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Iridescence in Heat-Treated Architectural Glass

Glass used in architecture today commonly includes clear and tinted glass substrates, low-emissivity and solar-control coatings, decorative ceramic-frit patterns and safety glazing considerations that require glass to be heat-treated. Heat-strengthened and fully tempered glass is designed to meet increased thermal and mechanical stresses, or other specified physical criteria. Tempered glass is also used to meet safety glazing code requirements. As a result of the heat-treating process, iridescence, or what is often referred to as a quench pattern/mark, strain pattern or anisotropy, may be visible in heat-strengthened and fully tempered glass under certain polarized lighting conditions.

The accepted industry consensus standard for heat-treated glass, ASTM International C1048 – *Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass*, addresses this optical phenomenon as follows:

Section 7. Fabrication

> 7.4 *Strain Pattern* — a strain pattern, also known as iridescence, is inherent in all heat-strengthened and fully tempered glass. This strain pattern may become visible under certain lighting and other conditions. It is a characteristic of heat-treated glass and should not be mistaken as discoloration, non-uniform tint or color, or a defect in the glass. The strain pattern does not affect any physical properties or performance values of the glass.

The intensity of the strain pattern may vary from lite to lite, and/or within a given lite. The presence of a strain pattern or the perceivable differences in the strain pattern is not a glass defect or blemish and is not a cause for rejection.

The Heat-Treating Process

In order to provide the required resistance to thermal and mechanical stresses, and to achieve specific break patterns for safety glazing applications, annealed float glass is strengthened through a thermal process known as heat-treating. Heat-treating includes both heat-strengthened and fully tempered glass. The most commonly used process for heat-treating architectural glass requires the glass to be cut to the desired size and shape. The edges are seamed, ground or polished as specified, then the glass is washed, and transported into a furnace. See Figure 1 for an outline of the heat-treating process.

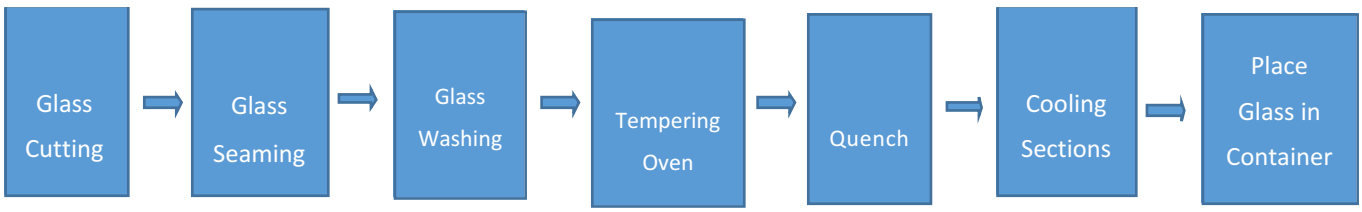

Figure 1. Tempering Process

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In the furnace, glass is heated to approximately 1150 °F (621 °C). Upon exiting the furnace, the glass is rapidly cooled (quenched) by blowing air on the top and bottom surfaces simultaneously. This quenching/cooling process induces permanent stress in the glass, putting the surfaces and edges of the glass in a state of compression and the central core of the glass in compensating tension.

During the quench process, air is supplied through nozzles or slots to the glass surface. Differing levels of stress on the glass surfaces can occur during the quenching process. Non-uniform heating in the furnace can also contribute to iridescence.

When light from the sun, polarized by atmospheric conditions, passes through the heat-treated glass, it experiences a phase shift due to an optical phenomenon known as birefringence as a result of the stress induced by quenching. The areas directly under the quench nozzles have a higher surface compression than the areas adjacent to the quench nozzles because they cool more rapidly than the areas away from the quench nozzles. These slight differences in surface compression result in light and dark areas observed in the glass.

Pattern Visibility

A pattern of perceived faint light and/or dark spots or lines in heat-treated glass may become apparent under certain conditions. Factors affecting visibility include, but are not limited to, viewing angles, location of the viewer (inside or outside), lighting conditions, glass thickness, and coatings or tints applied to the glass.

As frequently seen in back and side lites of automobiles, the strain pattern in fully tempered glass can become more visible when wearing polarized sunglasses. Polarizing filters or lenses for cameras will create the same phenomena and may cause the pattern to become more visible.

Glass Inspection

Construction sites may yield viewing angles and conditions that cause the strain pattern to become visible. However, upon completion of construction, the presence of interior walls, finishes and furniture frequently results in the strain pattern being less visible or not visible at all.

The stresses introduced in the heat-treating of glass are an inherent part of the fabrication process, and while they may be affected or altered depending on the heating process, controls and/or quench design, they cannot be eliminated. Design professionals should be aware that strain patterns are not a defect in heat-treated glass and, therefore, are not a basis for product rejection.

The phenomenon of strain pattern may be visible in any heat-treated glass. Consultation with the glass supplier and viewing full size mock-ups under typical site conditions and surrounding landscape is recommended in evaluating the visibility of the strain pattern. However, a mock-up may not cover all conditions over the life of the project that may cause a difference in the visibility of the strain pattern.

The Glass Association of North America (GANA) has produced this Glass Informational Bulletin solely to provide general information as to strain patterns in heat-treated architectural flat glass. The Bulletin does not purport to state that any one particular type heat-treating process or procedure should be used in all applications or even in any specific application. The user of this Bulletin has the responsibility to ensure the product literature from the heat-treated glass fabricator is considered in the selection and specification of the glass. GANA disclaims any responsibility for any specific results related to the use of this Bulletin, for any errors or omissions contained in the Bulletin, and for any liability for loss or damage of any kind arising out of the use of this Bulletin.

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