



Ceramics

Developing Technical Ceramics for Navy Applications



Bethesda, MD (NAVSEA Carderock)—Engineers are creating technical ceramics that have specialized uses in capacitors, electronic devices, fiber optic cables, and efficient engines. Ceramic materials are used in everyday life for bricks, dishes, mugs, tiles, and bathroom fixtures. Ceramics' high hardness and ability to withstand heat makes them good materials for many applications –construction materials, electronics, and aerospace systems. Engineers are making materials that have never been made before.

"Maybe the most famous example of a technical ceramic is the space shuttle tiles, which coat the entire bottom surface of the space shuttle." Jim Zaykoski, materials engineer

Framework

Middle School

Standards

- NSES - B.i.1 ➤ A substance has characteristic properties.
- NSES - B.i.2 ➤ Substances react chemically in characteristic ways.
- STL - 2.R ➤ Requirements are parameters placed on development.
- STL - 10.G ➤ Invention and innovation play a role.
- STL - 19.F ➤ Manufacturing changes materials.

Content Illustrated

- Comparison of temperatures reached in different heating environments and withstood by different materials.



Content



Physical Science

- Ceramics are a kind of material made from metal combined with another element, such as oxygen, carbon, nitrogen, or boron. They are strong, hard, and durable materials that can withstand chemicals and erosion. They also may be brittle and break easily.
- Ceramics typically have a very high melting point, even higher than metals. Some have melting points between 1700-3000°C. This can be compared to a kitchen oven at 250°C or the glowing wood of a campfire at 1200°C or the filament in a light bulb burning at 2000°C.
- The hardness of a mineral is measured on the Mohs scale. The softest material is talc and the hardest material is diamond. Ceramics can be made almost as hard as diamonds.

Technology

- Many household items are made of ceramics: bricks, dishes, tiles, and toilets.
- Technical ceramics, with their durable properties, are used for capacitors, fiber optic cables, and space shuttle tiles.
- Sintering is a process used to make new ceramics. Dry powders are mixed, placed in a mold, and heated in a very hot furnace. The mixture is heated to just below melting (1700-2200°C), when the powders will stick together in a strong crystal structure.
- Technical ceramics joined with other tools can grind or cut through almost anything.

Engineering

- Engineers try to make ceramics that are not brittle.
- Engineers are developing ceramics that will allow engines to be used by the Navy that will operate well at higher temperatures.

Guiding Questions

- What are the benefits of using ceramics?
- What are the challenges of using ceramics that engineers are addressing?

Suggested Activities

- Have students create their own ceramic-based technology (such as a cup or pencil holder) using either kiln-fired clays or air-dried clays.

Keywords

brittle
ceramics
melting point
metals
Mohs scale
sintering
technical ceramics

- *Ceramics* can be found online at www.ndep.us/Ceramics. Visit www.ndep.us/LabTV for a list of process skills modeled in webisodes.