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DETERMINATION OF THE CHEMICAL COMPOSITION OF COMPOSITE MATERIALS

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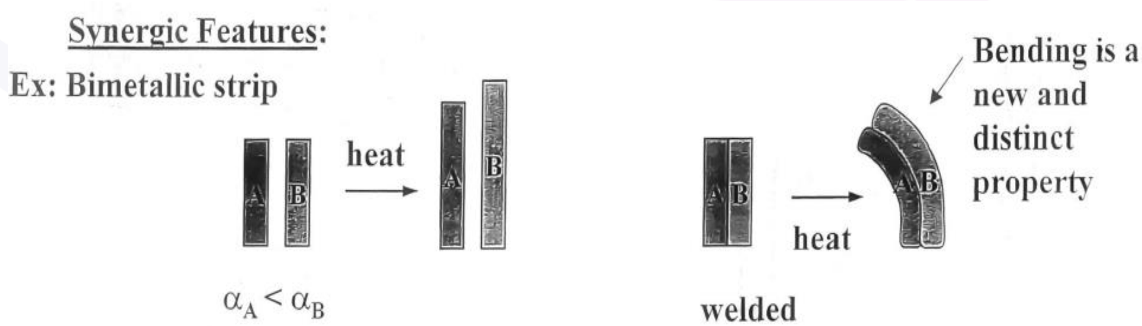
Abstract:
A mixture or hybrid that contains two or more chemically distinct and physically separable materials. One material is continuous and is termed the matrix, while the second, usually discontinuous phase, is the dispersed phase.
The dispersed phase (or phases) is imbedded in the matrix in a continuous or discontinuous form. It is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. It can be of the three basic material classes.



The combinations of two or more different materials are called composite materials. They usually have unique mechanical and physical properties because they combine the best properties of different materials. For example, a fibre-glass reinforced plastic combines the high strength of thin glass fibres with the ductility and chemical resistance of plastic. Nowadays composites are being used for structures such as bridges, boat-building etc.
Composite materials usually consist of synthetic fibres within a matrix, a material that surrounds and is tightly bound to the fibres. The most widely used type of composite material is polymer matrix composites (PMCs). PMCs consist of fibres made of a ceramic material such as carbon or glass embedded in a plastic matrix. Usually the fibres make up about 60 per cent by volume. Composites with metal matrices or ceramic matrices are called metal matrix composites (MMCs) and ceramic matrix composites (CMCs), respectively.
Continuous-fibre composites are generally required for structural applications. The specific strength (strength-to-density ratio) and specific stiffness (elastic modulus-to-density ratio) of continuous carbon fibre PMCs, for example, can be

better than metal alloys have. Composites can also have other attractive properties, such as high thermal or electrical conductivity and a low coefficient of thermal expansion.

Although composite materials have certain advantages over conventional materials, composites also have some disadvantages. For example, PMCs and other composite materials tend to be highly anisotropic — that is, their strength, stiffness, and other engineering properties are different depending on the orientation of the composite material. For example, if a PMC is fabricated so that all the fibres are lined up parallel to one another, then the PMC will be very stiff in the direction parallel to the fibres, but not stiff in the perpendicular direction. The designer who uses composite materials in structures subjected to multidirectional forces, must take these anisotropic properties into account. Also, forming strong connections between separate composite material components is difficult.

The advanced composites have high manufacturing costs. Fabricating composite materials is a complex process. However, new manufacturing techniques are developed. It will become possible to produce composite materials at higher volumes and at a lower cost than is now possible, accelerating the wider exploitation of these materials.Composite material is defined as the material formed by combining two or more different materials constituents macroscopically that are distinct in the properties and they do not dissolve into each other.

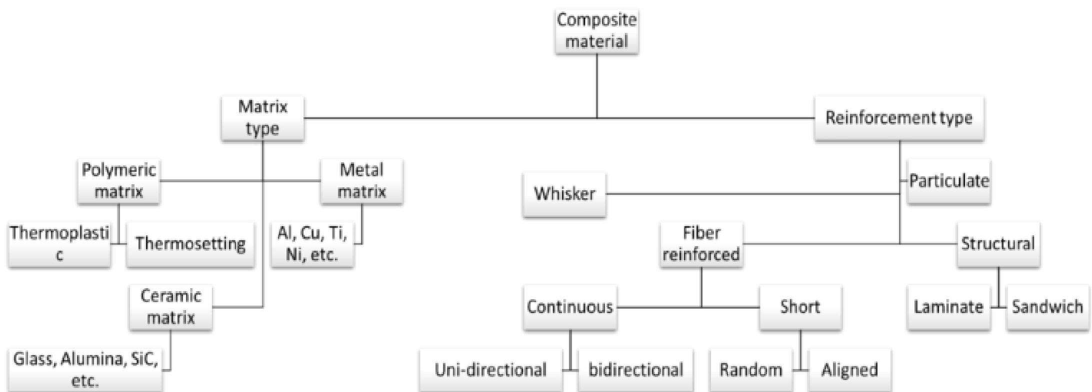
The combination of different constituents in the composites provides the composite material with unique properties which are different from the individual constituent.

An example of composites is the mud building bricks used since ancient times, which is formed by combining mud bricks and straws. This allowed the composite to have the strength and resistance of mud bricks and the tensile strength of straw.

In general, the composite material comprises three main components (a) the matrix, the continuous phase; (b) the reinforcements, the continuous or discontinues phase used to strengthen the composite, and (c) the fine interface region.

For thousands of years, composite materials have played crucial roles in human life, starting with enabling early civilizations to build houses and continuing on to making advances in modern technology possible.

People use composite materials in their day-to-day life, including the ceramic tiling in our bathroom, which help keep us dry.



Composites can indeed be found in the majority of common products, including building and engineering projects, medical applications, energy and transportation, sports, aircraft, automotive, and other fields.Composite materials are materials formed by a volumetric combination of chemically dissimilar components with a clear interface between them. Characterized by properties that none of the components, taken separately, possesses.

Composites include many building materials: concrete and reinforced concrete, mortars, fiber-reinforced concrete, asbestos cement, fiberboard, chipboard, MDF, etc. They do not have the strength of true composites, but in principle they consist of the same components: matrices and hardeners. The theory of composite materials consists primarily in the understanding of a composite as a system with several structural levels arranged through interfaces into a single monolith-conglomerate.

The mechanical and other properties of the composite are determined by three main parameters: the high strength of the reinforcing components, the rigidity of the matrix, and the strength of the bond at the matrix-reinforcement interface. The ratio of these parameters characterizes the entire complex of mechanical properties of the material and the mechanism of its destruction. The performance of the composite is ensured both by the correct choice of the initial components and by a rational production technology that ensures the preservation of their original properties.

The variety of reinforcing and matrix materials, as well as reinforcement schemes, makes it possible to purposefully adjust strength, stiffness, operating

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temperatures and other properties by selecting the composition, changing the ratio of components, etc.

For fibrous composite materials, there are several principles of classification, for example, materials science and constructive. A number of large groups of composites can be distinguished: with a polymer matrix (plastics), with a metal matrix (metal composites), with a ceramic matrix and a carbon matrix.

Depending on the nature of the reinforcing fibers, the following composites are distinguished, for example, on a polymer matrix: fiberglass, carbon fiber, boron plastics, organoplastics, etc.

Composites are also distinguished from reinforcement methods: compactly formed from layers reinforced with parallel-continuous fibers, reinforced with fabrics with random and spatial reinforcement.

Depending on the type of reinforcement, composites can be divided into two groups: dispersion-strengthened and fibrous, which differ in structure and mechanism of high strength formation.

Dispersion-strengthened composites are a material in the matrix of which fine particles are evenly distributed, their optimal content is 2-4%. But the effect of hardening is associated with the size of the particles and their convergence, i.e., concentration. For example, when hardening with fine particles d = 0.001-^0.1 µm, the volume concentration can reach up to 15%; with particles larger than 1.0 µm, the volume concentration can be 25% or more. This increases the strength, hardness, heat resistance, elasticity is preserved (for example, the matrix - bitumen, rubber, polymer; reinforcing particles - chalk, mica, carbon, silica, limestone). In such materials, when loaded, the matrix perceives the acting load.

In fibrous composites, high-strength fibers perceive the main stresses under external loads and provide the rigidity and strength of the composite. A feature of the fibrous composite structure is the uniform distribution of fibers in the plastic matrix, their volume fraction can reach 75% or more.

High-strength solids must have high elastic module and surface energy and the largest possible number of atoms per unit volume. These requirements are met by beryllium, boron, carbon, nitrogen, oxygen, aluminum and silicon. The strongest materials always contain one of these elements, and often consist of only these elements.

When creating fibrous composites, high-strength glass, carbon, boron and organic fibers, metal wires, as well as fibers and whiskers of a number of carbides, oxides, nitrides and other compounds are used. Reinforcing components in composites are used in the form of monofilaments, threads, wires, bundles, nets, fabrics, tapes, canvases.

Matrix materials. The matrix ensures the solidity of the composite, fixes the shape of the product and the relative position of the reinforcing fibers, distributes the acting stresses over the volume of the material, ensuring a uniform load on the fibers and its redistribution when the fiber particles are destroyed. The material of the matrix determines the method of manufacturing products, the possibility of making structures of given dimensions and shapes, as well as the parameters of technical processes, etc.

Section boundaries. The adhesive interaction between the fiber and the matrix determines the level of properties of the composites and their operation during operation. Local stresses in the composite reach their maximum values near or directly at the interface, where the destruction of the material usually begins.

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