Glass Fluxes and Modifiers

Li_2O (Lithia)

Lithia is a very effective flux, especially when used in conjunction with potash and soda feldspars. It is a valuable constituent in certain glasses having low thermal expansion because it permits the total alkali content to be kept at a minimum. Glasses containing lithia are much more fluid in the molten state than those containing proportionate amount of sodium or potassium. Therefore, much smaller amounts are required to produce a glass of the necessary viscosity for working without sacrificing the desired physical and chemical properties.

CaO (Lime)

Lime offers stability, hardness, viscosity, strength, and facilitates melting and refining. Lime decreases the viscosity at high temperature, but increases the rate of "setting" in working range. It greatly reduces the crushing strength when present in quantities > 12.9%. Lime will provide the highest tensile strength when it is properly mixed with soda and silica.

B_2O_3

In general, those glasses containing the greatest amount of boric oxide show a minimum expansion, a property which is of great importance in obtaining thermal durability.
In addition to its beneficial effects in melting, the presence of smaller amounts of borax in ordinary soda-lime-silica glass (resulting from use of borax in the batch) imparts greater brilliance, strength, durability and thermal shock resistance. It also decreases the tendency for glass to devitrify or crystallize.
Boric oxide in the glass composition has been found to increase both the impact and tensile strength of glass containers. It also decreases the coefficient of expansion and increases rate of heat transfer and strength, all of which play important roles in thermal endurance.

ZnO

Zinc oxide reduces the coefficient of thermal expansion, thus making possible the production of glass products of high resistance to thermal shock. It imparts high brilliance of luster and high stability against deformation under stress (i.e. higher elasticity). As a replacement flux for the more soluble alkali constituents, it provides a viscosity curve of lower slope. Specific heat is decreased and conductivity increased by the substitution of zinc oxide for BaO and PbO.

Thermal Expansion

Elasticity

The introduction of alkali oxide to vitreous silica produces a weakening of the structure through the formation of nonbridging oxygens, therefore, lower elastic modulus. In contrast, the additions of Al_2O_3 or B_2O_3 to alkali silicate glasses have the effect of raising the modulus of elasticity, since the number of nonbridging oxygens is diminished.

Strength

In general, one will anticipate that the strength of glass increases with increasing bonding strength of the glass structure. Therefore, glass strength increases with increasing B_2O_3 and CaO.

Hardness

Alkalies and PbO will decrease, whereas CaO, MgO, ZnO, Al_2O_3, or B_2O_3 will increase hardness.