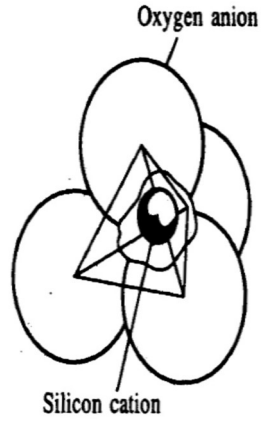


Nanocrystalline Solids

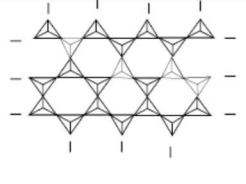
I. Glass:

Structure of Silica:



Silicate Structural Units:

| Number of oxygen ions shared | Structural unit | Structural formula | Charge balance | Examples of mineral |
|------------------------------|-----------------|--|---------------------------|--|
| 0 | | Island (SiO ₄) ⁴⁻ (ortho) | Si +4 O -8 Net -4 | Olivine (Mg, Fe) ₂ SiO ₄ |
| 1 | | Island (Si ₂ O ₇) ⁶⁻ (pyro) | Si +8 O -14 Net -6 | Hemimorphite Zn ₄ Si ₂ O(OH) ₂ ·H ₂ O |
| 2 | | Single (SiO ₃) ²⁻ | Si +4 O -6 Net -2 | Enstatite MgSiO ₃ |
| | | chain Ring (SiO ₃) ²⁻ | Si +4 O -6 Net -2 | Beryl Be ₃ Al ₂ (SiO ₃) ₆ |
| 2½ | | Double (Si ₄ O ₁₁) ⁶⁻ | Si +16 O -22 Net -6 | Tremolite (Asbestos)Ca ₂ Mg ₅ (OH) ₂ ·(Si ₄ O ₁₁) ₂ |

| | | | | |
|---|---|--|--------------------------|--|
| 3 |  | Sheet (Si ₂ O ₅) ²⁻ | Si +8 O -10 Net -2 | Muscovite (Mica) KAl ₂ (OH) ₂ (Si ₃ Al)O ₁₀ |
| 4 | Three- dimensional network | (SiO ₂) ⁰ | Si +4 O -4 Net 0 | Quartz SiO ₂ |

Glass-ceramics Composition

- Pyrex
 - 80% SiO₂, 14% B₂O₃, 4% Na₂O
- Fused Silica
 - 99.8% SiO₂
- Tsoft (Pyrex) < Tsoft (Fused Silica)
- Portland Cement
 - C₃S: 45%
 - C₂S: 30%
 - C₃A: 10%
 - C₄AF: 8%
 - Others (Binders): 7%

POLYMERS: THERMOPLASTICS VS THERMOSETS

II.

• Thermoplastics:

1. little cross linking
2. ductile
3. soften w/heating
4. polyethylene
5. polypropylene
6. polycarbonate
7. polystyrene

• Thermosets:

1. large cross linking
2. (10 to 50% of monomers)
3. hard and brittle
4. do NOT soften w/heating
5. vulcanized rubber, epoxies, polyester resin, phenolic resin, bakelite

Long Chain Polymers

- Plastics– Random orientation of long chain molecules

- Fibers– Alignment of chains
- Elastomers– Long chain molecules with rubbery behavior

| Name | Monomer Structure | | | | Uses |
|--------------------------------------|-------------------|----|-----------------|-------------------------------|---|
| | R1 | R2 | R3 | R4 | |
| Polyethylene (Polythene) | H | H | H | H | Sheets, tubes and containers |
| Polyvinyl chloride (PVC) | H | H | H | Cl | Electrical insulation, gramophone recorders |
| Polypropylene | H | H | H | CH ₃ | Ropes and filaments, vacuum flask, flash light casing |
| Polymethylemethacrylate (Plexiglass) | H | H | CH ₃ | COOCH ₃ | Transparent windows and fixture |
| Polystyrene | H | H | H | C ₆ H ₅ | As Styrofoam, sound proofing in refrigerators and buildings |

Ethylene Based Long Chain Polymer

REFESRENCE

- Book: Materials Science and Engineering: A First Course by V. Raghavan; Prentice-Hall of India Private Limited, 1989
- Book: Materials Science and Engineering: An Introduction by William D. Callister, John Wiley & Sons, 1997.