

# CERAMIC AND COMPOSITE MATERIALS

## Ceramics

The inorganic compounds of metallic and non-metallic elements which are bonded together by either ionic & covalent bond are called as ceramics.

Based on application, ceramics are two types

1. Traditional ceramics materials
2. Engineering ceramics materials.

## Traditional ceramics materials

- Traditional ceramic materials are generally clay products, cement and silicate glasses.
- The pottery from clay are produced by forming and burning the clay. This is the oldest and earliest process used in preparing ceramic materials.
- The porcelain enamels and clay products like brick, tile and other similar product are also included in type.
- The most distinct and important of all ceramic material is the refractories used in industries like fire clay products and heavy non-clay refractories like

Magnesite, chromite and similar composition

## Engineering Ceramic Materials

→ Engineering ceramic materials & advanced ceramics are the inorganic, highly engineered, high performance and value added objects with unique and superior qualities.

→ These ceramics are developed for the properties such as high temperature resistance, greater chemical resistivity, superior electrical and mechanical properties etc...

→ Some of the new engineering ceramics used in the industry are pure oxide ceramics, nuclear fuels based on  $O_2$ , electro-optic ceramics, magnetic ceramics, ceramic nitrides, metal-ceramic.

## Properties of ceramics

- Ceramics are hard and brittle
- They do not have elongation & reduction in area.
- They cannot be plastically moulded.
- They have excellent compressive strength
- They have highest hardness of engineering materials.

- They have good chemical resistance.
- They have less thermal expansion.

### Applications

- Ceramic kilns, electrolytic cells for production of aluminium.
- used in furnaces.
- used in making of building bricks, roofing tiles, stoneware, etc.....

### Glasses

Glasses are defined as the transparent silica products, which can be either amorphous & crystalline depending upon the heat treatment.

### Properties

- Glasses are resistant to devitrification.
- They available in clean and clear state.
- They are easily fusible at comparatively low temperatures.
- They are resistant to water.

### Proper

#### Application:

1. Window glass.
2. Bottles,

3. Electric bulbs

4. Plate glass.

5. Cheaper table ware etc..

## Ceramics

Glasses are following types

1. Pyrex glass

2. Alumina silicate glass.

Pyrex Glass (Heat Resistant Glass)

The trade name used for  $B_2O_3$  silicate glass is pyrex glass.

## Composition

Composition by weight

silica - 80 parts.

Boron oxide - 14 parts

Sodium - 4 parts.

Alumina - 2 parts.

Some trace of potassium oxide, calcium oxide and magnesium oxide are also added.

## Properties

→ Good chemical durability for resistance to heat and thermal shocks.

→ It possess good corrosion resistance and high light transmission

### Applications

→ This is used in

- i) Gauges and measuring instruments.
- ii) Mirrors of telescope.
- iii) Electronic tubes.
- iv) Laboratory equipments.
- v) Piping seals and pump impellers.

### Alumina silicate Glass

#### Composition

Alumina - 57%

Aluminium oxide - 20%

Sodium oxide - 1%

Calcium oxide - 55%

Boron oxide - 4%

Magnesium - 12%

#### Properties

→ They have high strength and greater thermal shock resistance.

→ Excellent resistance to corrosion from weathering, water and chemicals.

→ This type of glass can be easily worked on economical line., lower in cost).

### Applications

- i) Manufacturing of glass fibres.
- ii) Higher performance powder tubes
- iii) Stove top cookware.
- iv) High temp. thermometers.

### Cermets

A cermet is a composite material composed of ceramic (cer) and metallic (met) materials. A cermet is ideally designed to have optimal properties of both ceramic and metal.

### Properties of cermets.

1. High strength and hardness.
2. Resistance to high temp.
3. Corrosion resistant
4. Better wear resistant.

### Application of cermets

- Cermets are used as cutting and drilling tools in machine tools.
- They are used in resistors, capacitors, and vacuum tubes (valves).

→ They are also used in light weight protecting coating on clothes.

## Abrasive Materials

→ Abrasives are generally made from ceramic materials.

→ These are hard and mechanically resistant materials.

→ These are generally used for grinding & cutting.

→ Softer materials can also be worn off by abrasive.

## Properties

→ Abrasives are hard materials.

→ They possess great uniform hardness.

→ They can wear off softer materials.

## Applications

1. Brick and concrete saws

2. wire drawing dies

3. used in sand paper.

4. used for wood finishing

5. Cleaning of aircraft engine parts.

6. used for grinding precious metals, brass and aluminium.

# Nanomaterials

Nanomaterials describe in principle materials of which a single unit is sized between 1 and 1000 nanometers ( $10^{-9}$  meter) but is usually 1-100 nm

## Properties

- Nano materials are electro<sup>con</sup>ductive/anti static.
- They are antimicrobial
- Self-cleaning / Dirt free
- They have fire resistance, UV protection
- They have insulation / thermal conduct~~ion~~
- They are moisture absorbents.
- They are ultra hard and light weight material.

## Applications

- Next generation computer chips
- Machinable ceramics.
- Better insulation materials
- Kinetic energy penetrators with enhanced lethality.



- Tougher and harder cutting tools
- High power magnets.
- High energy density batteries.
- Low cost flat panel display.
- Phosphorous for high definition TV.
- Aerospace material etc.