Trulite
GLASS & ALUMINUM SOLUTIONS

Technical Bulletin

Strain Pattern

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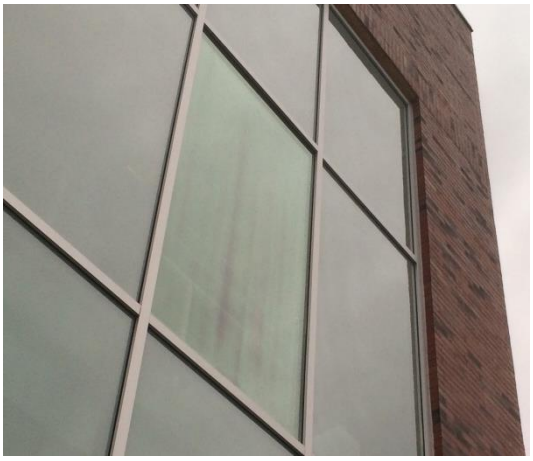
Strain pattern or quench marks are an inherent property of heat-treated flat glass products. The heat treating process involves quickly quenching glass after it that has reached its softening point. This quenching is attained by a series of air nozzles that force cool air across the hot glass. When this happens there is a small density change in the glass surface relative to the quench nozzle location. After processing, in the presence of polarized light the locations where the quench air first hits the glass can appear as iridescent or dark areas. The confirmed observation of this optical phenomenon is a positive indicator the glass has been thermally treated and is not considered a defect.



Said another way, the appearance of strain pattern is linked to polarization of light and the imparted property of birefringence that results during the heat treating process of glass. This process involves heating the glass to its softening point and then quickly cooling or 'quenching' the glass surfaces with a series of nozzles. The quenching strengthens the glass by imparting a surface compression or strain into the glass. Because air from the quench nozzles does not reach all areas of the glass surface at the same time nor with the same pressure, small localized areas of slightly different strain are created throughout the glass. This results in a localized change of the refractive index and creates a change in the appearance of light as it passes through different areas of the glass. The observer sees this as a pattern of dark or iridescent areas in the glass.

The key to determine strain pattern versus other defects is the viewing angle. In normal viewing conditions of approximately ninety degrees perpendicular to the plane of the glass the phenomena may not be visible. As the observer's angle of view decreases, the strain pattern or iridescence will become more visible and intense. Another key to identifying strain pattern is wearing of polarized sun glasses. These will make the pattern more pronounced.

There are also other factors influencing visibility of strain pattern. These are multi lite assemblies, reflective glass coatings, light level differences, and the acuity of the observer. In particular, the microscopic layers in reflective and low emissivity coatings can magnify the strain pattern. Additionally, during the construction phase of a building, low levels of interior light cause the pattern to appear more intense than what will be observable once construction is completed. The higher level of generated and reflected interior light will tend to cancel part of the polarization and reduce the phenomenon.

The glass industry recognizes the inherent property of birefringence in heat treated glass and addresses the issue in ASTM C 1048, Standard Specification for Heat Treated Flat Glass, Kind HS, Kind FT, Coated and Uncoated.

"Section 7.5 Strain Pattern – In heat strengthened and fully tempered glass, a strain pattern, which is not normally visible, may become visible under certain lighting conditions. It is characteristic of these kinds of glasses and should not be mistaken as discoloration or non uniform tint or color."

Often strain pattern in glass is compared between lites on one job or from one building to the next. However, one should consider that observations are based on the geometry of light source, nature of the light (polarized), the incident angle of the glazing, and the angle of view of the observer. When comparing, glazing substrate, coating type, heat treatment, and plane of the glazing must be identical to be meaningful. Even with these factors held constant, heat-treated glass may display a stronger or lesser birefringence, and/or display a different pattern of strain due to being processed on different furnaces and from different fabricators.

Since the phenomenon of strain pattern is the effect of ambient site conditions, the heat treating process, and glass or coating selection, remedial action is difficult to achieve. As such, the inherent appearance strain pattern is not a defect nor cause for rejection of heat treated glass.

Further information can be found in the GANA Glass Information Bulletin, TD 05-0108, *Quench Patterns in Heat-Treated Architectural Glass.*