Ceramics

❖ What is Ceramic ?

ceramic in different styles

❖ Definition

- ❑ Ceramics are non-metallic, inorganic materials made by the action of heat followed by cooling.
- ❑ They usually consist of metallic and non-metallic elements (e.g., oxides, nitrides, carbides).
- ❑ Ceramics can be crystalline, amorphous, or a combination (as in glass-ceramics).

❖ Key Characteristics

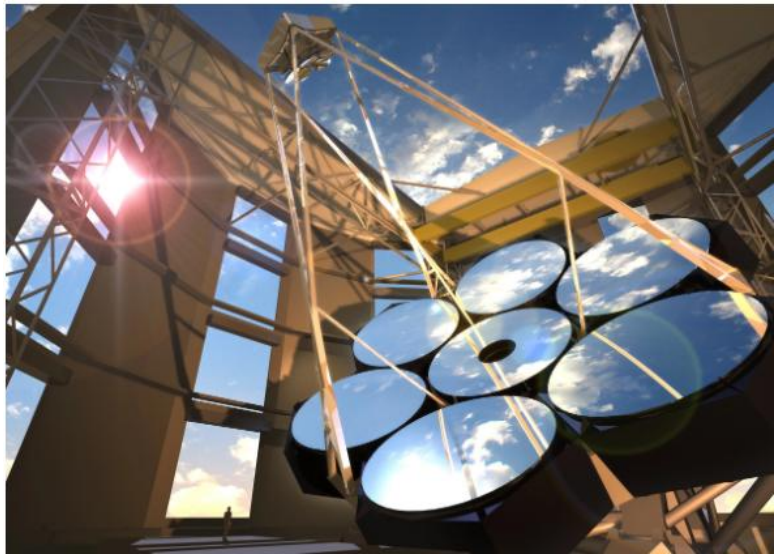
- ❑ Hardness: Extremely hard materials (e.g., SiC, Al_2O_3).
- ❑ High melting point and thermal stability.
- ❑ Low density compared to metals.
- ❑ Brittleness: High stiffness but low toughness (can fracture easily).
- ❑ Excellent wear and corrosion resistance.
- ❑ Electrical insulation (most ceramics are good insulators; some are semiconductors or superconductors).

https://doi.org/10.1016/j.jmrt.2023.07.257

Ceramics

Oxide Ceramics

Non-oxide Ceramics



Glass-Ceramics

❖ **Types of Structural Ceramics**

The paper categorizes ceramics into the following:

a. Oxide Ceramics

- ❑ Common types: Alumina (Al_2O_3), Zirconia (ZrO_2)
- ❑ Applications: Cutting tools, dental implants, bearings.

b. Non-oxide Ceramics

- ❑ Includes: Carbides (SiC), Nitrides (Si_3N_4), Borides (TiB_2)
- ❑ Applications: High-temp components, aerospace parts, nuclear industry.

c. Glass-Ceramics

- ❑ Intermediate between glass and crystalline ceramics.
- ❑ Applications: Cooktops, telescope mirrors, electronics.

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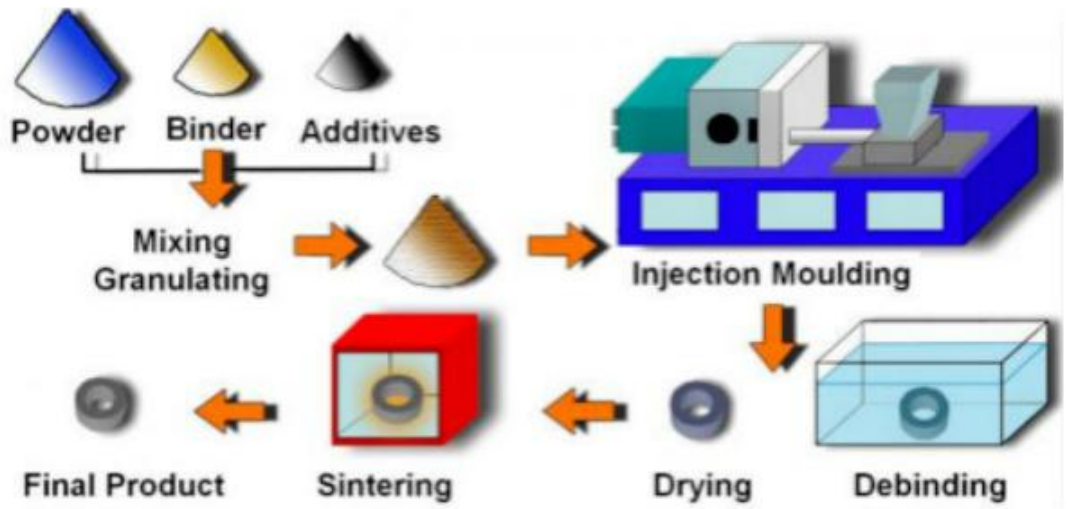
Ceramics

❖ Ceramics Fabrication Techniques



❖ Fabrication Techniques

Ceramics are formed using various advanced processes:

- ❑ Powder metallurgy
- ❑ Hot pressing and sintering
- ❑ Spark plasma sintering (SPS)
- ❑ Additive manufacturing (3D printing)

These methods help improve mechanical strength, microstructure, and densification.

❖ Recent Developments

- ❑ Toughened ceramics (e.g., zirconia toughened alumina)
- ❑ Nanostructured ceramics for better fracture resistance
- ❑ Bioinspired ceramics mimicking nacre and bone structures
- ❑ 3D-printed ceramics for customized components

https://www.preciseceramic.com/blog/five-processing-methods-of-advanced-ceramics-with-pictures.html https://doi.org/10.1016/j.jmrt.2023.07.257