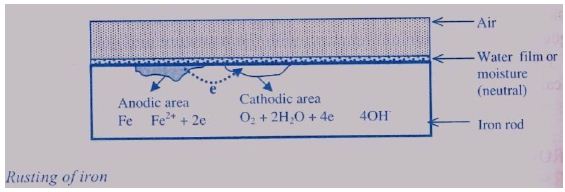
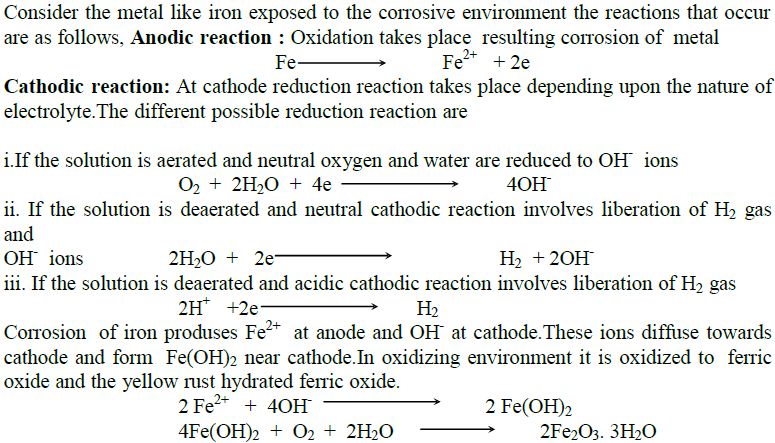
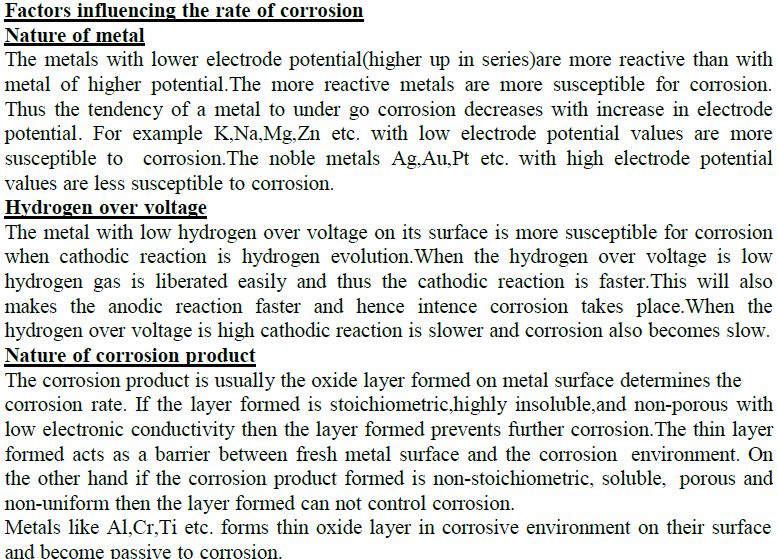


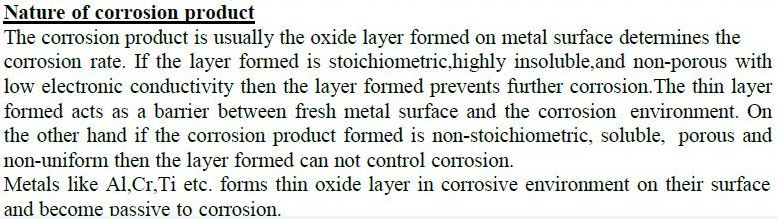
**MECHANISM OF CORROSION ( RUSTING OF IRON)**

**Rusting of iron**

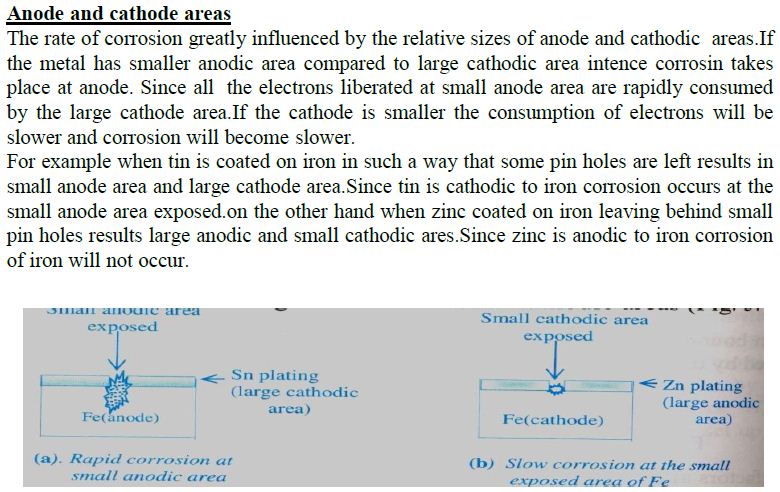


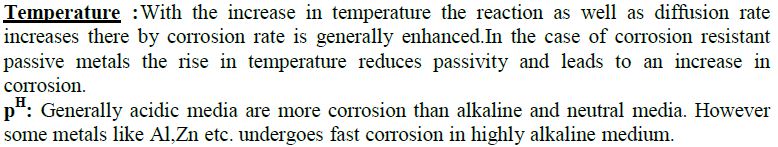


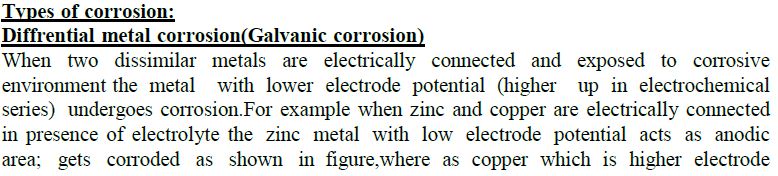


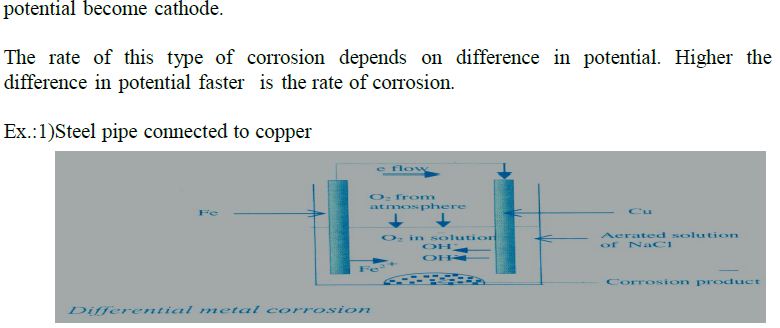


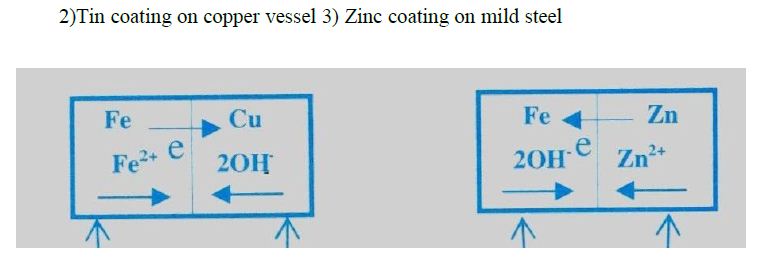
**Position of metal in Galvanic series**- more active metal or alloy present higher in the galvanic series with low potential undergoes faster corrosion than noblemetal or alloy lying at the later part of series. More the difference in electrode potential of two metals in contact ,faster is the rate of corrosion of active metal. Eg-Zinc in contact with copper metal, zinc undergoes faster corrosion compared to iron in contact with copper metal. Zinc has low electrode potential than iron.

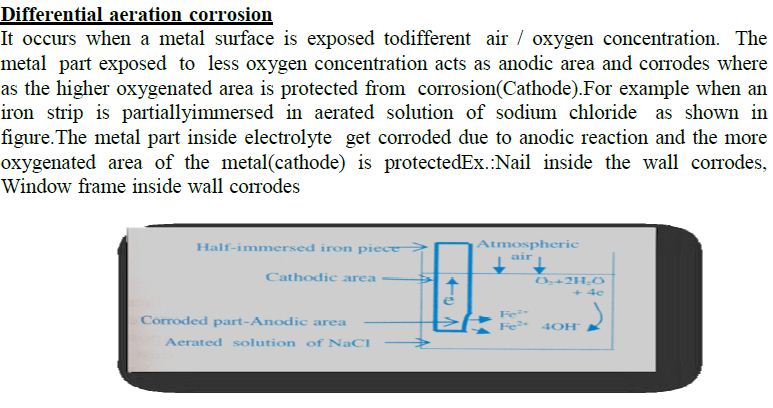


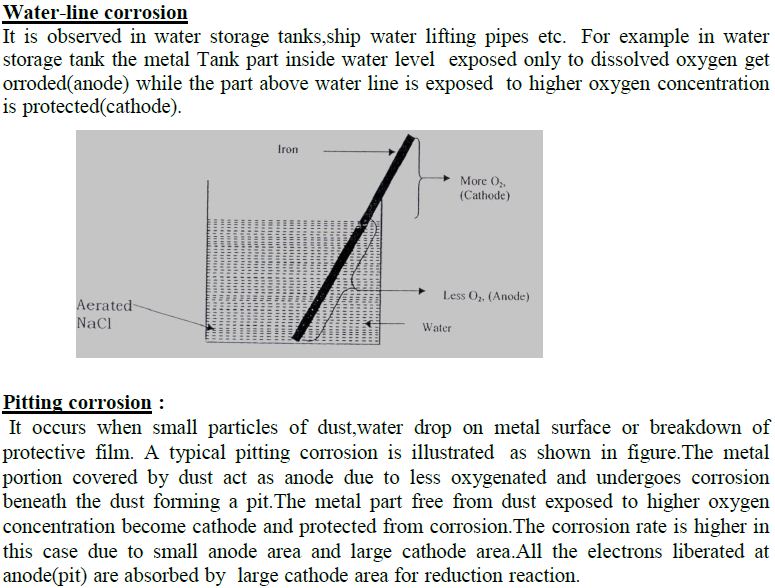


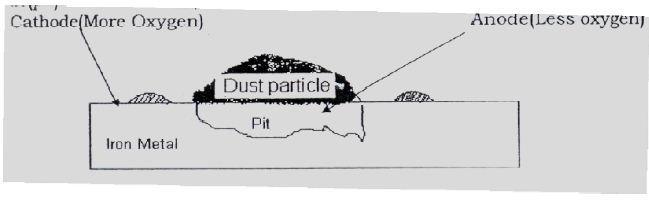


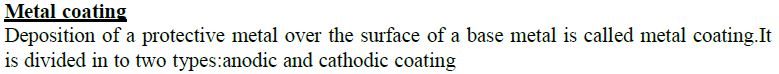


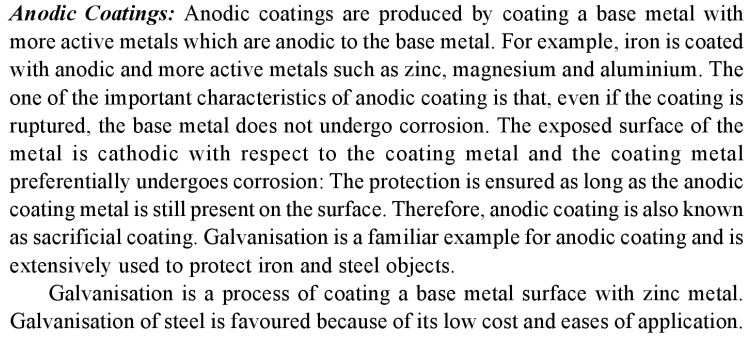


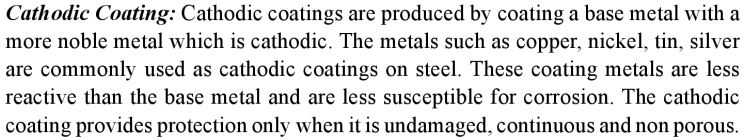


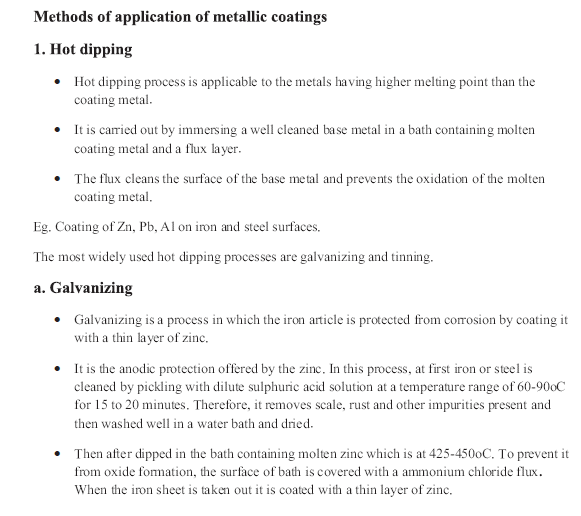
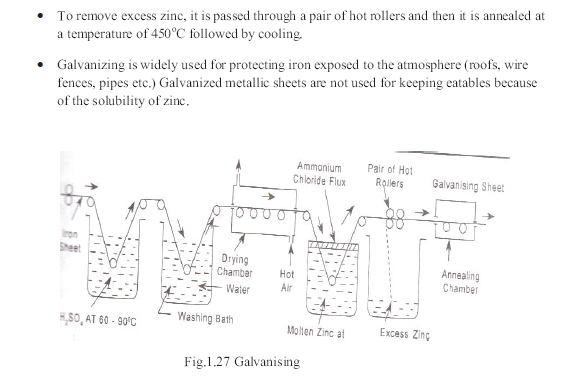


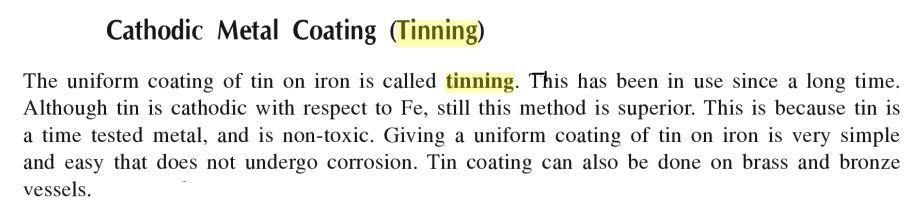


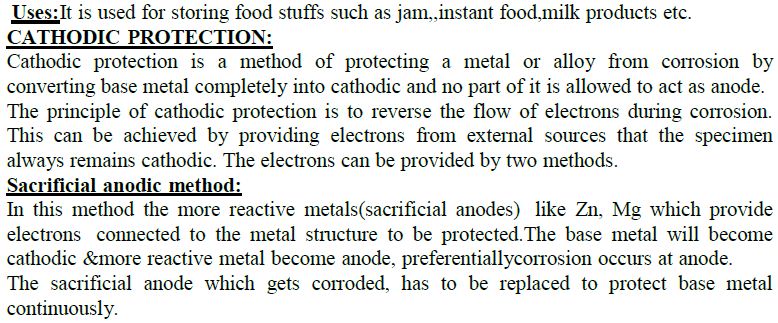


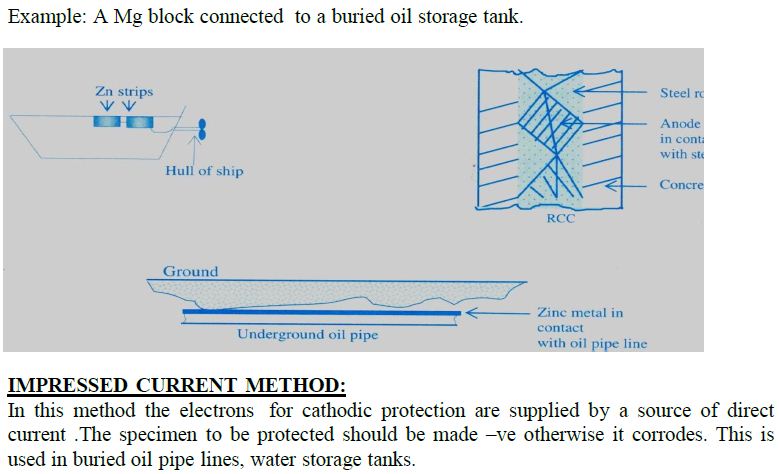


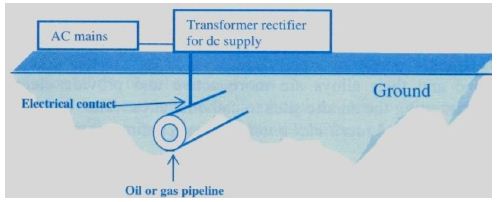












**Green chemistry's twelve principles**

These principles demonstrate the breadth of the concept of green chemistry:

1.**Prevent waste**: Design chemical syntheses to prevent waste. Leave no waste to treat or clean up.

**2. Maximize atom economy**: Design syntheses so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms.

**3. Design less hazardous chemical syntheses**: Design syntheses to use and generate substances with little or no toxicity to either humans or the environment.

**4. Design safer chemicals and products**: Design chemical products that are fully effective yet have little or no toxicity

**5. Use safer solvents and reaction conditions**: Avoid using solvents, separation agents, or other auxiliary chemicals. If you must use these chemicals, use safer ones.

**6. Increase energy efficiency**: Run chemical reactions at room temperature and pressure whenever possible.

**7. Use renewable feedstocks**: Use starting materials (also known as feedstocks) that are renewable rather than depletable. The source of renewable feedstocks is often agricultural products or the wastes of other processes; the source of depletable feedstocks is often fossil fuels (petroleum, natural gas, or coal) or mining operations.

**8. Avoid chemical derivatives**: Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.

**9. Use catalysts, not stoichiometric reagents**: Minimize waste by using catalytic reactions. Catalysts are effective in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and carry out a reaction only once.

**10. Design chemicals and products to degrade after use**: Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.

**11. Analyze in real time to prevent pollution**: Include in-process, real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts.

**12. Minimize the potential for accidents**: Design chemicals and their physical forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

**Composite material**s

A **Composite material** (also called a **composition material** or shortened to **composite,** which is the common name*) is a material made from two or more constituent materials with significantly different*[*physical*](https://en.wikipedia.org/wiki/Physical_property)*or*[*chemical properties*](https://en.wikipedia.org/wiki/Chemical_property)*that, when combined, produce a material with characteristics different from the individual components*.

***Composite: Two or more chemically different constituents combined macroscopically to yield a useful material .***

The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.

Typical [engineered](https://en.wikipedia.org/wiki/Materials_science) composite materials include:

* [mortars](https://en.wikipedia.org/wiki/Mortar_(masonry)), [concrete](https://en.wikipedia.org/wiki/Concrete)
* [Reinforced plastics](https://en.wikipedia.org/wiki/Reinforced_plastic), such as [fiber-reinforced polymer](https://en.wikipedia.org/wiki/Fiber-reinforced_polymer)
* [Metal](https://en.wikipedia.org/wiki/Metal) composites
* Ceramic composites ([composite ceramic and metal matrices](https://en.wikipedia.org/wiki/Composite_armor))

Composite materials are generally used for [buildings](https://en.wikipedia.org/wiki/Building), bridges, and structures such as boat hulls, swimming pool panels, race car bodies, [shower](https://en.wikipedia.org/wiki/Shower) stalls, [bathtubs](https://en.wikipedia.org/wiki/Bathtub), storage tanks, imitation [granite](https://en.wikipedia.org/wiki/Granite) and [cultured marble](https://en.wikipedia.org/wiki/Cultured_marble) [sinks](https://en.wikipedia.org/wiki/Sink) and countertops. The most advanced examples perform routinely on spacecraft and aircraft in demanding environments.

**Composition of composite materials**-

Composites are made up of individual materials referred to **as constituent materials**. There are two main categories of constituent materials: **matrix** ([binder](https://en.wikipedia.org/wiki/Binder_(material))) and **reinforcement**. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination..

**Why use composites?**

The biggest advantage of modern composite materials is that they are light as well as strong. By choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements of a particular application. Composites also provide design flexibility because many of them can be moulded into complex shapes. The downside is often the cost. Although the resulting product is more efficient, the raw materials are often expensive.

**Natural composites** Natural composites exist in both animals and plants.

Wood is a composite – it is made from long cellulose fibres (a polymer) held together by a much weaker substance called lignin.Cellulose is also found in cotton, but without the lignin to bind it together it is much weaker. The two weak substances – lignin and cellulose – together form a much stronger one.

The bone in your body is also a composite. It is made from a hard but brittle material called hydroxyapatite (which is mainly calcium phosphate) and a soft and flexible material called collagen (which is a protein). Collagen is also found in hair and finger nails. On its own it would not be much use in the skeleton but it can combine with hydroxyapatite to give bone the properties that are needed to support the body.

– Granite: Granular composite of quartz, feldspar, and mica.

**• Some examples of man‐made composites** – Concrete: Particulate composite of agg g re ates (limestone or granite), sand, cement and water –

Plywood: Plywood: Several Several layers of wood veneer glued together –

Fiberglass: Fiberglass: Plastic Plastic matrix reinforced reinforced by glass fibers –

Cemets: Ceramic and metal composites –

Fibrous composites: Variety of fibers (glass, kevlar, graphite, nylon, etc.) bound together by a polymeric matrix

* **Properties of composites**. ​Composites are extremely versatile products - their benefits being:
* High Strength to Weight Ratio. Fibre composites are extremely strong for their weight. ...
* Lightweight. ...
* Fire Resistance. ...
* Electrical Properties. ...
* Chemical & Weathering Resistance. ...
* Colour. ...
* Translucency.

**Classification of composites: based on matrix and based on re-enforcement material**

**• Matrix**

1. **Organic Matrix Composites (OMCs)-** **carbon‐carbon composites**-

2**) Polymer Matrix Composites (PMCs)-**

3) **Metal Matrix Composites (MMCs**)-

4)**Ceramic Matrix Composites (CMCs**)-

**• Reinforcements:**

1)**Fibre reinforced composites**- (FRC), 2)**Layered composites,** 3)**Particulate composites**

1)**Fibre reinforced composites**- (FRC)

Most fiber-reinforced composites provide improved strength and other mechanical properties and strength-to-weight ratio by incorporating strong, stiff but brittle fibers into a softer, more ductile matrix. The matrix material acts as a medium to transfer the load to the fibers, which carry most off the applied load. The matrix also provides protection to fibers from external loads and atmosphere. These composites are classified as either continuous or discontinuous. Generally, the highest strength and stiffness are obtained with continuous reinforcement. Discontinuous fibers are used only when manufacturing economics dictate the use of a process where the fibers must be in this form.

Fibers very strong – Provide significant strength improvement to material –

Ex: fiber-glass Particle-reinforced Fiber-reinforced Structural

• Continuous glass filaments in a polymer matrix

• Strength due to fibers • Polymer simply holds them in place

**Fiber Materials** – Whiskers - Thin single crystals - large length to diameter ratio • graphite, SiN, SiC • high crystal perfection – extremely strong, strongest known • very expensive Particle-reinforced Fiber-reinforced Structural– Fibers • polycrystalline or amorphous • generally polymers or ceramics • Ex: Al2O3 , Aramid-⇒ Kevlar polyamide (poly(paraphenylene terephthalamide ), E-glass, Boron, UHMWPE – Wires • Metal – steel, Mo, W

2)**Layered composites**-**Laminar composites** - A structural composite is normally composed of both homogeneous and composite materials. (laminates and sandwich structures)

**Laminate:** A laminate is a layered construction of a number of lamine arranged in a proper sequence. The layers are stacked and subsequently cemented together such that the orientation of fiber direction (θ) varies with each successive layer.

Laminar composite example: continuous and aligned fiber reinforced plastics with matrixes such as epoxy, polyester, PE, PA, PET…

Other Laminar Composite Structures • Automotive tires - consists of multiple layers bonded together • FRPs - multi-layered fiber-reinforced plastic panels for aircraft, automobile body panels, boat hulls • Printed circuit boards - layers of reinforced plastic and copper for electrical conductivity and insulation • Snow skis - composite structures consisting of layers of metals, particle board, and phenolic plastic • Windshield glass - two layers of glass on either side of a sheet of tough plastic

Stacked and bonded fiber-reinforced sheets- benefit: balanced, in-plane stiffness.

**Sandwich panels** -A structural composite is normally composed of both homogeneous and composite materials.

• Sandwich panels -- low density, honeycomb core -- benefit: small weight, large bending stiffness.

3)**Particulate composites**- **PARTICULATE REINFORCED COMPOSITES**.**-** refer to a material consisting of two or more individual constituents. The **reinforcing** constituent is embedded in a matrix to form the **composite.**

Particulate composites are other class of particle-reinforced composites. These contain large amounts of comparatively coarse particles. These composites are designed to produce unusual combinations of properties rather than to improve the strength.

Particulate composites are used with all three material types – metals, polymers and ceramics. Cermets contain hard ceramic particles dispersed in a metallic matrix. Eg.: tungsten carbide (WC) or titanium carbide (TiC) embedded cobalt or nickel used to make cutting tools. Polymers are frequently reinforced with various particulate materials such as carbon black. When added to vulcanized rubber, carbon black enhances toughness and abrasion resistance of the rubber. Aluminium alloy castings containing dispersed SiC particles are widely used for automotive applications including pistons and brake applications. Concrete is most commonly used particulate composite. It consists of cement as binding medium and finely dispersed particulates of gravel in addition to fine aggregate (sand) and water. It is also known as Portland cement concrete. Its strength can be increased by additional reinforcement such as steel rods/mesh.Example- Concrete – gravel + sand + cement, cemented carbide, Automobile tires.

**Advantages**

• Lower density (20 to 40%)

• Higher directional mechanical properties (specific tensile strength (ratio of material strength to density) 4 times greater than that of steel and aluminium

. • Higher Fatigue endurance .

• Higher toughness than ceramics and glasses.

• Versatility and tailoring by design

. • Easy to machine.

• Can combine other properties (damping, corrosion)

. • Cost.

High specific strength and High specific stiffness Long fatigue lifeΨ High creep resistanceΨ Low coefficient of thermal expansionΨ Low densityΨ Low thermal conductivityΨ Better wear resistanceΨ Improved corrosion resistanceΨ Better temperature dependent behaviorΨ

**Applications**

**Space craft**: Antenna structures, Solar reflectors, Satellite structures, Radar, Rocket engines, etc. **Aircraft:** Jet engines, Turbine blades, Turbine shafts, Compressor blades, Airfoil surfaces, Wing box structures, Fan blades, Flywheels, Engine bay doors, Rotor shafts in helicopters, Helicopter transmission structures, etc.

**Glass fiber-reinforced polymers (GFRPs)-** reinforced with continuous fibers and fabrics are baseline in numerous commercial, consumer, and aerospace/defense structural applications. Aerospace/defense applications include solid fuel rocket motor cases; rocket launchers; aircraft fairings flooring, interiors, and cargo containers; helicopter rotor blades; patrol boats; mine hunter ships; and ballistic armor.

**Miscellaneous**: (1) Bearing materials, Pressure vessels, Abrasive materials, Electrical machinery, Truss members, Cutting tools, Electrical brushes, etc. (2) Automobile: Engines, bodies, Piston, cylinder, connecting rod, crankshafts, bearing materials, etc.