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The Study of Ceramic Chemistry

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Ceramics are classified as inorganic and nonmetallic materials that are essential to our daily lifestyle. Ceramic and materials engineers are the people who design the processes in which these products can be made, create new types of ceramic products, and find different uses for ceramic products in everyday life.

Ceramics are all around us. This category of materials includes things like tile, bricks, plates, glass, and toilets. Ceramics can be found in products like watches (quartz tuning forks-the time keeping devices in watches), snow skies (piezoelectric-ceramics that stress when a voltage is applied to them), automobiles (sparkplugs and ceramic engine parts found in racecars), and phone lines. They can also be found on space shuttles, appliances (enamel coatings), and airplanes (nose cones). Depending on their method of formation, ceramics can be dense or lightweight. Typically, they will demonstrate excellent strength and hardness properties; however, they are often brittle in nature. Ceramics can also be formed to serve as electrically conductive materials, objects allowing electricity to pass through their mass, or insulators, materials preventing the flow of electricity. Some ceramics, like superconductors, also display magnetic properties.

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INTRODUCTION

Ceramics are generally made by taking mixtures of clay, earthen elements, powders, and water and shaping them into desired forms. Once the ceramic has been shaped, it is fired in a high temperature oven known as a kiln. Often, ceramics are covered in decorative, waterproof, paint-like substances known as glazes.

The word Ceramics is derived from the Greek word Keramos which means potter's earth or clay. Therefore, ceramics may be considered to be material made from naturally occurring clay or earth. Scientifically, ceramics are compounds of metallic and non-metallic elements. There are also manufactured ceramic materials such as diamond, SiC and Si3N4 and so on. In modern applications, a broader definition applies to the term ceramic, that is everything that is not a metal or organic material. Ceramics are inorganic as well as non-metallic materials which have been processed or used at high temperatures.

The American Ceramic society has defined ceramic products as those manufactured "by the action of heat on raw materials, most of which are of an earthy nature -- while of the constituents of these raw materials, the chemical element silicon, together with its oxide and the compounds thereof, occupies a predominant position." That branch of knowledge which deals with the expertise of manufacturing and treatment of ceramic materials is called ceramic engineering.

FINDINGS:

There are various types of ceramic products which we have classed under four distinct categories-

1. Structural - it includes roof and floor tiles, pipes and bricks.

2. White wares - they include objects like decorative, sanitary ware, table ware and wall tiles. The examples of white ware ceramics are stone ware, porcelain, bone china and earthen ware.

3. Refractories like glass and steel building crucibles, gas fire radiant and kiln linings.

4. Technical or fine ceramics. such products include tiles applied in the space shuttle program, ballistic fortification, bio-medical implants, missile nose cones, nuclear fuel uranium oxide pellets and jet engine turbine.

The various properties of ceramics are discussed below-

1. MECHANICAL PROPERTIES- they are crystalline or amorphous and are usually covalently bonded or iconic substances. Ceramic materials also show plastic deformations.

2. ELECTRICAL PROPERTIES- they are semi conductors and most of them are transitional metal oxides. However under extremely low temperatures some ceramics become superconductors.

CLASSIFICATION OF CERAMICS-

They are classified as non -crystalline and crystalline ceramics. The non-crystalline ceramics are formed from melts and are called glass ceramic. They are produced after a great range of processing whereas the crystalline ceramics do not require much doling out.

Apart from the ones discussed above, ceramics have a wide range of usage

1. It is used in making knives and ceramic knives are sharper than steel knives. Though they are brittle, their blades are more durable.

2. Ceramics like alumina and boron carbide are used as "Small Arms Protective Inserts"

3. Steel can be replaced by ceramic balls in ball bearings. Due to their hardness they have a longer lifetime. Their electrical insulating capacities are also valuable in bearings but a major drawback is their high cost.

4. Ceramic engines can be used in laboratories due to their high fuel efficiency and they do not need any cooling system. However mass production is not possible because cracks can easily develop in ceramics which may result in dangerous equipment failure.

5. Nowadays bio-ceramics are made which include synthetic bones and dental implants.

6. High tech ceramic is also employed in making watch cases.

INDUSTRIAL CERAMICS

Thousands of engineering gears have used from advanced ceramics solutions for wear resistance, corrosion resistance & thermal resistance, providing significant lifetime added to over conventional metal gears. It is not always the best possible design solution, commonly advanced ceramics can be benefited as direct substitutes for available designs.

Typical gears include wear plates & thermal barriers, bearings for high speed and high stiffness spindles, bushes, gears and many others. Dynamic-Ceramic can provide now hundreds of case histories on the successful and cost effective application of advanced ceramics solutions in mechanical engineering applications.

Although ceramics have been used by man for many centuries, until recently their applications have been limited by their mechanical properties. Unlike metals, most ceramics materials do not exhibit a non-linear plastic region before failure. Instead, ceramics are known to be brittle and fail catastrophically. Their application in engineering applications has certainly been limited by their lack of toughness.

APPLICATIONS

Ceramics are used in an array of applications:

- Compressive strength makes ceramics good structural materials (e.g., bricks in houses, stone blocks in the pyramids)

- High voltage insulators and spark plugs are made from ceramics due to its electrical conductivity properties

Good thermal insulation has ceramic tiles used in ovens and as exterior tiles on the Shuttle orbiter
Some ceramics are transparent to radar and other electromagnetic waves and are used in radomes and transmitters

- Hardness, abrasion resistance, imperviousness to high temperatures and extremely caustic conditions allow ceramics to be used in special applications where no other material can be used

- Chemical inertness makes ceramics ideal for biomedical applications like orthopaedic prostheses and dental implants

- Glass-ceramics, due to their high temperature capabilities, leads to uses in optical equipment and fiber insulation

Metals, plastics & ceramics are the significant engineering material. Among the three ceramic are largely synthetic. Ceramics comprise of Routine materials like cement, glass, porcelain, and brick & strange material like spacecraft & electronics. Due to the excellent power of resistance to heat & chemicals, ceramics finds wide use in industries.

Common ceramics are made from minerals such as feldspar, talc. clay, and silica, These minerals known as silicates form the majority of the earth's crust. In the laboratory Chemists formulate advanced ceramics like alumina, silicon carbide, and barium titanate from mix excluding silicates.

Ceramic products resist to high temperatures, gases, water, salts & acids based on their mineral component, Properties of all ceramic products are

not identical they vary from each other. Ceramics are normally bad conductor of electricity; in certain cases when cooled, they turn into super conductor. Few of the ceramics are magnetic engineers have power over these properties by scheming the ratio and nature of material being used.

Ceramics property makes them particularly appropriate products. Products made out of ceramic materials consist of construction materials, grinding materials, electrical equipment, dinnerware, glass products, and heat-resistant materials.

Ceramic materials that contain alumina and silicon carbide are extremely rigid and are used to sand various surfaces, cut metals, polish, and grind. Ceramics that consist of silica, zirconium oxide, magnesium oxide, silicon carbide & alumina are used in making refractories. Engineers continually research developing the various uses of ceramics.

INDUSTRIAL CERAMICS

Usually, Ceramic products are divided into 4 sectors

- Structural, pipes, including bricks, roof tiles & floor
- Refractory, such as kiln linings, gas fire radiant, steel and glass making crucibles
- White wares, sanitary ware, including tableware, pottery products and wall tiles
- Technical, is also known as Engineering, Advanced, Special, and Fine Ceramics. Those items include tiles used in the Space Shuttle program, ballistic protection, nuclear fuel uranium oxide pellets, gas burner nozzles, bio-medical implants, missile nose cones, and jet engine turbine blades. Repeatedly the raw materials do not include clays.

INDUSTRIAL CERAMIC PRODUCTS

CUMI is offering the following industrial ceramics products based on the industry.

- Engineered Ceramics
- Metallized Ceramics
- Wear Resistant liner
- Ballistic Protection
- Lined equipment
- Grinding Media

INDUSTRIAL CERAMICS INDUSTRY

- Ceramic Tiles
- Cement
- Power Generation
- Steel Industry
- Fluid Handling
- Power Distribution Equipment
- Coal Washery
- Armour