Advanced Materials

•These are materials used in High-Tech devices those operate based on relatively intricate and sophisticated principles (e.g. computers, air/space-crafts, electronic gadgets, etc.).

•These materials are either traditional materials with enhanced properties or newly developed materials with high-performance capabilities. Hence these are relatively expensive.

•Typical applications: integrated circuits, lasers, LCDs, fiber optics, thermal protection for space shuttle, etc. Examples: Metallic foams, inter-metallic compounds, multi-component alloys, magnetic alloys, special ceramics and high temperature materials, etc.

Composite materials

Composite materials are multiphase materials obtained by artificial combination of different materials to attain properties that the individual components cannot attain.

These are materials made up from, or composed of, a combination of different materials to take overall advantage of their different properties.

The main classes of composites are metal-matrix, polymer-matrix, and ceramic-matrix.

- Composites offer many advantages over other materials. The main advantages of composites may be summarized as:
- Stronger and stiffer than metals on a density basis
    - For the same strength, lighter than steel by 80% and aluminium by 60%
    - Superior stiffness-to-weight ratios
- Capable of high continuous operating temperatures
    - Up to 250°F in many composites
    - Up to 2000°F with specialist composites
- Highly corrosion resistant
    - Essentially inert in the most corrosive environments
- Electrically insulating properties are inherent in most composites (depending on reinforcement selected).
    - Yet composites can be made conducting or selectively conducting as needed.
- Tolerable thermal expansion properties
    - Can be compounded to closely match surrounding structures to minimize thermal stresses
- Tunable energy management characteristics
    - High energy absorption or high energy conductivity at designer's choice
    - Frequency selective acoustical and electromagnetic energy passage

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- Exceptional formability
  - Composites can be formed into many complex shapes during fabrication, even providing finished, styled surfaces in the process.
- Outstanding durability
  - Well-designed composites have exhibited apparent infinite life characteristics, even in extremely harsh environments
- Low investment in fabrication equipment
  - The inherent characteristics of composites typically allow production to be established for a small fraction of the cost that would be required in metallic fabrication.
- Reduced Part Counts
  - Parts that were formerly assembled out of several smaller metallic components can be fabricated into a larger single part. This reduces manufacturing and assembly labour and time.
- Corrosion Resistance
  - The non-reactive nature of many resins and reinforcements can be custom selected to resist degradation by many common materials and in corrosive environments.
  - Benefits include lower maintenance and replacement costs.

Ceramics

Ceramics form an important part of materials group. Ceramics are compounds between metallic and nonmetallic elements for which the inter-atomic bonds are either ionic or predominantly ionic.

Advantages of ceramics

•Most of them have high hardness hence they are used as abrasive powder and cutting tools.

•They have high melting point which makes them excellent refractory material

•They are good thermal insulators this is another reason to use them as refractory material

•They are high electric resistivity which makes them suitable to be used an insulator

•They have low mass density which results in lightweight components

•They are generally chemically inert which makes them durable

Disadvantages of ceramics

•They are brittle in nature

•They have almost zero ductility

•They have poor tensile strength

•The show a wide range in the variation of strength, even for the identical specimens

•They are difficult to shape and machine

Types of ceramics

•They are mainly of two types based on their atomic structure.

•Crystalline ceramics

•Non-crystalline ceramics

•They can also be classified into three different material categories.

•Oxides

•Non-oxides

composites

Properties of ceramics

•High hardness

•High melting point

•Good Thermal insulator

•Highly electricity resistance

•Low mass density

•Generally, chemically inert

•Brittle in nature

•Zero ductility

•Low tensile strength

Applications of ceramics

•They are used in space industry because of their low weight

•They are used as cutting tools

•They are used as refractory materials

•They are used asa thermal insulator