Intro to Ceramics

For more than 70 years, Goodfellow, the leading global supplier of Metals, Alloys, Ceramics, Glasses, Polymers, Compounds and Composites, has been ahead of the market in product innovation.

Ceramics represent a range of diverse materials which includes traditional products such as those used in pottery or as a refractory material, as well as advanced engineering materials such as Alumina and Silicon Nitride which are used in electronic devices, aerospace components and cutting tools.

Goodfellow recently provided advanced ceramics for a permanent exhibition at The National Museum of Scotland in Edinburgh. The properties of ceramics have many applications across industry, science and technology, and ceramics have been a key component in global trade for thousands of years. The materials provided by Goodfellow have helped to showcase the decorative and practical uses of ceramics, highlighting current uses of high-performance ceramics.

More information about our ceramics case studies can be found on Goodfellow.com

A Review of the Leading and Innovative Ceramic and Glass Materials

Ceramics exhibit very strong ionic and/or covalent bonds which are stronger than the bonds found in metals. These confer the properties commonly associated with ceramics, namely hardness, high compressive strength, low thermal and electrical conductivities, and chemical inertness.

In general, the microstructure of ceramics can be entirely crystalline or a combination of crystalline and glassy. When the microstructure is entirely glassy, non-crystalline and amorphous, the material is defined as glass.

Many components are either made or contain ceramic and glass materials. Examples include:

- Fibre optics which have uses in many areas including communication networks, sensors and imaging devices. (Sapphire, Silica)
- Heat-resistant tiles on the outer surface of the Space Shuttle (Silica coated with Reaction Cured Glass (RCG) which contains Tetrasilicide and Borosilicate glass)
- The touch screens of electronic components (Indium Tin Oxide (ITO), Aluminosilicate glass, Piezoelectric ceramics like Titanates or Zirconates)
- Hybrid materials containing Alumina or Zirconia are used for dentistry and arthroplasty
- Batteries and fuel cells (Alumina, Stabilised Zirconia, Perovskites)

By the late 1990s, enough fibre optic cable had been installed to go to and return from the moon 160 times

Some ceramics are so strong that a 1-inch diameter cable could lift 50 cars


Our collection of ceramics in more than 30 forms is available off the shelf, with most subject to free delivery within 48 hours and with no minimum order quantities.
Shapal® Hi-M Soft

Shapal® Hi-M Soft is a composite ceramic material of AlN and BN. It has a crystal structure which makes it hard, yet it can be machined using carbide-tipped tools. With a thermal conductivity of approximately 5x that of Alumina, along with excellent mechanical properties, Shapal® Hi-M Soft is an excellent material for engineering applications, as close-tolerance components can be easily fabricated. Goodfellow supplies rods and sheets of Shapal® Hi-M Soft from stock and can also supply machined components.

Applications
- THz optical and spacecraft design components
- Semiconductor parts
- Electronic parts where electrical insulation and heat dissipation are required
- Heat sinks
- Crucibles for vacuum deposition
- Vacuum components

MACOR®

MACOR® Machinable Glass Ceramic is a versatile engineering material that is machinable using conventional metalworking or carbide tools. With a maximum use temperature of 1000°C and excellent electrical properties, MACOR® is an ideal material for prototypes and small-to-medium volume production requirements.

Goodfellow supplies rods, bars and sheets from stock. We are also able to supply components produced to specific customer requirements.

Manufacturing Applications of MACOR® Machinable Glass Ceramic
- Precision coil formers (electronic/semiconductor industry)
- Spacers, cavities and reflectors (laser industry)
- Thermal breaks, coil supports and vacuum feed-throughs (aerospace industry)
- Fixtures and reference blocks in power generation (nuclear industry)

MACOR® is a registered trademark of Corning Incorporated
Boron Nitride Nanotubes are a next-generation nanomaterial which will lead the 4th Industrial Revolution. Boron Nitride Nanotubes (BNNTs) represent another form of Boron Nitride. Structurally they are nano-cylinders with sub-micrometre diameters and micrometre lengths. They are composed of hexagonal Boron Nitride, constructed by combining Boron and Nitrogen. The key features of BNNTs are light weight, mechanical strength, thermal and chemical stability, high electrical resistivity and neutron absorption capacity.

**Applications**
- Electrically insulating thermal materials
- Piezoelectric sensors
- High-temperature catalyst
- Fire retardant cables
- Aerospace & nuclear engineering
- Polymer nanocomposites
- Ceramic composites
- Biomedical

Goodfellow supplies a variety of windows and optical components.

**Sizes**
Depending on the material, standard sizes start from 0.025mm thick and lengths of 2mm.

**Materials**
- BK7 Glass, B270, Corning Eagle 2000 XG
- Quartz, Fused Silica, Sapphire, Zerodur, Potassium Aluminosilicate and Filter Glasses.

**Infrared Materials**
- Germanium, IR Grade Quartz, Calcium Fluoride, Sapphire.

**Components**
- Beamsplitters, FS mirrors, prisms, light guides, viewports, precision spheres, aspheric lenses, crucibles and domes.

**Coatings**
- Anti-Reflection (AR) coatings, optical coatings, metallic coatings and electrically conductive coatings.

Click here for the Technical Data Sheet
Click here for the Technical Information
Opaque Fused Quartz is a popular choice of melting tray material due to its excellent thermal and chemical stabilities and superior thermal shock resistance. It is ideal for situations where rapid temperature changes may occur during processing.

Some material manufacturing processes can lead to inconsistencies in the melting vessels that risk a much-reduced lifetime or even failure during the melting process. To overcome these shortcomings, Goodfellow supplies high-purity (>99.995%) moulded Opaque Fused Quartz melting trays which provide excellent characteristics for demanding melting applications.

Applications
- High-temperature processing vessels
- Calcining and melting vessels
- Solder pots

Introducing our new range of Ceramic Perovskites

Researchers are currently focusing on the development of Perovskites, materials which are demonstrating great potential for optoelectronic applications.

Perovskites are a group of materials having a unique versatile crystal structure. This crystal structure consists of a variation in the chemical formula ABX₃, with many Perovskites occurring as oxides (ABO₃), where A and B are typically metal cations. Due to their lattice, these materials are characterised by special properties like superconductivity, magnetoresistance, piezoelectricity and dielectric and pyroelectric behaviours.

Therefore, these materials are being considered as excellent candidates for multilayer capacitors like fuel cells, solar cells, sensors and electric batteries, or even next-generation display screens, LEDs, memory devices (RAM) and high-temperature superconductors.

Goodfellow has a range of Perovskites including BaTiO₃, CaTiO₃, PbTiO₃, in different forms such as powders or sputtering targets.

Materials we stock in powder and solid forms:
- Barium Titanate
- Bismuth Aluminate
- Bismuth Titanium Oxide
- Calcium Titanate
- Copper Tungsten Oxide
- Lithium Titanate
- Lead Titanium Oxide
- Lanthanum Titanate
- Samarium Ferrite

Click here for the Technical Information
Click here for the Technical Data Sheet
<table>
<thead>
<tr>
<th>FORMS</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Bar</strong></td>
<td>A straight length of rectangular, square or oval section material.</td>
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<tr>
<td><strong>Bead</strong></td>
<td>A small piece of material with a hole through it. Beads can be spherical, tubular or “fish-spine” interlocking forms.</td>
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<tr>
<td><strong>Bolt</strong></td>
<td>A threaded pin that can be screwed into a nut or a tapped hole to fasten items together. Bolts are available with different head styles and also in metric and inch threaded sizes.</td>
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<tr>
<td><strong>Chopped Fibre</strong></td>
<td>Fibres cut into short lengths called cut, staple or chopped fiber.</td>
</tr>
<tr>
<td><strong>Clearance</strong></td>
<td>A vessel in which other materials may be heated or melted, usually at high temperatures.</td>
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<tr>
<td><strong>Fabric</strong></td>
<td>Woven fabrics are made by the regular interlacing of two arrays of yarns at right angles to each other, these being referred to as the warp and weft (see also Non-woven fabric).</td>
</tr>
<tr>
<td><strong>Fibre</strong></td>
<td>Yarns or tows consisting of several approximately parallel individual filaments, each filament usually being smaller in diameter than a monofilament. Yarns contain a defined number of filaments, typically three to several hundred; tows contain thousands of filaments whose number is only defined approximately. Both are primarily specified by their linear density measured in “tex”, the weight in grams of a 1 km length of material.</td>
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<tr>
<td><strong>Film</strong></td>
<td>A non-metallic sheet material with a thickness &lt; 0.5mm.</td>
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<tr>
<td><strong>Foam</strong></td>
<td>A low density, permeable structure of cells and continuous ligaments offering a high surface area to volume ratio, and also a high strength to weight ratio.</td>
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<tr>
<td><strong>Foil</strong></td>
<td>Thin sheets of pure metal and metal alloys. Due to their fragile nature, some foils are coated on one side with an acrylic or polyester support. Where foils are supported they are indicated in the detailed item description.</td>
</tr>
<tr>
<td><strong>Granule</strong></td>
<td>Pellets of an approximately regular shape. Granules may vary in size and, therefore, the dimensions stated are nominal. In addition, the shape of a granule may vary from item to item.</td>
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<tr>
<td><strong>Honeycomb</strong></td>
<td>A cellular structure similar in appearance to natural honeycomb.</td>
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<tr>
<td><strong>Ink</strong></td>
<td>A liquid or paste used for writing, printing or drawing. In many instances it is a colloidal sol system of fine pigment particles dispersed in a solvent. The ink will impart colour and its properties by being adsorbed/absorbed onto the substrate, often via ionic bonding.</td>
</tr>
<tr>
<td><strong>Insulated Wire</strong></td>
<td>A single or multiple flexible strand of metal or alloy with an insulating sheath.</td>
</tr>
<tr>
<td><strong>Laminate</strong></td>
<td>Layers of material which have been bonded together by the use of heat, pressure and, possibly, adhesive.</td>
</tr>
<tr>
<td><strong>Lump</strong></td>
<td>A solid piece of material with no defined shape.</td>
</tr>
<tr>
<td><strong>Metallised Film</strong></td>
<td>Film which is coated with a metal. The thickness of the metal is measured and described in terms of the material’s specific electrical resistance in ohms per square.</td>
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<tr>
<td><strong>Microfoil</strong></td>
<td>An extremely thin sheet of metal or alloy mounted on a permanent support. This support cannot be removed without destroying the Microfoil.</td>
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<tr>
<td><strong>Microleaf</strong></td>
<td>An extremely thin sheet of metal mounted on a removable support. Microleaf is not available for metals which are too brittle to be free standing.</td>
</tr>
<tr>
<td><strong>Monofilament</strong></td>
<td>A single strand of a non-metallic material.</td>
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<tr>
<td><strong>Non-Woven Fabric</strong></td>
<td>Non-woven fabrics are made by methods other than weaving or knitting, the yarns and fibres being held together, often quite loosely, by means other than geometric interlacing. Due to the open and porous nature of this material, all other dimensions are nominal.</td>
</tr>
<tr>
<td><strong>Powder</strong></td>
<td>Small particles with an approximately defined size range. Those materials described as alloy precursors are not true alloys - they are made by sintering a blend of powders of the component metals to achieve alloying by diffusion. The resultant cake is ground and sieved to the required particle size range. Unless otherwise stated, the particle sizes shown are for guidance only. We do not guarantee either any particular size distribution between the quoted minimum and maximum sizes, or a specific particle shape.</td>
</tr>
<tr>
<td><strong>Powder</strong></td>
<td>Generally a flat piece of material with a thread hole which can be screwed onto a bolt to fasten items together. Nuts typically have a hexagonal external shape. Nuts are available in metric and inch threaded sizes.</td>
</tr>
<tr>
<td><strong>Sputtering Target</strong></td>
<td>A high purity material used as a source for sputtering, a cold vaporization process in which atoms are physically removed from the target surface by ion bombardment.</td>
</tr>
<tr>
<td><strong>Single Crystal</strong></td>
<td>A material grown as a monocrystal, generally to a specific orientation, dimension and surface finish. It may contain a dopant. Single crystals are usually made to order.</td>
</tr>
<tr>
<td><strong>Sphere</strong></td>
<td>A regular solid or hollow three-dimensional form in which every cross-section is a circle. Spheres are available with standard or precision tolerances, and can be supplied with different surface finishes depending on the material.</td>
</tr>
<tr>
<td><strong>Sheet</strong></td>
<td>Flat material with a thickness &gt;0.5mm.</td>
</tr>
<tr>
<td><strong>Single Crystal</strong></td>
<td>A material grown as a monocrystal, generally to a specific orientation, dimension and surface finish. It may contain a dopant. Single crystals are usually made to order.</td>
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<tr>
<td><strong>Rod</strong></td>
<td>A straight length of circular section material.</td>
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<tr>
<td><strong>Tube</strong></td>
<td>A hollow length of material normally circular in section. Most tubes are straight except those made of flexible polymer.</td>
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<tr>
<td><strong>Washer</strong></td>
<td>A thin, flat piece of material with a hole in the middle, used in conjunction with bolts and nuts to distribute the load of a threaded fastener.</td>
</tr>
<tr>
<td><strong>Wire</strong></td>
<td>A single or multiple flexible strand of pure metal or alloy.</td>
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