Current anisotropy inspection equipment, such as this scanner from Viprotron, inspects more than just anisotropy, combining multiple solutions in one machine.

Photo: Viprotron

Mitigating the Menace

Anisotropy Scanners Aid Fabricators to Improve Aesthetics

by Jordan Scott

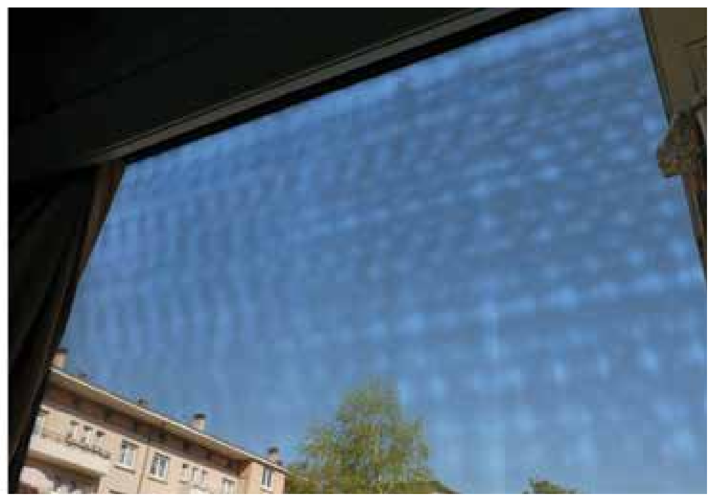

Photo: Viprotron

Anisotropic effects often appear as gray or colored spots or striped patterns on the glass, which isn't aesthetically appealing.

Anisotropy is an unwelcome presence. It could even be called a menace to architectural aesthetics. If polarized light hits a glass façade with high levels of anisotropy, it will appear distorted to the eyes of everyone who looks upon it—including the architect. While it may be impossible to rid glass of anisotropy completely, technological developments in scanning equipment are providing fabricators with the information they need to better prevent their tempering lines from producing glass with high levels of anisotropy.

What is Anisotropy?

The Merriam-Webster definition of anisotropic is "exhibiting properties with different values when measured in different directions." Annealed glass has no anisotropy. However, when glass is tempered it is brought to a high temperature and then cooled rapidly. The edges of the glass and the areas directly under the air nozzles cool faster than other areas, resulting in different stresses throughout the glass. This effect typically is more pronounced in thicker glass because the inside of the glass takes longer to cool than the surface.

According to Nate Huffman, president of Softsolution in Glenview, Ill., if light is passed through glass under stress, then different changes in direction, depending on the wavelength, result in the glass mass. The light waves emerge from the glass with a certain delay. If the light is polarized by natural or artificial factors, such as reflecting off of water, these delays become visible as grey or colored spots or striped patterns.

"Anisotropy will be there no matter what. Scanners allow manufacturers to control the end result of glass to limit how bad anisotropy will be," says Huffman.

Measure by Measure

In the past, fabricators could look for anisotropy manually using a polarized light in a time-consuming process. In the past two to three years, several companies began offering online anisotropy scanning equipment, which has made the process quicker and more accurate. These scanners are placed on the tempering line after the cooling process, giving fabricators real-time information about the anisotropic effect in their glass.

LiteSentry, based in Northfield, Minn., partnered with Stress Photonics

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to create the Osprey 8 Anisotropy Inspection System, which measures glass for iridescence, retardation and average stress using cameras with a light source underneath the glass. Jakub Kowalczyk, sales and marketing manager with LiteSentry, says the Osprey 8 can be installed with any tempering line. It gives live, on-line measurements of the light retardation in nanometers as the glass leaves the quench or cooler. Light waves are broken up through the tempered lite due to the different stresses caused by the tempering process and the Osprey 8 looks for differences in light behavior due to those stresses. The system can also measure predictive iridescence, which Kowalczyk says is a visible derivative of retardation.

"Theoretically, you can get a pair of polarized sunglasses for a few bucks at the store and go look at anisotropy, but that doesn't give you any information … We use a three-color polarized light source from underneath the glass and we inspect the glass for polarized states," he says.

The system does not need to be recalibrated for different glass types or colors. Kowalczyk believes that anisotropy- and iridescence-free glass will continue to be in demand among architects, driving the glass industry to measure these characteristics in tempered glass.

"Architects and consumers are demanding higher quality glass; they are demanding anisotropy- and iridescence-free glass … I think, absolutely, anisotropy and distortion measurement in a single footprint is going to become the standard for 10-20% of your high-quality producers; they're not going to be able to win jobs or bid for projects without it," he says.

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Softsolution's system, the LineScanner, also passes light through the glass using telecentric light modules with a special polarizer foil and measures the speed difference as light passes through the glass with its various stresses. The LineScanner gets a nanometer delay value that quantifies the defects in the glass using line sensors. Huffman says that anisotropy below 60 nanometers is not visible to the human eye. Between 60 and 150 nanometers the eye will notice distortion and above 150 nanometers the distortion will be obvious.

"Due to the precise 90-degree constant angle across the entire inspection width, the path taken by the polarized light through the glass body undergoing testing is always the same length. This ensures that there is no distortion to the result of the evaluation, which is based on the delay of the light," explains Huffman.

The system also measures edge stress, surface defects and dimension oriented defects.

Huffman says that one thing that sets the LineScanner apart is that it's able to scan completed units as well as single lites so that a fabricator doesn't have to guess how the anisotropy will appear in a completed insulating glass unit.

The StrainScanner from Arnold Glas Corp., based in Remshalden, Germany, is made in partnership with Arcon and Ilis. It measures light from an LED panel with a polarimeter device that includes cameras. The cameras measure for optical retardation in nanometers, similar to other anisotropy inspection equipment, and give immediate feedback to the oven operator. Stefan Goebel, general manager for the company, says that current technology gives a good measure of anisotropy, especially with a polarizer. The StrainScanner can also simulate the worst-case viewing angle.

Rainer Feuster, sales director at Viprotron GmbH in Pfungstadt, Germany, says that his company's anisotropy scanner works by finding the differences in light transmittance, rather than measuring stress, to determine optical retardation. The company's anisotropy scanner currently on the market is the second version of the system. It was updated to have tighter tolerances, according to Feuster.

White Haze

Viprotron's and LiteSentry's systems can both inspect for white haze. Feuster describes white haze as an effect of the rollers in the tempering furnace that can look similar to anisotropy. It appears when cooling is uneven on the top and bottom of the glass during the tempering process, which can cause the glass to bow slightly. Feuster says that it's possible for the glass fabricator to polish it away after it's been detected by the scanner.

Fine-Tuned Tempering

Fabricators can take the information they receive from the anisotropy inspection systems and use that to fine-tune their tempering furnaces through trial and error to mitigate anisotropy.

That's what Luis Hidalgo, quality assurance/quality control manager, has been doing for AGC Interpane, which is based in Lauenförde, Germany.

He says that ten years ago, the industry believed anisotropy was unavoidable and not a big concern, but that's changed in the recent past.

"At that time anisotropy scanners had not been developed. We could only rely on the furnace manufacturer's instructions," says Hidalgo, who added that the company also used polarized screens to visually inspect for the effects of anisotropy.

"It was off line and took a long time to monitor units. We couldn't do every unit and needed an on-line scanning system," he says.

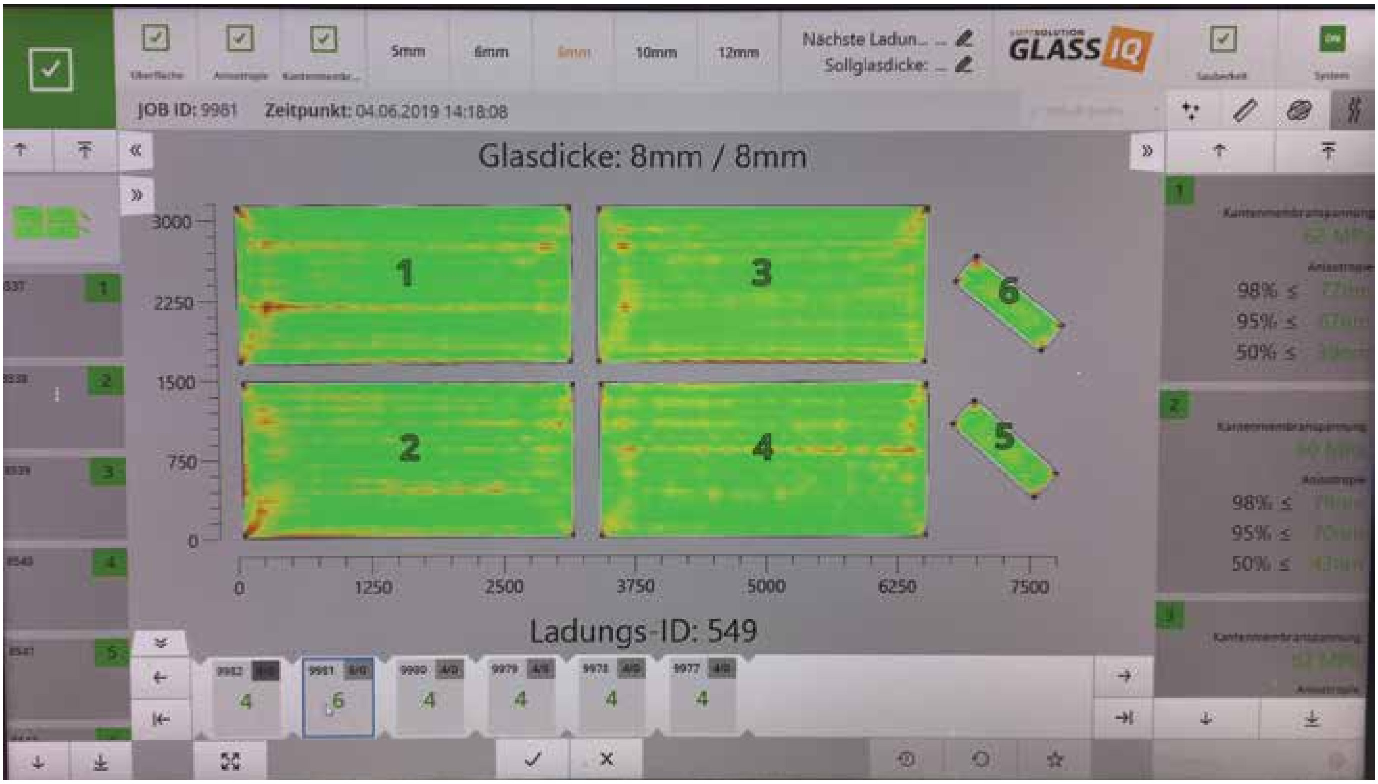

Photo: AGC Interpane

AGC Interpane uses Softsolution's LineScanner to inspect glass for anisotropy in real time.

The development of on-line anisotropy inspection equipment provided fabricators with the tool to collect more fluent and comprehensive information. AGC Interpane uses Softsolution's LineScanner system.

"Tempering is not a static production process. The conditions in furnaces change easily and we must monitor them to understand what's happening with the glass … With the scanners we can better monitor the quenching and heating sections. The information we get helps us to understand where the effect may come from so to help us control these effects," says Hidalgo, noting that anisotropy is not fully avoidable.

When glass exhibits high anisotropy levels, Hidalgo says the company can either dispose of it or re-treat the glass.

"There is a certain risk with running the glass through the tempering line again because heat-treated glass also experiences a strong expansion at the beginning of the heating process which unbalances internal stresses. There is a higher probability that the glass will break there," he says. "The preferred method is to try to minimize anisotropic effects from the beginning, with proper settings."

While Hidalgo believes that on-line anisotropy scanning technology is the best approach to restrain and minimize anisotropic effects, he says there are additional approaches based on the particular production methodology used by certain manufacturers.

"As an example, our factories in Plattling and Lauenförde process most of the heat-treated architectural glass with clear (uncoated) glass. As we are equipped with coating lines, the coating can be deposited on already heat-treated glass. The benefit out of this procedure is that clear glass can be heat-treated with lower heating powers and in a more efficient and homogeneous way as compared with coated glass," he says. "Solar control or low-E coatings in glass reflect most of the infrared power used to heat up the glass in the furnace, which requires stronger heating powers, longer heating cycles or even stronger convection heating powers to keep the glass flat in the heating chamber. The stronger the heating powers involved and the longer the heating cycles with coated glass, the more probable it is to end up either with irregular heating along the surface of the glass piece and, hence, anisotropy…"

Standard in the Works

Currently, there are no guidelines for fabricators to know which measurements are within acceptable limits. To solve this problem, an ASTM task group has been formed to create a standard that defines the acceptable limits of anisotropy in glass. According to Huffman, it will go to ballot this summer.

He says the ultimate goal is to define what's acceptable and to work with end customers to determine acceptable patterns. Goebel says that another part of the standard is agreeing on how to measure for anisotropy.

Next Steps?

Many anisotropy experts agree that the current technology being integrated into the tempering line was a major step for the industry, but what's next? Goebel says that being able to measure anisotropy in curved glass could be the next progression in the field.

the author

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