Introduction:

Strain patterns (iridescence) are a characteristic of heat-treated glass. The condition cannot be eliminated and it only can be controlled to a limited extend. At Garibaldi Glass we are continually addressing the heat treating recipes to reduce the strain patterns as much as possible.

Technical References:

- ***ASTM C 1048-04, 7.5 Strain Pattern*:** In heat-strengthened and fully tempered glass, a strain pattern, which is not normally visible, may become visible under certain light conditions. It is characteristic of these kinds of glasses and should not be mistaken as discoloration or nonuniform tint or color.

- ***Guardian SunGuard, Technical Info*:** Strain pattern refers to a specific geometric pattern of iridescence or darkish shadows that may appear under certain lighting conditions, particularly in the presence of polarized light (also called “quench marks”). The phenomena are caused by the localized stresses imparted by the rapid air cooling of the heat-treating operation. Strain pattern is characteristic of heat-treated glass and is not considered a defect.

- ***Cardinal TSB #FG01-01/16, Strain Pattern Characteristics*:** Heat-treated glass (heat-strengthened or tempered) can have an optical phenomenon that is called iridescence, strain pattern, or quench pattern. Under certain lighting conditions, this phenomenon can appear as faint spots, blotches, or lines. It is the direct result of the heat treatment process and is not considered to be a glass defect.

Strain Pattern Explained:

The process for heat-treating glass involves heating the glass to its softening point in a furnace and then quickly cooling or quenching the glass as it exits the furnace. It is this quenching that gives the added strength and breakage characteristics required in heat-treated glass. Unfortunately, the quenching also creates a strain pattern. While it may vary from one lite of glass to the next, it is part of the process and cannot be eliminated.

Quenching the glass is achieved in the process using several arrays of air nozzles to uniformly disperse cool air across the glass. Ideally, the nozzles would cool the glass with perfect uniformity. In practice, there are slight differences in the rate of cooling across the glass, which results in slight differences in strain.

These differences in strain show up optically when viewed under polarized light. Since direct sunlight has a component that is polarized, it can cause the pattern to become visible. Wearing polarized glasses will increase the effect.

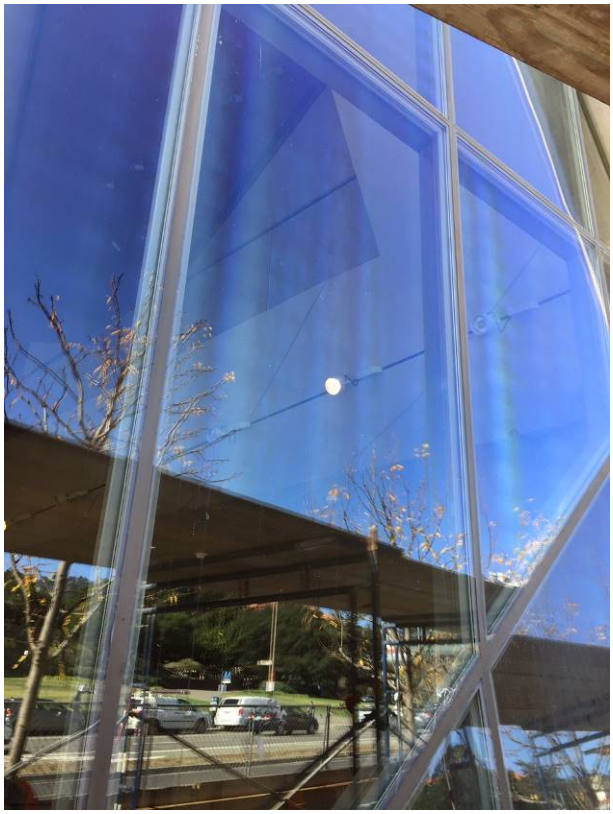
The color and shape of the strain pattern will vary depending on the design of the cooling nozzles. Sometimes no color is observed (dark and light) and sometimes the pattern is iridescent.

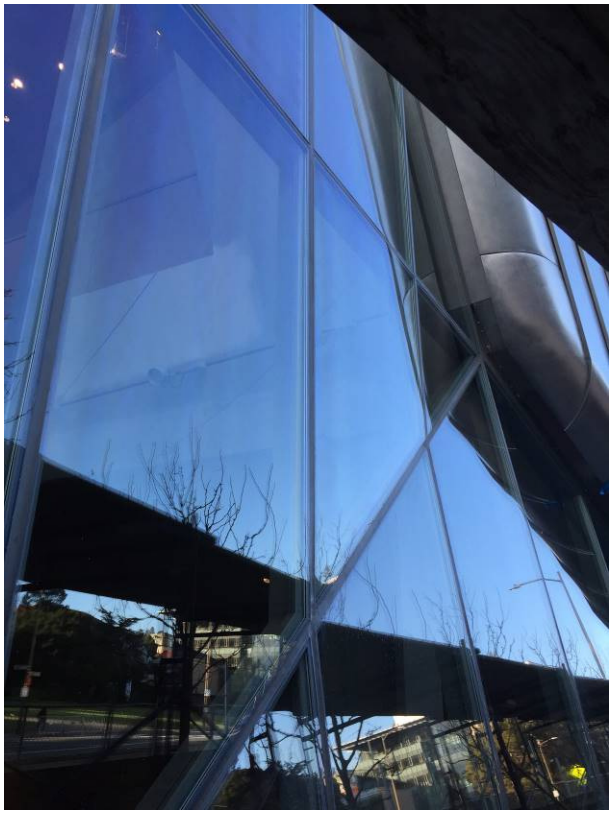
The intensity of the strain pattern is influenced by the viewing angle, lighting conditions and by the perception of the viewer. It may be accentuated if two lites of heat-treated glass are used in an IG unit, if there is no finishing behind the glass (such drywall, drapes, furniture, etc.), if there is a light foreground in front of the glass (such dry concrete, construction site dust, water, etc.), or if the atmosphere is highly polarized (close to the ocean).

Examples:

Field example:

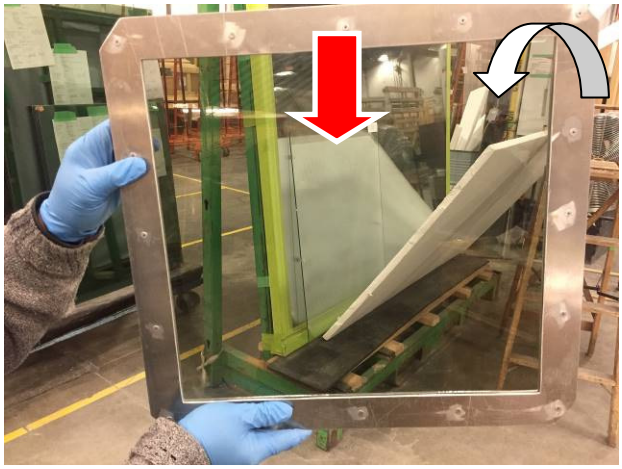
In the two pictures below, the iridescence is visible with different intensities. The pictures were taken with the same camera, from the same angle yet at a different time of the day.



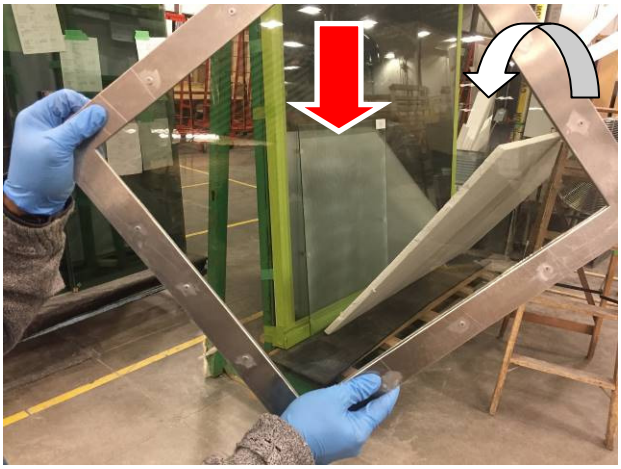


Lab example:

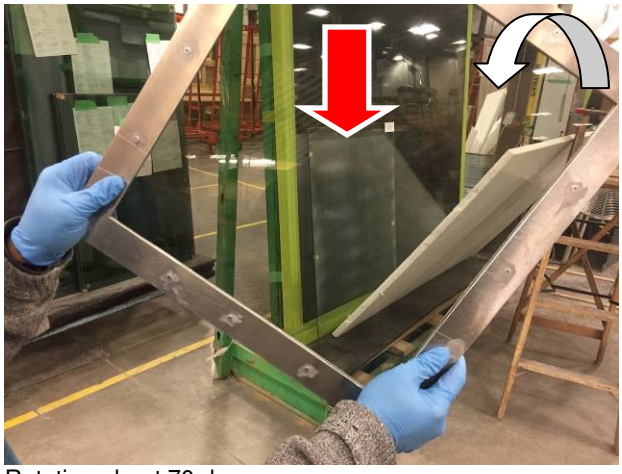
The following pictures were taken through a polarized film, with the same camera and at the same time of the day. The polarized film was rotated from 0 – 90 degrees, to amplify the effect of the strain patterns.



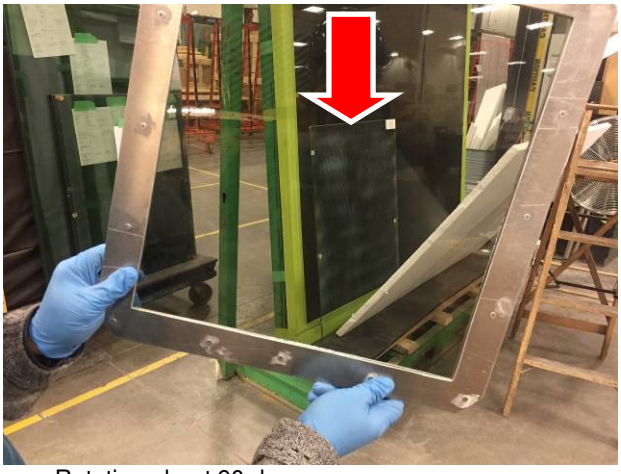
Rotation 0 degrees



Rotation about 40 degrees



Rotation about 70 degrees



Rotation about 90 degrees

References:

- ASTM C 1048-04
- Guardian SunGuard
- Cardinal TSB #FG01-01/16
- Garibaldi Glass Industries Inc.