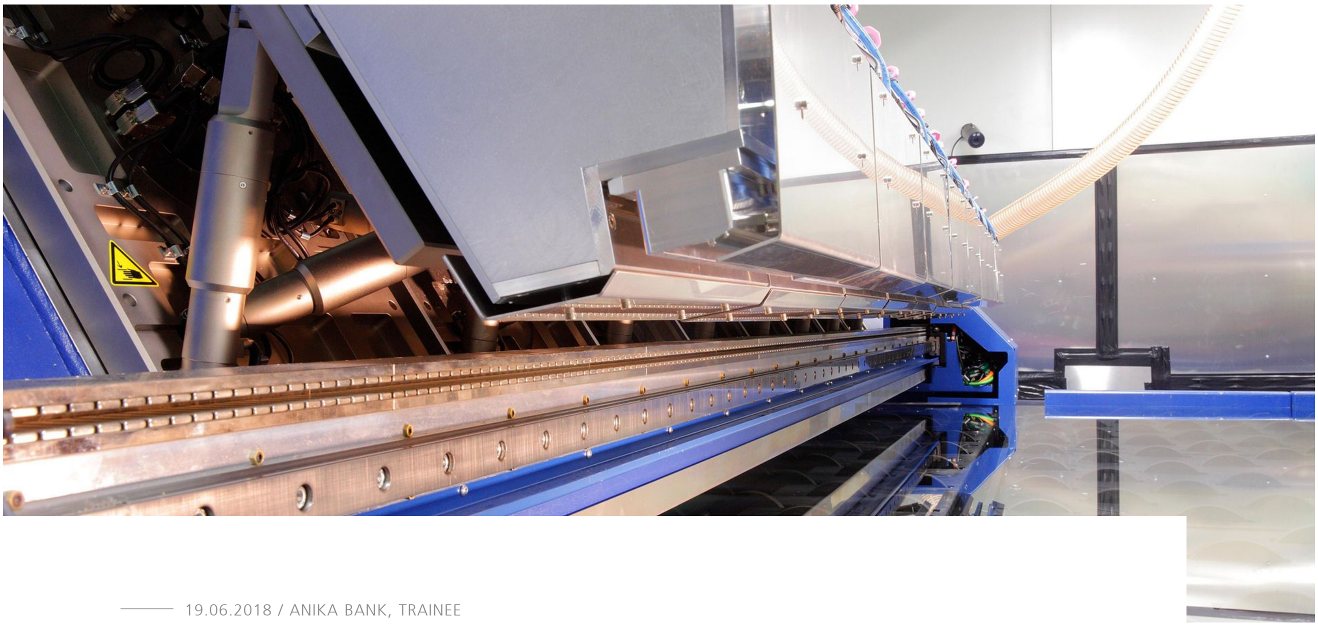

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The new light source

A new kind of window glass from Saint-Gobain lets in lots of light and strongly reduces heat losses. All it took was an impossible laser optic.

There it is: an impressive 45 meters long and eight meters wide. A kind of bridge spans it over a width of 3.30 meters. The bridge carries eight boxes manufactured with high precision, each equipped with a laser optic. A fiber-optic cable connects each of these with powerful TruDisk lasers.

Together the twelve high-performance lasers generate 144 kilowatts of power. Their combined beam strength would not melt steel. It only heats up a thin silver coating just a few nanometers thick, changing its amorphous state to a crystalline one. A small alteration, to be sure – but one that has tremendous results.

A monster machine to make jumbo-size panes

This very large system is located in Cologne, Germany, on the premises of French glass manufacturer Saint-Gobain. One remarkable feature is what is known as the rapid thermal processing unit: it is used for the heat treatment of functional coatings, such as silver, on jumbo-size glass.

Produced by Saint-Gobain, the glass measures 3.2 meters in width, 6 meters in length, and weighs some 750 kilograms. During the heat treatment process, a conveyor section moves the glass panels under the bridge at speeds reaching 25 meters a minute.

Heat and run

The high speed is vital because the ultra-thin laser line – less than 100 micrometers – heats up the coating very briefly at a high degree of intensity to more than 500 degrees. At this temperature the silver crystallizes. But as the coating absorbs a majority of the laser energy, the glass substrate remains unaffected. The term for this is rapid thermal processing; it was TRUMPF experts who developed the extraordinary optic that made it possible on an industrial scale. But let’s start at the beginning.

Laws dictate that window glass must use what is known as low-emissivity, or low-e, glass. This is glass coated with an ultra-thin sputtered metal coating, such as silver encapsulated in-side a precise sequence of layers to impart all required functions.

The functional layer reflects infrared rays in both directions, inwards and outwards; in other words, it reduces the glass’s emissivity while allowing heat to remain inside the house and ensuring considerable transmission of visible light.

Sounds simple, but ...

As long as ten years ago, Saint-Gobain launched a project aimed at developing glass that fulfilled the statutory energy-efficiency requirements of triple glazing but was as transparent as double glazing. The experts were sure this could be done by changing one element: if the silver coating on glass could be changed from an amorphous state to a crystalline one, its conductivity would increase by around 20 percent – as would its insulating effect. Sounds easy, but it’s not.

Theory shattered by reallity?

Coatings are in an amorphous state when they are applied in cold environments. They must be crystallized during a subsequent thermal process. While this is being done, the temperature of the glass substrate must remain under 150 degrees so that the glass can be easily processed further.

Lorenzo Canova, RTP project leader at Saint-Gobain Glass Germany, says: “We were sure that a short, high burst of heat that heats only the coating and not the glass substrate can be accomplished only using a laser with high efficiency.” The glass specialists developed a laboratory facility with a complex laser unit as its centerpiece. Using rapid thermal processing, they created a procedure that enabled them to verify their chosen approach. So far, so good.

An ultrathin laser line — thinner than 100 micrometers — briefly heats the functional coating on sheets of glass to over 500 degrees. Image: Ralf Kreuels

Heating the glass coating very briefly to a high temperature is an essential part of the hardening process. The glass experts at Saint-Gobain spent five years working on their rapid thermal processing method. Image: Ralf Kreuels

But making this system suitable for industrial use proved to be a technical impossibility. “We got in touch with Manz, a high-tech machine manufacturer in Reutlingen,” Canova explains. The experts there eventually brought TRUMPF on board – and a four-year development partnership got under way.

Saint-Gobain was clear about what it needed its partners to provide: the solution had to be robust, suitable for industrial use, cost-effective and compatible with typical glass sizes.

Live data collection

The Manz employees involved in the project start by working on the development of a new conveyor path and added it to an existing unit in Cologne. “We had never designed such a jumbo-sized and highly accurate glass conveyor.

The biggest challenge was achieving consistently high synchronization, which is crucial to the laser process,” explains Axel Zemler, senior mechanical-design engineer at Manz. During a six-month live test run, the specialists in Reutlingen together with Saint-Gobain teams collected and evaluated data for the construction of the new system. This data was also crucial for the developers at TRUMPF.

Michael Lang, from microtechnology industry management at TRUMPF, says: “It was our job to deliver the lasers and optics, because it was clear that several would be needed. It’s simply a technical impossibility to create such a long line with one single optic. No machine in the world could make lenses and reflectors with these dimensions.” Using the data collected in Manz as well as Saint-Gobain’s process and product expertise, the laser experts set to work.

Tamed beam

Although the core team of five employees could rely on the combined laser expertise of their colleagues from Schramberg and Ditzingen, there were two problems that pushed them to their limits. As Lang describes it, “We needed to guarantee a laser beam that was extremely homogeneous; that is, within a range of plus/minus five percent. If heat is applied unevenly, the coating is very unforgiving and immediately goes streaky.”

But not just that: homogeneity also had to be guaranteed in the areas where the laser beams from two adjacent optics meet each other.

Drop the beam to catch the waves

To ensure an unusually high level of individual beam uniformity, the team developed a new kind of optic in which the laser beam is especially formed until it has achieved the necessary uniformity. Lang explains, “An optic like this didn’t exist before. It’s built around core TRUMPF know-how.”

The optic features an impressively low line width and a high depth of field, and it can be used with the most powerful lasers available on the market. For homogeneous transitions between the individual beams, the TRUMPF experts resorted to a procedure that has been mastered by just a few in the industry: wave optics simulation.

He continues: “We took our expertise to the next level in this project. That was the only way we were able to understand the interference effects at the ends of the line segment – by means of precise mathematical calculation – and to check that the homogeneous beam path could be reproduced across the full width of the glass.”

Safely shielded

The laser process was tested on a model system at Saint-Gobain’s development center in Thourotte in northern France, and only then – to some extent in parallel – transferred to the industrial pilot machine.

The extremely highpower levels of the laser line meant the mechanical engineers at Manz had to equip the inline system with certain extras. Along with the high-precision conveyor section, they supplied the bridge with the boxes housing the optics.

» **“Thanks to the new process, we are in a position to create brand-new products.”

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Lorenzo Canova, project manager for rapid thermal processing at Saint-Gobain

The process called for maximum manufacturing precision. “The laser light shield we had to install around the laser line was a first for us,” Zemler explains. Beam traps, as they are known, are located both underneath and above the conveyor section.

He adds, “Depending on the coating type, the laser beam either goes through the glass and must be captured and cooled down below it, or is reflected back from the surface. In that case, you need the protection on top.”

New scopes

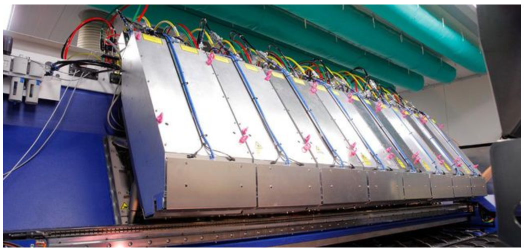
Moreover, all parts of the laser line need to be cooled, and all
cables and water lines must be shielded from scattered radiation.
“Besides the pure development work, it was challenging to install and ramp up the new machine without affecting production, where some glasses are coated using laser hardening and others are not,” Canova recalls.

But their efforts and the five years in total, during which more than ten specialists from the glass manufacturer’s various development departments were involved in the project, have paid off.

At the Glasstech 2016 trade fair in Dusseldorf, Saint-Gobain introduced SGG ECLAZ: a new generation of thermally insulating glass for double and triple glazing, which offers not only high light-transmittance values but also 20 percent higher energy efficiency compared to similar glass. A satisfied Lorenzo Canova adds: “Thanks to the new process, we are in a position to create brand-new products.”

Zwölf Hochleistungslaser erzeugen 144 Kilowatt Leistung. Bild: Ralf Kreuels

Lorenzo Canova, Projektleiter Rapid Thermal Processing bei Saint Gobain, koordinierte die Zusammenarbeit der Spezialisten des Glasherstellers mit Experten von TRUMPF und Manz über fünf Jahre. Bild: Ralf Kreuels



Die Boxen mit den Optiken sind in einer Brücke untergebracht, die die Förderstrecke überspannt. Bild: Ralf Kreuels

Strahlfallen befinden sich oberhalb und unterhalb der Laserlinie. Bild: Ralf Kreuels

Laserlichtleitungen verbinden die Optiken mit den Lasern. Bild: Ralf Kreuels

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