

TABLE 1 Properties, Compositions, and uses of Important Commercial Silicate Glasses

| Glass Type | Corning Number | Kimble Number | Approximate Composition (wt. %) | | | | | | | | Relative thermal Expansion $10^{-7}/^{\circ}\text{C}$ | Density (gms/cm ³) | Refractive index | Uses |
|---------------------------------|----------------|---------------|---------------------------------|-------------------------------|--------------------------------|------|------|-----|-------------------|------------------|---|--------------------------------|------------------|---------------------------------|
| | | | SiO ₂ | B ₂ O ₃ | Al ₂ O ₃ | CaO | MgO | PbO | Na ₂ O | K ₂ O | | | | |
| Soda lime | 0080 | R-6 | 72.6 | 0.8 | 1.7 | 4.6 | 3.6 | | 15.2 | | 92 | 2.47 | 1.51 | Windows, lamps |
| “Pyrex” boro-silicate | 7740 | KG-33 | 81.0 | 13.0 | 2.0 | | | | 4.0 | | 33 | 2.23 | 1.47 | Headlamps, cooking, and labware |
| Soda boro-silicate | 7050 | K-705 | 68.0 | 24.0 | 1.0 | | | | 7.0 | | 46 | 2.24 | 1.48 | Sealing |
| Alkali lead | 0010 | KG-1 | 77.0 | | | 1.0 | | 8 | 9.0 | 5.0 | 93 | 2.86 | 1.54 | Lamp tubing, sealing |
| Alkaline earth Alumino-silicate | 1720 | EZ-1 | 64.0 | 4.5 | 10.4 | 8.9 | 10.2 | | 1.3 | 0.7 | 42 | 2.52 | 1.53 | High temperatures |
| “E” Fiber-glass | | | 55.0 | 7.0 | 15.0 | 21.0 | | | 1.0 | 1.0 | 60 | 2.61 | 1.55 | Fiberglass |

Table 14.3 *Compositions of Some Common Commercial Borosilicate Glasses*

| <i>Component (wt%)</i> | <i>CGW-7740 (labware)</i> | <i>CGW-7070 (electrical)</i> | <i>CGW-7059 (substrate)</i> | <i>CGW-7052 (sealing)</i> |
|--------------------------------|-------------------------------|----------------------------------|---------------------------------|-------------------------------|
| SiO ₂ | 81 | 72 | 49 | 64 |
| Li ₂ O | — | 0.5 | — | 1 |
| Na ₂ O | 4 | 0.5 | — | 2 |
| K ₂ O | — | 1 | — | 3 |
| BaO | — | — | 25 | 3 |
| Al ₂ O ₃ | 2 | 1 | 10 | 8 |
| B ₂ O ₃ | 13 | 25 | 15 | 19 |

Table 14.5 *Compositions of Common Glass Fibers*

| <i>Component (wt%)</i> | <i>Wool</i> | <i>E-glass</i> | <i>S-glass</i> | <i>C-glass</i> |
|--------------------------------------|-------------|----------------|----------------|----------------|
| SiO ₂ | 55–70 | 52–56 | 65 | 64–68 |
| Na ₂ O + K ₂ O | 13–18 | 0–2 | – | 7–10 |
| MgO | 0–5 | 0–5 | 10 | 2–4 |
| CaO | 5–13 | 16–25 | – | 11–15 |
| BaO | 0–3 | – | – | 0–1 |
| Al ₂ O ₃ | 0–7 | 12–16 | 25 | 3–5 |
| B ₂ O ₃ | 3–12 | 5–10 | – | 4–6 |
| TiO ₂ | 0–0.5 | 0–1.5 | – | – |
| Fe ₂ O ₃ | 0.1–0.5 | 0–0.8 | – | 0–0.8 |
| F | 0–1.5 | 0–1 | – | – |
| SO ₂ | 0–0.5 | – | – | – |

| | SiO₂ | Al₂O₃ | Fe₂O₃ | B₂O₃ | CaO | MgO | BaO | Na₂O | K₂O | PbO | SrO |
|------------------------------|------------------------|------------------------------------|------------------------------------|-----------------------------------|------------|------------|------------|------------------------|-----------------------|------------|------------|
| Flint Container | 72.5 | 1.7 | 0.05 | | 10.0 | 0.8 | | 14.0 | 0.5 | | |
| Amber Container | 71.5 | 2.2 | 0.35 | | 10.0 | 1.0 | | 14.1 | 0.55 | | |
| Window Glass | 72.0 | 1.5 | 0.15 | | 9.6 | 2.5 | | 13.8 | 0.45 | | |
| Tableware | 74.0 | 1.2 | 0.04 | | 5.3 | 4.0 | | 14.0 | 1.4 | | |
| Heat Resisting | 81.0 | 2.5 | | 12.0 | | | | 4.5 | | | |
| Fiber Glass (E-glass) | 54.5 | 14.5 | | 8.5 | 17.5 | 4.5 | | 0.5 | | | |
| TV Faceplate | 61.0 | 3.4 | | | 3.0 | 2.1 | 2.0 | 7.2 | 9.0 | 2.0 | 10.0 |

Wt %

Table 1.5
Calculated single bond strengths of some oxides

| <i>Metal</i> | <i>Dissociation energy (E_d) (kcal mol⁻¹)</i> | <i>Coordination number (N)</i> | <i>Single bond strength (E_d/N) (kcal mol⁻¹)</i> |
|--------------|---|--------------------------------|--|
| B | 356 | 3 | 119 |
| | | 4 | 89 |
| Si | 424 | 4 | 106 |
| Ge | 431(?) | 4 | 108 |
| P | 442 | 4 | 111 |
| V | 449 | 4 | 112 |
| As | 349 | 4 | 87 |
| Sb | 339 | 4 | 85 |
| Zr | 485 | 6 | 81 |
| Zn | 114 | '2' | 72 |
| Pb | 145 | '2' | 73 |
| Al | 317–402 | 6 | 53–67 |
| Na | 120 | 6 | 20 |
| K | 115 | 9 | 13 |
| Ca | 257 | 8 | 32 |

Glass Viscosity Fixpoints & Viscosity Units

| log ₁₀ (viscosity in ...) | | Description |
|--------------------------------------|---------|---|
| Pa·s | Poise | |
| 1 | 2 | Melting Point (glass melt homogenization and fining) |
| 3 | 4 | Working Point (pressing, blowing, gob forming) |
| 4 | 5 | Flow Point |
| 6.6 | 7.6 | Littleton Softening Point (Glass deforms under its own weight. Standard procedures ASTM C338, ISO 7884-3) |
| 8-10 | 9-11 | Dilatometric Softening Point T _d , depending on load |
| 10.5 | 11.5 | Deformation Point |
| 11-12.3 | 12-13.3 | Glass Transition Temperature T _g |
| 12 | 13 | Annealing Point (Stress is relieved within a few minutes.) |
| 13.5 | 14.5 | Strain Point (Stress is relieved within several hours.) |

Viscosity Units:

$$10 \text{ Poise} = 10 \text{ P} = 1 \text{ Pa}\cdot\text{s}$$

$$\log(\text{viscosity in Poise}) = \log(\text{viscosity in Pa}\cdot\text{s}) + 1$$









