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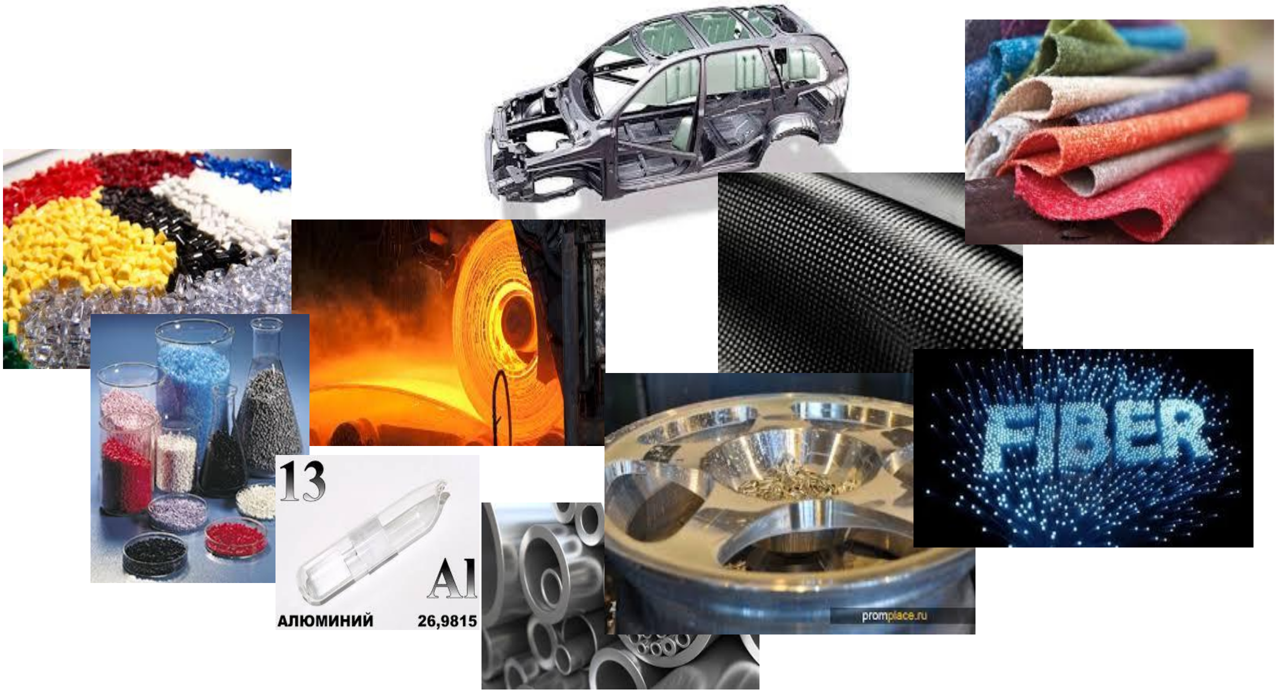
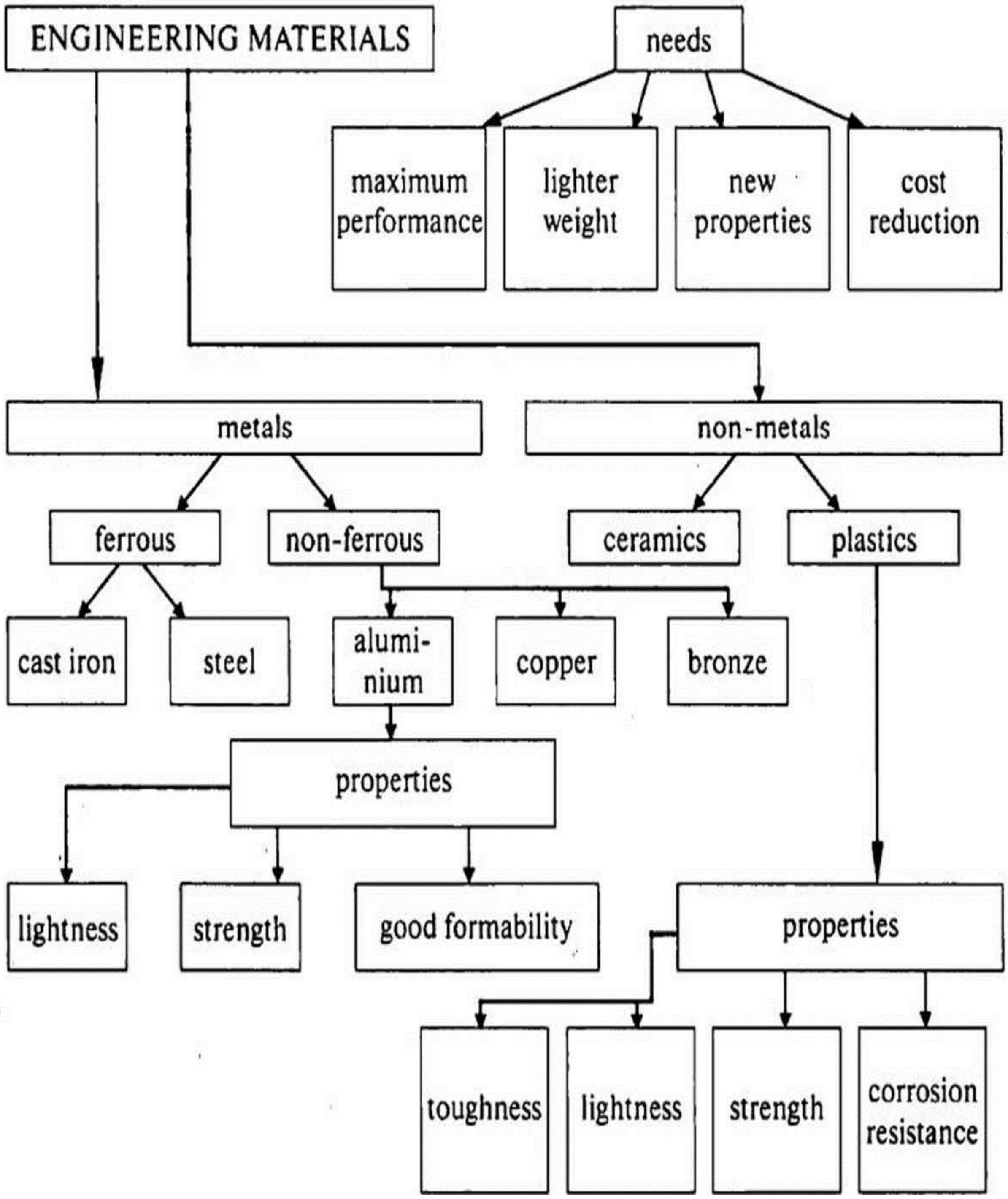


WHAT IS ENGINEERING MATERIALS?

Engineers have to know the best and most economical materials to use. Engineers must also understand the properties of these materials and how they can be worked.

There are two kinds of materials used in engineering — metals and non-metals. We can divide metals into ferrous and non-ferrous. The former contain iron and the latter do not contain iron. Cast iron and steel, which are both alloys, or mixtures of iron and carbon, are the two most important ferrous metals. Steel contains a smaller proportion of carbon than cast iron. Certain elements can improve the properties of steel and are therefore added to it. For example, chromium may be included to resist corrosion and tungsten to increase hardness. Aluminium, copper, and the alloys (bronze and brass) are common non-ferrous metals

Plastics and ceramics are non-metals; however, plastics may be machined like metals. Plastics are classified into two types — thermoplastics and thermosets. Thermoplastics can be shaped and reshaped by heat and pressure but thermosets cannot be reshaped because they undergo chemical changes as they harden. Ceramics are often employed by engineers when materials which can withstand high temperatures are needed.



PICTURE'S

THE PLASTIC AGE

It's in our homes. It's the most common material in the workplace. Sometimes it's even in our bodies. We may be moving into the Information Age, but it's hard to believe that we are not living in the Plastic Age.

The very name "plastic" means versatility. You can bend it, mold it, model it, twist it and ply it in a number of different ways. The finished product can be a soft and airy foam or a hard and strong compound rivaling the sturdiest metal alloys. In its many forms, plastic has forever changed the way we live.

The first in the long line of man-made plastics was called Bakelite, after its inventor, Leo Baekeland. Many years of work in his chemistry lab in Yonkers, New York, led him in 1907 to the invention of the first synthetic polymer (plastic), made by linking small molecules together to make large ones.

Baekeland made his new material by mixing the carbolic acid (phenol) with the strong-smelling formaldehyde to make a third material that was nothing like the original two. It turned out to be a substance that would change the world.

Some of the early uses for plastic were to make things like radio cabinets, buttons, billiard balls, pipe-stems, toilet seats, airplane parts and, the object of Baekeland's research, shellac. Baekeland's trick was to take the resin produced by the two chemicals and heat it under pressure to produce a soft solid that could be molded and hardened or powdered and set under pressure. With this innovation, the plastic revolution was under way.

ECOLOGICAL SAVE TO PRODUCTION

NEW STEELS MEET CHANGING NEE

As a structural material steel has two drawbacks: its weight and its susceptibility to rust. However, due to its advantages, steel has long been used, and in great quantities, in structural applications from bridges and buildings to ships, automobiles and household appliances. Steel is superior to other structural materials in strength, toughness, workability and other properties that are critical for such applications, and it is mass-produced with uniform, reliable quality and at low cost.

Since steel is the most popular structural material available, steelmakers make every effort to meet the changing needs of these markets. New, more sophisticated processes for steel-making and treatment have led to steel products of higher grade and greater variety.

Yet, it can no longer be said that a steel product is satisfactory if it is simply a good structural material. Today's market needs can be classified broadly as: 1) the need for lighter weight; 2) the need for new properties; 3) the need for maximum performance; and 4) the need for cost reduction.

The need for lighter weight is really a requirement for materials having higher specific strength (strength/specific gravity). Materials offering new properties not found in conventional materials will include new breeds of steel, hybrid materials and truly novel materials such as amorphous metal. The need for maximum performance calls for materials approaching the limits of durability, toughness and the like. Finally, the need to reduce costs is leading to materials diversification in which steel materials precisely suited to a specific application are developed. New families of steel products are steadily emerging to meet these needs. Let us look now at how steel needs have changed in automotive industry and how steelmakers have met these needs

NEW TENOLOGY

NON-FERROUS METALS

Although ferrous alloys are specified for more engineering applications than all non-ferrous metals combined, the large family of non-ferrous metals offers a wider variety of characteristics and mechanical properties. For example, the lightest metal is lithium, 0.53 g/cm3, the heaviest, osmium, weighs 22.5 g/cm3 — nearly twice the weight of lead. Mercury melts at around-38°F, and tungsten, the metal with the highest melting point, liquefies at 6,170°F.

Availability, abundance, and the cost of converting the metal into useful forms — all play important parts in selecting a non-ferrous metal. One ton of earth contains about 81,000 g of the most abundant metal of land, aluminium. One ton of sea water, on the other hand, contains more magnesium than any other metal (about 1,272 g). All sources combined, magnesium is the most abundant metal on earth. But because magnesium is difficult to convert to a useful metal, it may cost several times that of the least expensive and most easily produced metal, iron billet. Although nearly 80% of all elements are called “metals”, only about two dozen of these are used as structural engineering materials. Of the balance, however, many are used as coatings, in electronic devices, as nuclear materials, and as minor constituents in other systems

ALUMINIUM

Aluminium is lightweight, strong, and readily formable. Aluminium and its alloys, numbering in the hundreds, are available in all common commercial forms. Because of their high thermal conductivity, many aluminium alloys are used as electrical conductors.

Commercially pure aluminium has a tensile strength of about 13,000 psi. Cold-working the metal approximately doubles its strength. For greater strength aluminium is alloyed with other elements such as manganese, silicon, copper, magnesium or zinc. Some alloys are further strengthened and hardened by heat treatments. Most aluminium alloys lose strength at elevated temperatures, although some retain significant strength to 500°F

PLASTICS

Plastics are a large and varied group of materials consisting of combinations of carbon and oxygen, hydrogen, nitrogen, and other organic and inorganic elements. While solid in its finished state, a plastic is at some stage in its manufacture, liquid and capable of being formed into various shapes. Forming is most usually done through the application, either singly or together, of heat and pressure. There are over 40 different families of plastics in commercial use today, and each may have dozens of subtypes and variations.

A successful design in plastics is always a compromise among highest performance, attractive appearance, efficient production, and lowest cost. Achieving the best compromise requires satisfying the mechanical requirements of the part, utilizing the most economical resin or compound that will perform satisfactorily, and choosing a manufacturing process compatible with the part design and material choice.

Most people have now outgrown the impression that plastics are low- cost substitute materials. Those that still view plastics as cheap and unreliable have not kept up with developments in polymer technology for the past ten years. But the new materials did not necessarily replace the older ones permanently nor made them obsolete. In many cases, they met an increased demand that could not be met by the natural product alone.

Today's engineering resins and compounds serve in the most demanding environments. Their toughness, lightness, strength, and corrosion resistance have won many significant applications for these materials in transportation, industrial and consumer products. The engineering plastics are now challenging the domains traditionally held by metals: truly load-bearing, structural parts.