Corning® Gorilla Glass™ (Code 2318)
Chemical tempering procedures

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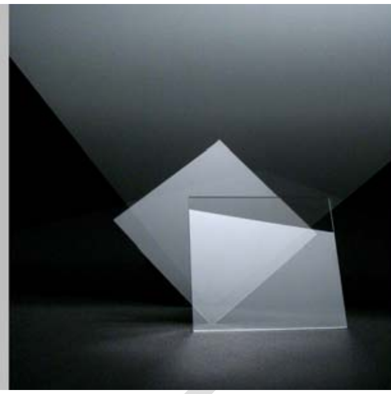

Technical
Materials

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Corning® Gorilla Glass™ is a sheet glass that provides high compressive stress and a deep depth of layer on the surface when chemically strengthened. This glass can be utilized in applications such as touch screen panel covers, mobile phone display windows, and display windows for other handheld devices.

Chemical tempering strengthens the glass by putting the surface of the glass into compression by "stuffing" larger sized ions into the glass surface. During chemical tempering process, the glass is submersed in a bath of molten salt at prescribed temperatures. The heat causes the smaller ions to leave the surface of the glass and larger ions present in the molten salts to enter it. Once the glass is removed from the bath and cooled, they shrink. The larger ions that are now present in the surface of the lens are crowded together. This creates a compressed surface, which results in stronger glass that is more resistant to breakage.

Chemical tempering also creates a uniform layer of stress. This is because the ion exchange occurs uniformly on all surfaces. Unlike air-tempering process, the degree of chemical tempering is not related to the thickness of the glass.

The degree of chemical tempering is measured by the magnitude of compressive stresses (CS) and the depth of the compressive stress layer (also called depth of layer, or DOL). The magnitude of compressive stresses and the DOL is dependent on the time the glass is left in the salt bath, the temperature of the salt bath and the composition of salt bath. Generally, ion exchanging at a higher temperature causes a deeper DOL while the CS is slightly lower due to the tendency of glass to relax some of the stress.

Code 2318 glass is designed to be a rugged protective glass cover for displays in hand-held consumer devices. It is formulated to withstand typical failure modes observed in mobile electronics devices. This glass can be exchanged to have deep depth of layer while maintaining high compressive stresses at the surface. The dependency of compressive stress on the time and temperature for code 2318 glass are shown in Figure 1.

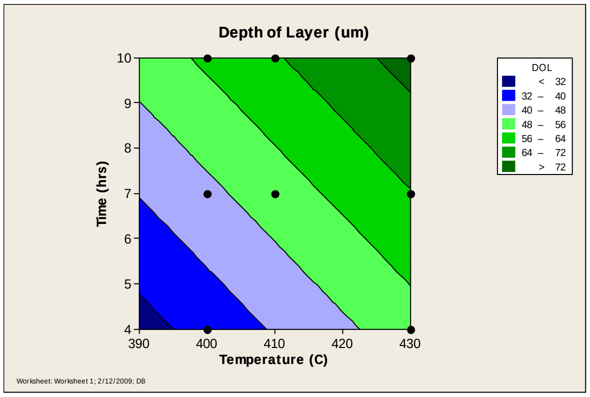

Figure 1. Effect of time and temperature on the Depth of compression Layer for Gorilla glass

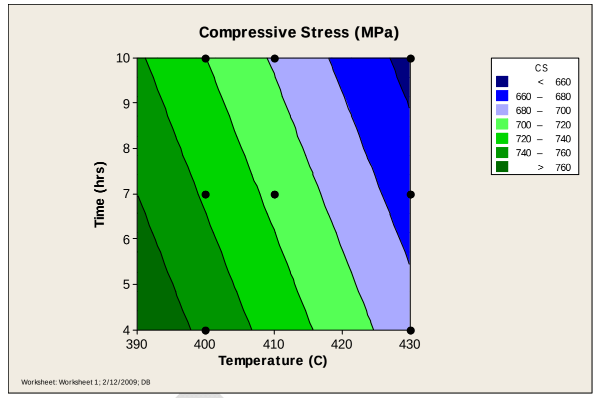

Figure 2. Effect of time and temperature on the surface compressive stress for Gorilla glass

Dimensional changes during chemical tempering:

There are two mechanisms that contribute toward dimensional change in glass. The first is the volume change when the glass is annealed and the second is the expansion due to stuffing the glass with potassium ions. Some glasses are not completely annealed during manufacture. These glasses further anneal during the chemical tempering baths that cause the dimensions to shrink. The shrinkage is dependent on the degree of anneal during manufacture.

When the glass surface is stuffed with larger potassium ions, there is a tendency for the glass to expand. The bulk of the glass opposes this tendency to expand and the dimensions are maintained. If the total thickness of the glass becomes smaller the ratio of the layer under compression and the total thickness become larger causing the glass to expand during chemical tempering. For example, a 50 µm DOL on a 0.75 mm thick glass sheet will cause the sheet to expand 0.05% on chemical tempering

The net dimensional change is the addition of the contraction due to annealing and expansion due to ion exchange. The expansion is thus a function of the DOL, thickness of the glass sheet and the volume of ions exchanged. For 0.75 mm thick code 2318 glass ion exchanged to a 50 mm DOL, one can expect an expansion of 0.05% on ion-exchange. Since these are dependent on the process parameters, this expansion needs to be determined if very tight dimensional control in necessary.

Chemical Tempering Time/Temperature:

Achieving the desired compressive stress characteristics is time/temperature dependent. Gorilla glass, unlike most soda lime glasses, is not self limiting in depth of layer. So good time/temperature control is essential for a stable process. Although Gorilla glass may be chemically tempered at temperatures up to 460°C Corning recommends an operating range between 390°C and 420°C with the target salt temperature maintained to +/- 2°C. Tempering time should be controlled within +/- 5 min.

Post chemical strengthening polishing

The compressive stress decreases with depth of layer. In a glass with a surface compressive stress of 750 MPa with a depth of layer of 50 µm, the compressive stress decreases at the rate of 15 MPa/µm. Any post polishing will decrease the surface compressive stress and make the part weaker.

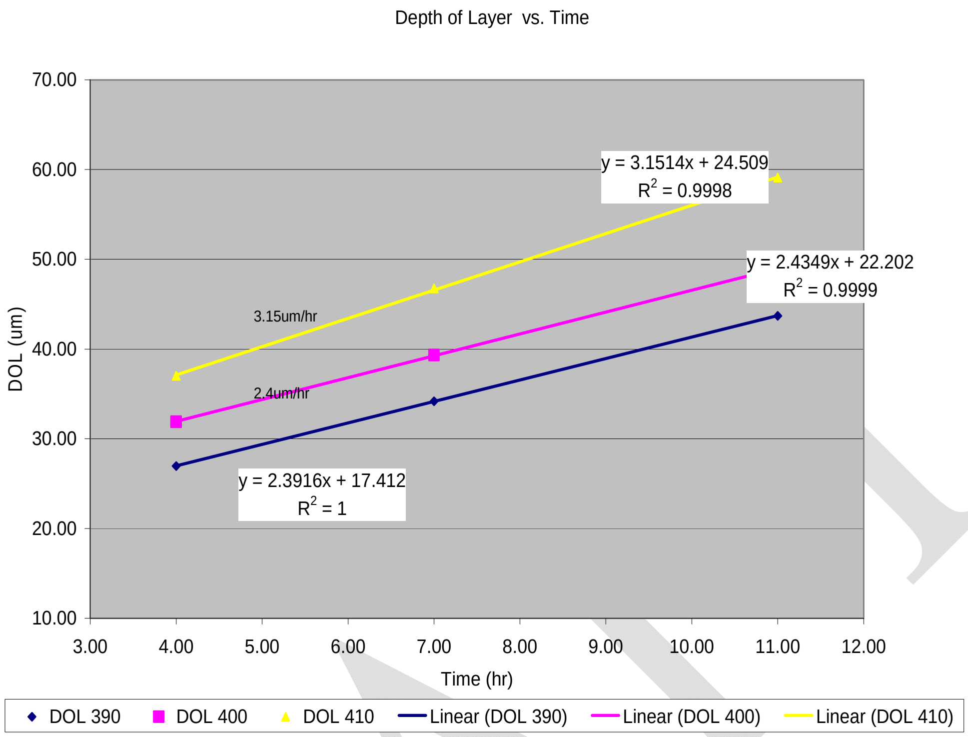

Figure 3 shows the rate at which the DOL increases with time at typical temperatures.

Problems often occur when products are not tempered to the correct temperature and/or time. The key problems are;

- Excessive Central Tension – Over tempering (Too hot or too long) causes excessive tensile stresses to develop in the glass interior. The breakage characteristics of strengthened glass can be controlled by changing the internal tensile stresses
- Low Strength – Usually associated with not enough tempering (too cold, not enough time, or using depleted bath)

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For additional information, or to request a sample, please contact:

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