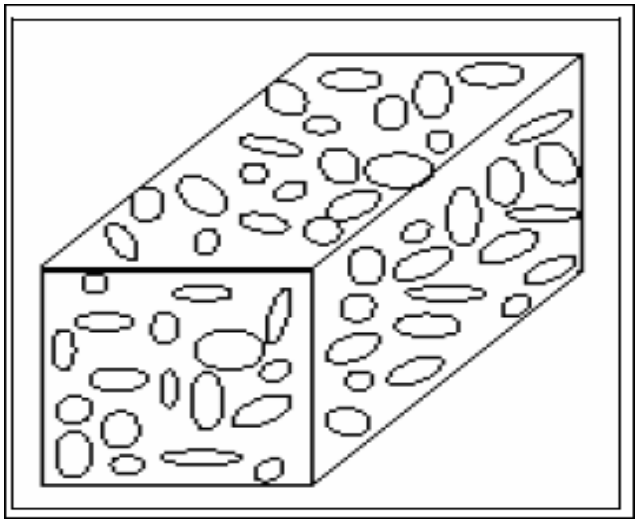
Flakes are often used in place of fibers as can be densely packed. Metal flakes that are in close contact with each other in polymer matrices can conduct electricity or heat, while mica flakes and glass can resist both. Flakes are not expensive to produce and usually cost less than fibers.



Flake composites

FILLED COMPOSITES

Fillers may be the main ingredient or an additional one in a composite. The filler particles may be irregular structures, or have precise geometrical shapes like polyhedrons, short fibers or spheres.



Filled composites

Fillers may be the main ingredient or an additional one in a composite. The filler particles may be irregular structures, or have precise geometrical shapes like polyhedrons, short fibers or spheres.

MICROSPHERES

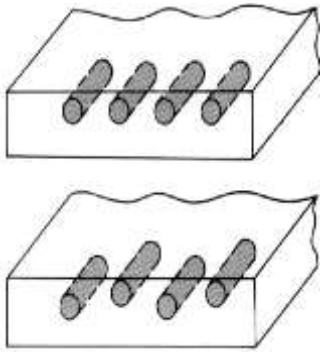
Microspheres are considered to be some of the most useful fillers. Their specific gravity, stable particle size, strength and controlled density to modify products without compromising on profitability or physical properties are it's their most-sought after assets.

Solid Microspheres have relatively low density, and therefore, influence the commercial value and weight of the finished product. Studies have indicated that their inherent strength is carried over to the finished molded part of which they form a constituent.

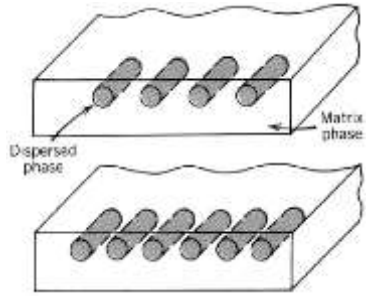
Hollow microspheres are essentially silicate based, made at controlled specific gravity. They are larger than solid glass spheres used in polymers and commercially supplied in a wider range of particle sizes.

FACTORS AFFECTING PROPERTIES OF COMPOSITES

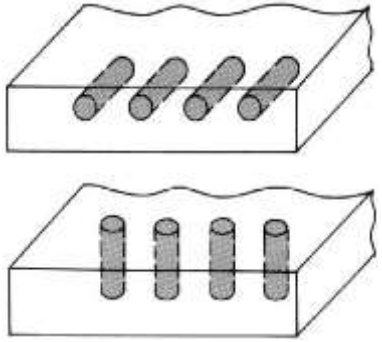
- The type, distribution, size, shape, orientation and arrangement of the reinforcement will affect the properties of the composites material and its anisotropy



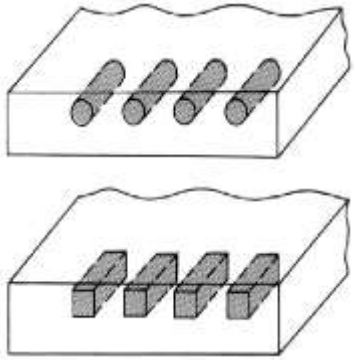
Distribution



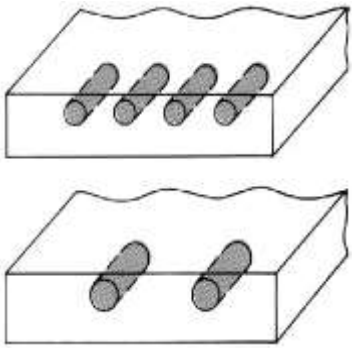
Concentration



Orientation



Shape



Size

ADVANTAGES

- ✓ Light in weight and Lower density
- ✓ High creep resistance
- ✓ Strength-to-weight and Stiffness-to-weight are greater than steel or aluminum
- ✓ Fatigue properties are better than common engineering metals
- ✓ Composites cannot corrode like steel
- ✓ Ease of fabrication of large complex structural shapes or modules-Modular construction
- ✓ Ability to incorporate sensors in the material to monitor and correct its performance-Smart composites
- ✓ High resistance to impact damage.
- ✓ Improved corrosion resistance

LIMITATIONS

- High cost of raw materials and fabrication.
- Composites are more brittle than wrought metals and thus are more easily damaged.
- Transverse properties may be weak.
- Matrix is weak, therefore, low toughness.
- Reuse and disposal may be difficult.
- Difficult to attach.
- Difficulty with analysis
- Cost can fluctuate.

DIFFERENCE BETWEEN SMART AND COMPOSITE MATERIALS

Smart materials have multiple functions, which generally include sensor/actuator ability in addition to having form, or being able to support at least some structural weight. The classic example is Nitinol, which is a Nikcle-Titanium allow. After mechanical deformation (for example, bending), it can be heated up and will return to the pre-deformed structural shape

Composites are materials that are combinations of at least two different materials, which allow the engineering of desired properties (like tailoring mechanical stiffness, conductivity, etc). Classic examples are glass fiber composites,

FAILURE MODES OF COMPOSITE MATERIALS

- Delamination
- Matrix tensile failure
- Matrix compression failure
- Fiber tensile failure
- Fiber compression failure

CONCLUSION

- Several innovative FRP systems have been presented showing the different advantages that each of them can provide to designers and contractors involved in these types of upgrade.
- Fiber reinforced composite plate bonding offers significant advantages over steel plate bonding for the vast majority of strengthening applications
- The potential future benefits of smart materials, structures and systems would prove amazing in their scope.
- A smart structure has the capacity to respond to a changing external environment such as loads, temperatures and shape change, as well as to varying internal environment

REFERENCES

- Bashir Ahmed Mir- August 8, 2017- Smart Materials and Their Applications in Civil Engineering: An Overview- International Journal of Civil Engineering and Construction Science
- Dr. Srikari S.- Composites and Applications- M.S Ramaiah School of Advanced Studies – Bangalore
- E.Agneloni1, P.Casadei2, and G.Celestini3-10 FEB 2011- Innovation on advanced composite materials for civil engineering and architectural applications: case studies-SMAR
- Engineering and Design composite materials for civil engineering structures- Washington- 31 March 1997
- Fidanboylu, K.- fiber optic sensors and their applications
- Harvinder Singh, Ramandeep Singh- 15 December 2015- Smart Materials: New Trend in Structural Engineering- International Journal of Advance Research and Innovation

REFERENCES

- Nachiketa Tiwari- Introduction to Composite Materials and Structures- Indian Institute of Technology Kanpur
- Ning Hu-August, 2012- composites and their properties-Published by InTech
- Pizhong Qiao (Chiao), Ph.D., P.E., SECB- Composite Materials in Civil Infrastructure (Structural Composites)- Department of Civil and Environmental Engineering Washington State University
- Prof. Parihar A.A.1 , Ms. Kajal D. khandagale2 , Ms. Pallavi P. Jivrag3- Sep. - Oct. 2016),- Smart Materials- IOSR Journal of Mechanical and Civil Engineering
- Sherif Mohamed Sabry Elattar- 18 August, 2013- Smart structures and material technologies in architecture applications- Scientific Research and Essays
- Susmita Kamila- 2013-07-18- introduction, classification and applications of smart materials: An Overview- American Journal of Applied Sciences

THANK YOU

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