BMM1523/BHA1113
ENGINEERING MATERIALS

CERAMICS

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Chapter Description

- **Aims**

  To understand the properties of different types ceramic materials.

- **Expected Outcomes**
  - Student able to classify the types of ceramic materials.
  - Student able to describe the different properties of traditional and advanced ceramic materials.
- **References**

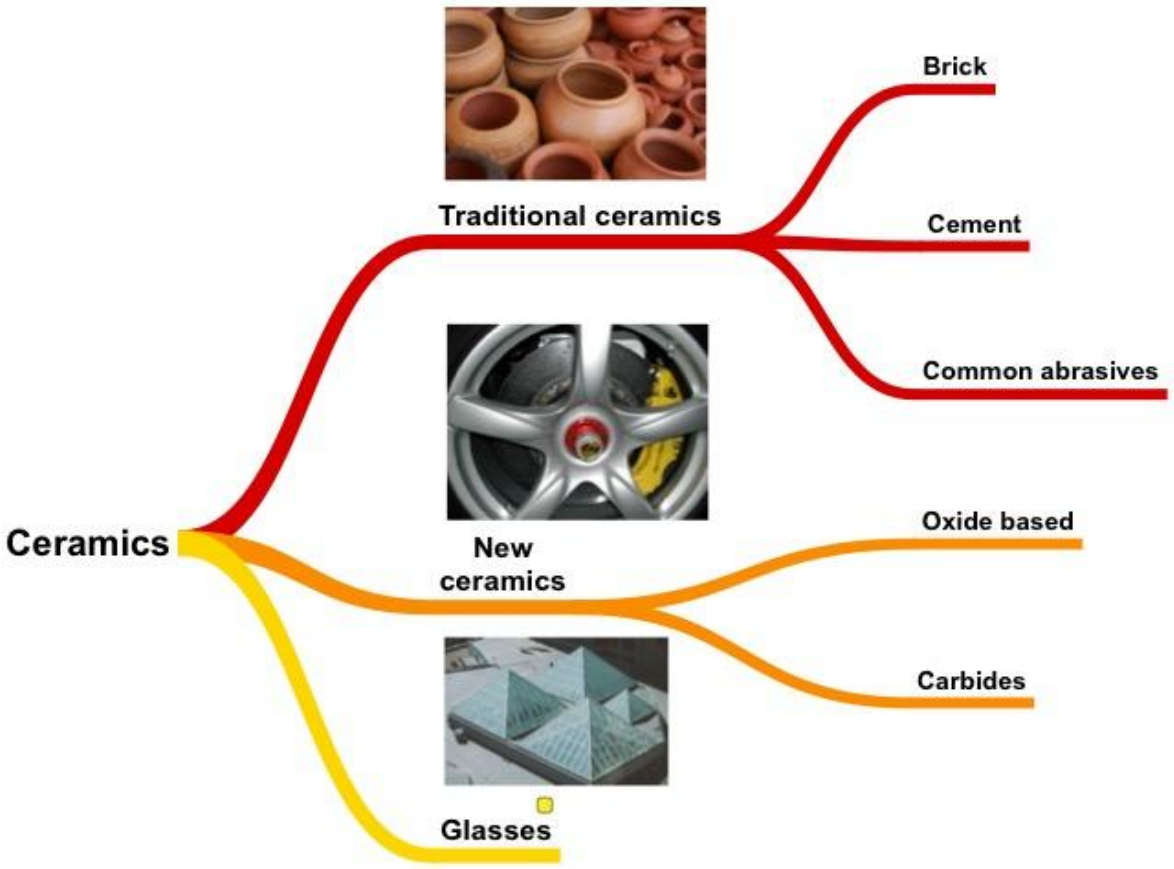
1. William D. Callister and David G. Rethwisch. Materials science and enginnering: An Introduction, 9th Ed. Wiley, 2014.

Introduction of ceramic

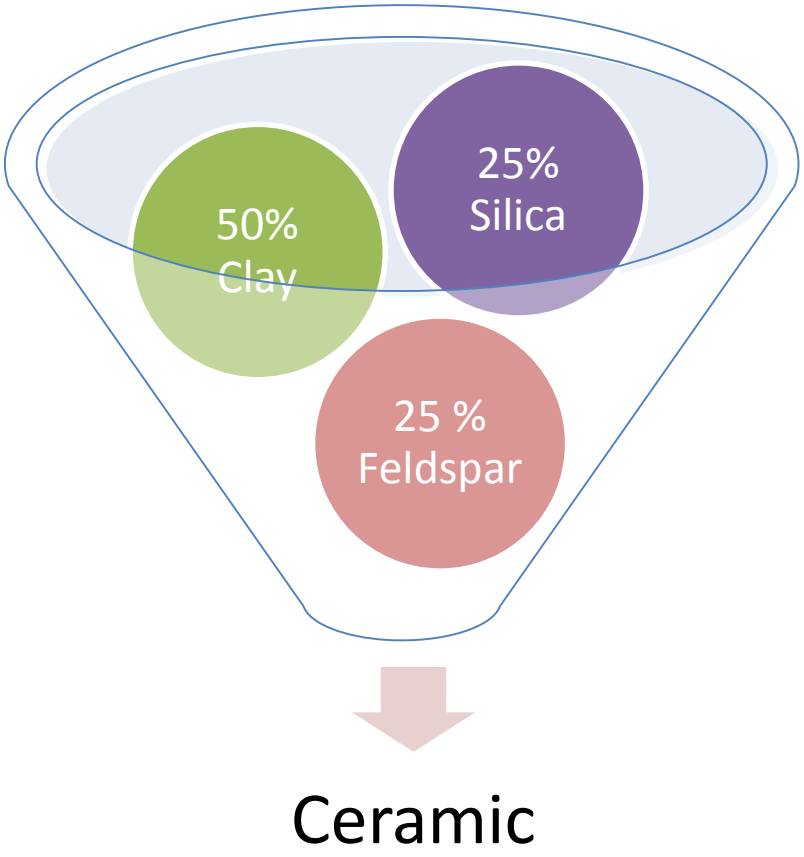
Definition: Inorganic, nonmetallic materials that consist of metallic and nonmetallic elements bonded together primarily by ionic and/ or covalent bonds.

Properties and characteristic:

- Hard and brittle with low toughness and ductility.
- Usually good electrical and thermal insulators
- High melting temperatures and high chemical stability



Traditional ceramic



Feldspar (Fluxing agent)

- Bond the refractory component
- Makes a glass when the ceramic mix was fired

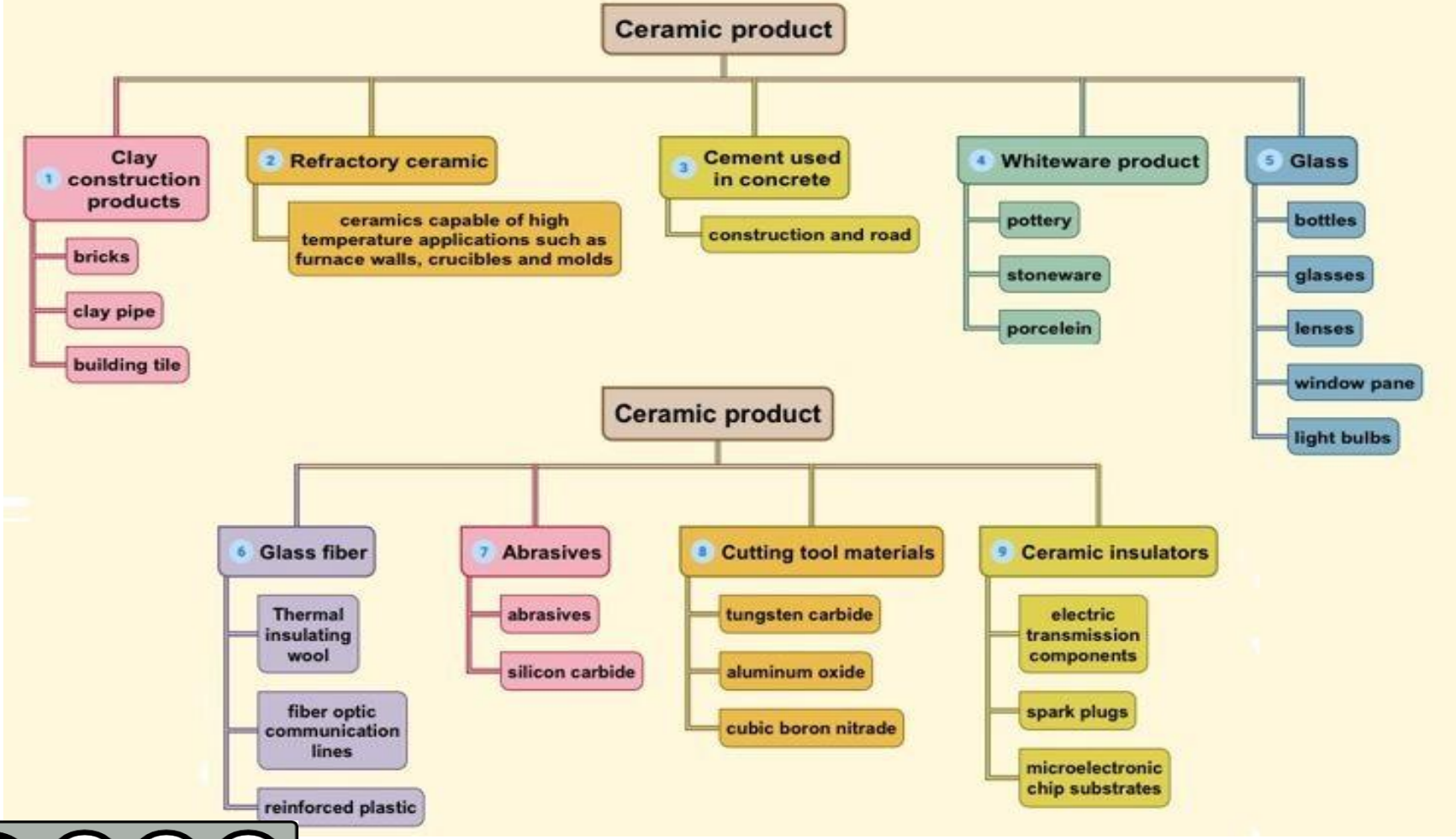
Clay

- Constitute the major body material
- provides workability of the material before firing hardens it

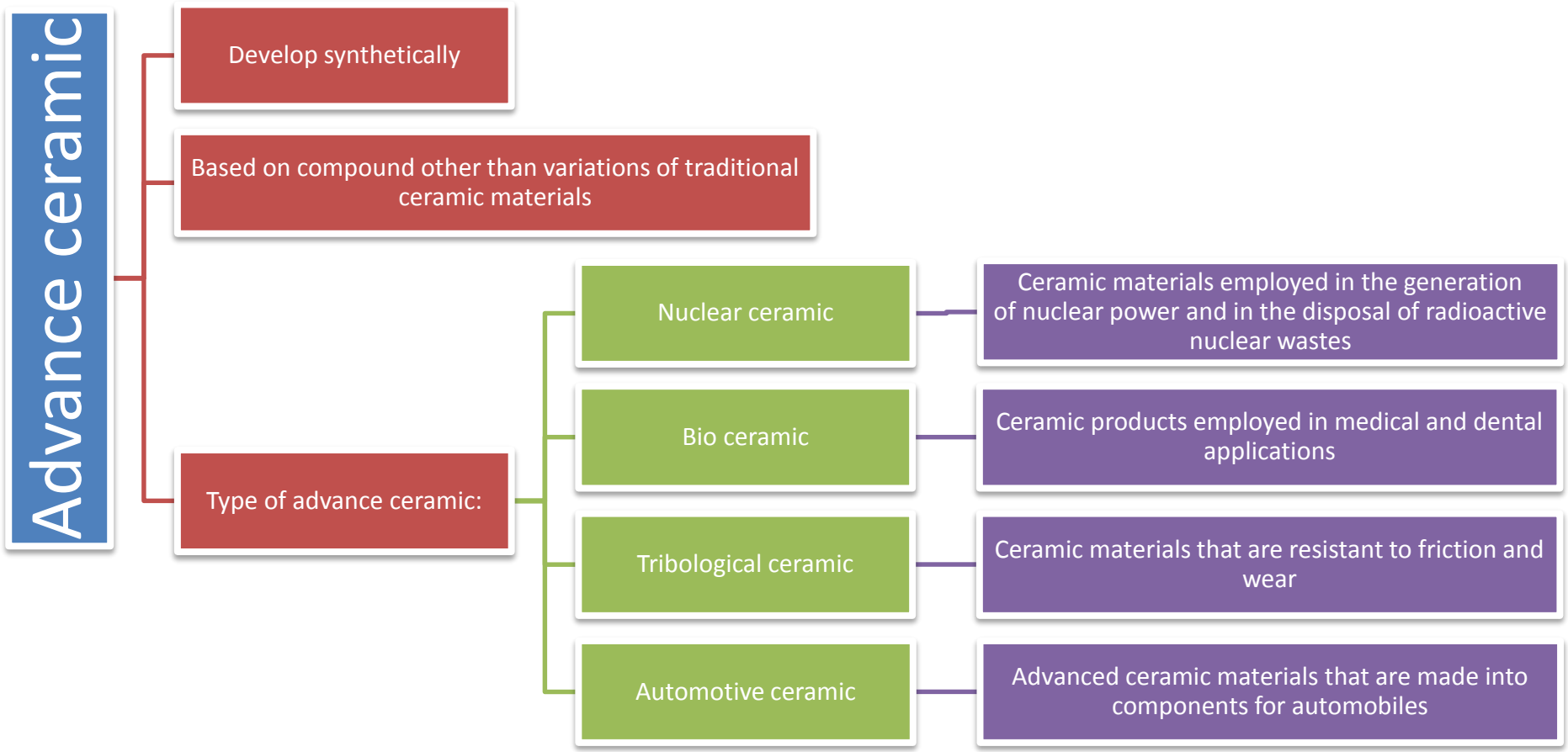
Silica/Filler

- Refractory component

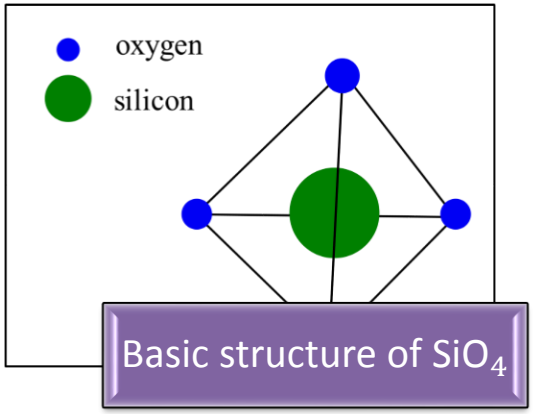
Traditional Ceramic

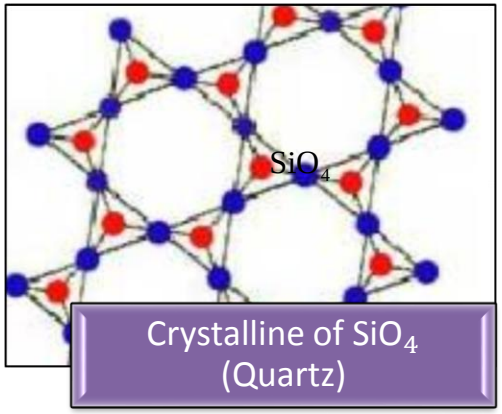


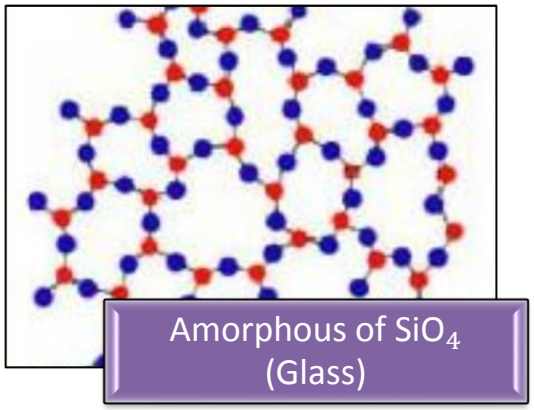
New / Advanced Ceramic



Glass



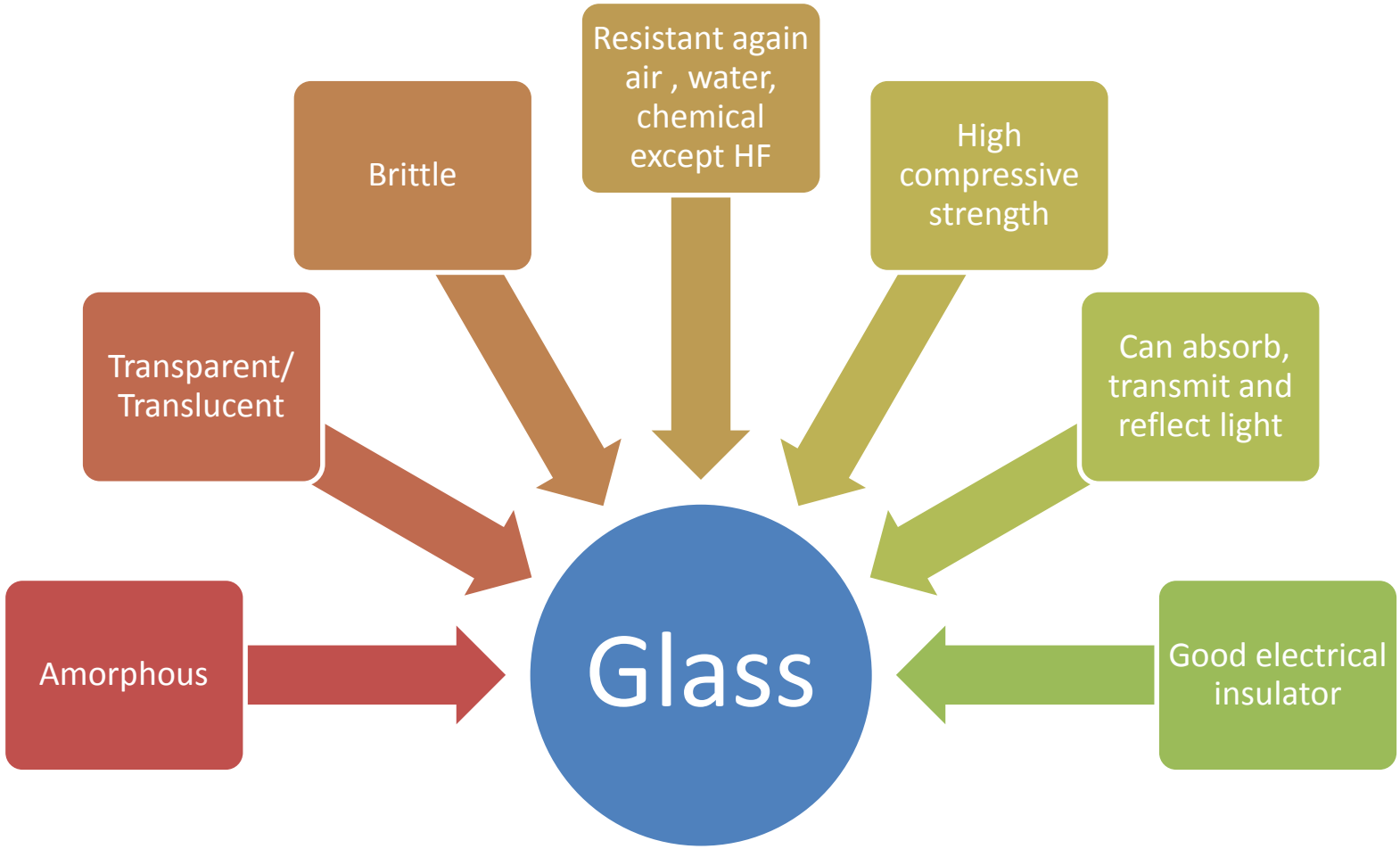




Glass is noncrystalline (amorphous)

- Fused silica is SiO_2 to which no impurities have been added
- Other common glasses contain impurity ions such as Na^+, Ca^{2+}, Al^{3+}, and B^3

Properties of Glass



Type of Glass

Type of glasses	Composition	Advantages and disadvantages
Fused silica glass, vitreous silica glass	100% Silica	• low thermal expansion, hard and resist high temperature • resist against weathering
Soda-lime-silica, window glass	silica 72% + sodium oxide (Na_2O) 14.2% + magnesia (MgO) 2.5% + lime (CaO) 10.0% + alumina (Al_2O_3) 0.6%.	• transparent, easily formed • has a high thermal expansion and poor resistance to heat
Sodium borosilicate glass (Pyrex)	silica 81% + boric oxide (B_2O_3) 12% + soda (Na_2O) 4.5% + alumina (Al_2O_3) 2.0%.	• Stands heat expansion much better than window glass. • low coefficients of thermal expansion
Lead-oxide glass, crystal glass	silica 59% + soda (Na_2O) 2.0% + lead oxide (PbO) 25% + potassium oxide (K_2O) 12% + alumina 0.4% + zinc oxide (ZnO) 1.5%.	• high refractive index. • cannot stand heating very well
Aluminosilicate	20% aluminium oxide (alumina-Al_2O_3)	• able to withstand high temperatures and thermal shock
Oxide glass	alumina 90% + germanium oxide (GeO_2) 10%.	• Extremely clear glass

Ceramic Fabrication Methods

Glass forming

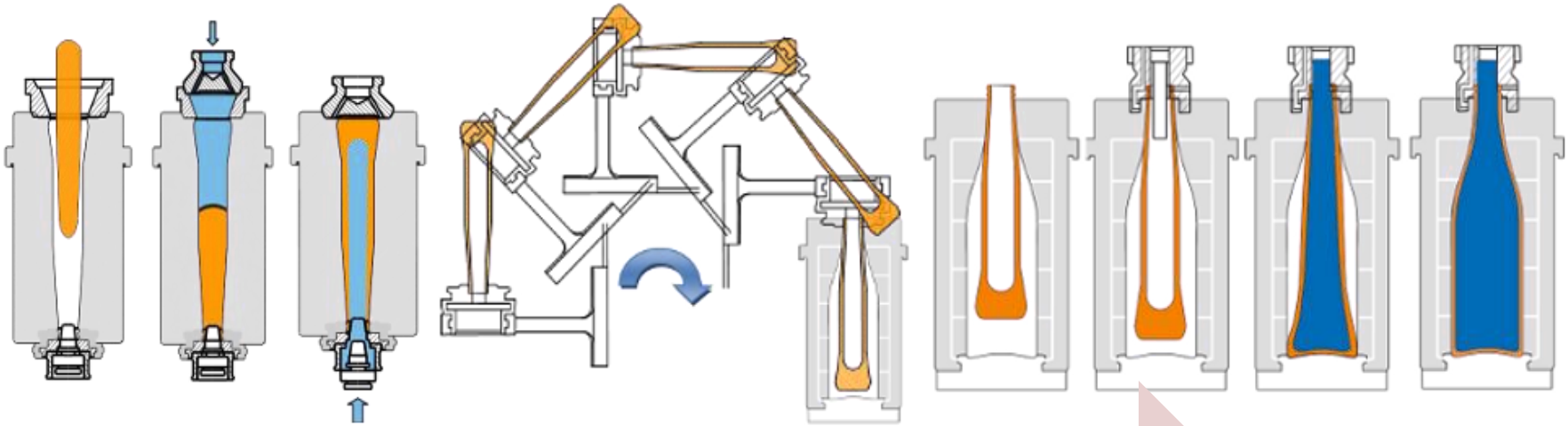
- **Pressing**
- **Blowing**
- **Drawing**
- **Fiber forming**

Particulate forming

- **Powder pressing:** Hot; Uniaxial; Isostatic
- **Hydro plastic forming**
- **Slip casting**
- **Tape casting**

Cementation

Glass forming: Blow and blow method



Gob dropped in blank mold

Neck formed

Blank blown

Blank shape

Blank transferred to blow mould

Final shape blown

Finished bottle

Particulate forming (Slip casting)

Preparing slurry

- Mix clay and dispersing agent into water

Formation of cast

Partial drying

Final drying

Fill in Mold

Draining

Plugging and separating

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Research Interest:

- ❑High Temperature Physical Chemistry
- ❑Thin Films Technology
- ❑Metals and Alloys.

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Research Interest:

- ❑Natural-fiber composites
- ❑Polymer based materials.

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