FERRO
ELECTRONIC MATERIALS

Electronic & Technical Glasses

Product Selection and Application

Glasses should be selected to provide optimum compatibility with the device requirements and usage, as well as the application technique used to apply it. The most critical characteristics of a glass are:

- Type of glass
- Coefficient of Thermal Expansion at the glass set point (CTE @ Set Pt)
- Transformation temperature (T_g)
- Particle size distribution (PSD)
- Glass flow and wettability at the processing temperature
- Compatibility of the glass composition with the application

Glasses are generally of two types, vitreous and devitrifying (crystallizing). Vitreous glasses are thermoplastic and flow at the same temperature each time they are fired. Devitrifying glasses are thermosetting and crystallize during firing to form glass-ceramic, which have different properties than the original glass. The actual crystallization and resultant glass-ceramic can be modified by changing firing conditions and particle size distribution. They typically have greater strength and allow higher device operating temperatures than the vitreous form.

Glasses may also be a composite of several different glasses, or glass and ceramic fillers. This is typically done to meet specific requirements, such as thermal expansion and firing temperature, that are not possible with a single glass.

The CTE @ Set Pt should be as close as possible to the substrate material to prevent stress within the glass and/or substrate that can lead to cracking and failure. The largest recommended difference between glass and a substrate is ± 5 x 10^{-7}/°C; this is generally termed a "matched" fit. In some special configurations, a "compression fit" can allow the joining of two significantly different thermal expansion materials by an intermediate glass.

Each glass has a maximum operating temperature, or the temperature a device can be operated without degrading the glass which can lead to device failure. This is typically somewhat lower than the T_g of the glass. A devitrifying glass, after firing, will have a maximum operating temperature dependent on the crystalline phase formed and is higher, sometime significantly, than the original glass.

The PSD, or powder type, as expressed in maximum (D_{99}) and average (D_{50}) particle sizes, should only be as small as necessary to achieve the desired fired thickness and line definition using the application technique chosen. The smaller a powder type is, typically, the more difficult to process efficiently. In the case of devitrifying glasses (crystallization during firing), changes in the PSD can affect fired CTE, flow and wetting, densification and strength.

Although some products have unique distributions, our powders have the following typical properties:

Powder Type	Typical Range (µm)	
	D_{99}	D_{50}
VSD	150	> 15
TF	44	10 - 15
VEG, REG	74	6 - 10
MVG	34	4 - 6
VWG, RWG	20	2 - 4
SRRG	7	1 - 2
SMZ	5	<1