



GLASSWERKS – TECHNICAL BULLETIN

STRAIN PATTERNS (ANISOTROPY) IN HEAT-TREATED GLASS

TECHNICAL DOCUMENT: GW-TB-008

Strain patterns—commonly referred to as anisotropy, iridescence, or quench patterns—are inherent visual characteristics of heat-treated architectural glass. They result from the thermal tempering or heat-strengthening process and may become visible under certain lighting or viewing conditions. This bulletin explains how these patterns form and outlines what can be expected in the field.

HOW STRAIN PATTERNS FORM DURING HEAT TREATMENT

To manufacture heat-strengthened or fully tempered glass, the glass is heated to near its softening point and then rapidly cooled using high velocity air. This controlled cooling, often called quenching, creates:

- High surface and edge compression
- Balancing interior tension
- Localized compression variations opposite quench air nozzles

Areas receiving more concentrated airflow cool more quickly, resulting in slightly higher levels of surface compression and correspondingly denser glass at those locations. These variations create optical effects that become visible under polarized or partially polarized light.

OPTICAL CAUSE

Because the cooling process induces internal stress, the glass exhibits **birefringence**, meaning it changes the phase of polarized light differently depending on the stress pattern. This produces visual effects such as:

- Dark spots or bands
- "Leopard spot" patterns
- Iridescent streaks or blotches
- Visible patterns when viewed through polarized sunglasses or camera lenses

These effects do *not* indicate product failure; they are a natural outcome of heat treating all architectural glass.

VISUAL APPEARANCE AND VARIABLES AFFECTING VISIBILITY

Strain patterns vary in shape and intensity based on quench design, glass type, and viewing conditions. Several factors influence how noticeable the pattern may become:

- **Glass and Coating Type**
 - Highly reflective or coated surfaces can intensify the visibility of anisotropy.
 - Thinner or uncoated clear glass may show milder contrast.



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- **Lighting Conditions**

Strain patterns are most visible when:

- Viewing through polarized light, either natural or artificial
- Sunlight is at a low angle
- Sky brightness is uneven
- Light is reflected off nearby buildings

Daylight contains varying levels of polarized light depending on weather, atmospheric conditions, and time of day, which is why the appearance of anisotropy can change from one moment to the next.

- **Viewing Geometry**

Patterns are typically more noticeable at **oblique angles** or when viewed through polarized glasses.

INHERENT NATURE OF ANISOTROPY

Strain patterns are **unavoidable** in heat-treated glass. International standards, including ASTM specifications for tempered and heat-strengthened glass (ASTM C1048), describe anisotropy as:

- A normal characteristic of heat-treated glass
- Not a discoloration, tint, or coating defect
- Not indicative of performance issues
- A visual condition that does not impair the safety or strength of the glass

Although different producers may have unique quench equipment or layouts, no heat-treating method can eliminate anisotropy entirely.

ASSESSMENT OF STRAIN PATTERN VISIBILITY

Comparing anisotropy between different buildings or installations rarely provides meaningful results because:

- Glass type, thickness, and coatings may differ
- Viewing direction and height vary
- Atmospheric polarization changes throughout the day
- Surrounding environments influence contrast (e.g., shaded façades vs. reflective backgrounds)



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Meaningful evaluation requires:

- Identical glass type and processing
- Side by side viewing
- Similar daylight conditions, particularly the same degree of polarization
- Similar viewing angle and distance

During construction, anisotropy may appear more pronounced because of open interiors, lack of finishes, and surrounding reflective surfaces. Once the building is occupied and interior finishes, furniture, and landscaping are added, the visibility typically diminishes.

SUMMARY

- Strain patterns (anisotropy) are natural and unavoidable in all heat-treated glass.
- Visibility depends heavily on lighting and viewing angle.
- Patterns do not impact structural performance, safety, or code compliance.
- Industry standards recognize anisotropy as an intrinsic characteristic of the heat-treating process.

REFERENCES

- **ASTM C1048** - *Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass*
- **EN 12150-1** - *Thermally Toughened Soda Lime Silicate Safety Glass – Definitions and Characteristics*
- **GANA (Glass Association of North America)** - Informational Bulletins on Iridescence and Anisotropy