

Materials**Ceramics****Introduction**

Ceramics are crystalline, inorganic non-metals. Ceramic materials are produced by fusing raw mineral substances via baking in a kiln. Depending on the state of the raw materials, the production process may require the application of pressure.

Ceramics have the following generalised material properties

- low density
- low toughness
- high moduli
- very hard
- very high melting points
- excellent electrical and thermal insulation
- good retention of properties at high temperatures.

Commonly used ceramics materials can be divided into three groups:

Oxides	Aluminium Oxide (Alumina) Magnesium Oxide (Magnesia) Silicon Dioxide (Silica) Zirconium Dioxide (Zirconia)
Carbides	Diamond Graphite Silicon Carbide Tungsten Carbide
Nitrides	Boron Nitride Silicon Nitride

There are four main applications for ceramics; these can be categorised as Engineering Ceramics, Construction Ceramics, Pottery and Glass (glass is a non-crystalline solid).

Engineering Ceramics

Engineering Ceramics are high performance materials that are used for their hardness, retention of properties at high temperatures and electrical resistance properties.

Ceramics are used in small quantities as cutting tool inserts for machine tools, where the majority of the cutting tool body is manufactured from a lower cost material and the ceramic insert is bolted to the tool body to provide superior cutting properties. Example materials of this type are Tungsten Carbide and Industrial Diamond (Cubic Boron Nitride (CBN)).

Ceramics are used in the manufacture of specialised high performance composites, where the ceramic material can be both the reinforcement and the matrix elements.

Construction Ceramics

Construction ceramics are materials that are used in the building industry, such as clay bricks, roof tiles, tiling, and drainage piping, primarily using heavy clay raw material.

Pottery Ceramics

Pottery ceramics are used to provide barrier and aesthetic properties, for products from table and ovenware to flower pots. Ceramic materials used in pottery include Earthenware, Porcelain and Terra Cotta.

Glass

Glass can be supplied in block, tube and sheet form. The vast majority of glass applications use its excellent light transmitting and barrier qualities. Glass is widely used in the food and pharmaceutical industries because it is almost inert, is easy to clean and can be sterilised at high temperatures.

The major disadvantage of glass is that it is a brittle material and can be shattered by very low shock loads. By varying the composition of the materials and through heat treatments the toughness can be improved dramatically.

When used in conjunction with other materials, glass can provide a wide range of properties, in fibre form to reinforce plastic composites or combined with plastics in sheet form to provide toughened window panels.

The three main commercial grades of glass are:

Soda-Lime Glasses

The major constituent of soda-lime glass is silica, between 50 and 80% by volume. Common uses of this glass are window panes and food jars. High purity silica glasses are used for fibre-optic cables.

Lead Glasses

Lead glasses contain in the region of 24 to 30% lead oxide for decorative purposes and in the region of 65% lead oxide for radiation shielding purposes.

Borosilicate Glasses.

Borosilicate glasses contain in the region of 70 to 80% silica and between 7 and 13% boric oxide. The composition provides the properties of chemical and thermal shock resistance, leading to their widespread use in chemical process equipment and ovenware.

Internet Resources

The [British Ceramic Confederation](#) provides support for its members by acting in the interests of the ceramics industry and promoting the use and development of ceramic materials.

The [British Glass](#) website is a resource that combines the activities of the British Glass Manufacturers Confederation (BGMC) and Glass Technology Services Limited (GTS). The BGMC represents the interests of the glass manufacturing industry and GTS carries out independent technical research.

The [Society of Glass Technology](#) aims to advance the technology and application of glass over a wide range of market sectors.

The [Digitalfire Corporation](#) is a company that provides ceramics materials data, through software and physical testing. The website is a resource that provides information and education on a large number of ceramic materials. Some of the software packages that can be purchased provide means for calculating material properties and recipes for ceramic materials.