Sparklike

BREAKTHROUGH TECHNOLOGY FOR NON-INVASIVE MEASUREMENT OF GAS FILL FOR INSULATING GLASS

Sparklike is the developer of the world's first non-invasive gas analyzer for insulating glass. The company's Gasglass product line has become the de facto world standard for gas fill measurement of IGUs. The products are sold worldwide and are in daily use by leading global insulated glass manufacturers, testing laboratories and window processors. To meet tightening industry standards and keep pace with the fast developments of state-of-the-art glass manufacturing, Sparklike has developed a new laser based technology for high-performance gas fill measuring. Alongside the new technology, this article discusses the advantages of gas fill for thermal performance and the latest developments in gas fill measurement.

Miikkael Niemi
Sparklike Ltd.

HIGH PERFORMANCE GLAZING

Certified energy-efficiency

Today's architectural design favours the use of glass both as a day-lighting and as a structural element in modern construction. Different types of windows increase the attractiveness of commercial and residential buildings, improve day-lighting and add to the comfort of life and work in offices and homes. At the same time, glass windows are one of the most sensitive building components when it comes to assuring energy-efficiency in construction. Energy flow in and out of buildings, depending on their location and prevailing weather conditions, has been a traditional focus of attention for building owners and their suppliers particularly in view of increasing energy costs.

The window industry has responded to energy-efficiency requirements by developing different types of insulated glass structures. Multiple-layer glazing, double- or triple-pane solutions and insulated glass units (IGUs) utilize advanced insulation materials ranging from glass types, frames, sealants and cavity fills to maximize the thermal performance and minimize the U-factor - energy penetration through the glass. Double- and triple-glazing, gas fill and specific coatings have contributed immensely to the energy-efficiency of windows and have become the best solution and state-of-the-art choice for high performance IGUs.

VIEWS ON GAS FILL

Glass manufacturers are looking to maximize gas fill resistance to heat conductivity, the so-called R-factor, and thus minimize the outflow of energy through the window. To date, this is best done by noble gas between the glass layers of an IGU. A vacuum solution between the glass panes is seldom recommended in areas of great temperature differences (variations of 35° or more). Air fill is an option, but the use of noble gases provides superior resistance to heat conductivity in comparison with air. While air has a thermal conductivity of 0.024, argon with 0.016 is only 67 per cent of that, and krypton, at 0.0088, is just half the conductivity of argon.

The favoured gas is, however, argon because it is clearly the most effective noble gas to use. Argon is an economic choice since krypton is significantly more expensive and xenon even more so. Compared to air fill, it has been estimated that the raw material cost of well-sealed, argon-filled IGUs goes up by only 1 per cent. However, regardless of the choice of fill, the gas content of an IGU is generally considered to be adequate when exceeding 90 per cent. Different markets have different standards for gas content but the European standard is EN 1279 and the US standard ASTM. Most of the time the gas content needs to exceed 90 per cent, with a margin, but some regions have approved lower standards that match the quality performance of their local IGU manufacturing closer. The challenge for an IGU supplier is to be able to verify this figure by reliable measurement as solid evidence of consistent product quality.

Measuring Handheld

INSULATING GLASS PERFORMANCE

Reason for quality control

The performance of coated, multi-layer and gas-filled insulated glass elements (IGU) increases strongly with the simultaneous application of all these elements. The coating provides protection against excess heat inflow from the outside from solar radiation while the IGUs provide protection against energy-loss from heat convection from the inside through the windows. The efficiency improvement in the U-factor is some 16 per cent with the use of argon gas and as much as 27 per cent in the case of krypton as documented i.e. by the PPG Glass Eduction Center. It is thus easy to see why the IGUs, and more specifically gas fill, have a strong position in promoting the energy-economy of buildings. It should also be underlined in this context that reports by the EU commission show that nearly one third of all energy consumption of a modern urban society is associated with buildings, which puts the significance of energy-savings into perspective.

For IGU producers, the keys to high quality and energy-efficient solutions lie in proper processing of advanced glass products, such as tempered, laminated and coated glass, and skillful sealing of the gas-filled IGUs through high manufacturing quality. Even if everything is done

Gasglass Handheld

adhering to the best practices, the escape of gas fill from an IGU of some 1 per cent per year is considered normal and acceptable due to the pressure difference between outside conditions and the gas-filled cavity of the IGU.

The requirement for manufacturing quality naturally includes assuring that the gas-fill is successful and adequate. If the processing quality is not on a high-enough level, the gas escape could be much more than 1 per cent per year and in the end that may lead to quality problems in the glass and, in the worst scenario, cause the collapsing of the entire glass structure.

ADEQUATE MEASUREMENT

The difficulty for IGU manufacturers has been ensuring that the performance quality of the product is adequate and the inert gas-fill up to standards. Traditionally, insulation gas fill was tested by taking random samples off the production line and drilling holes in the glass to measure gas fill and thus the insulation performance of the IG-unit. This was a functioning but costly method that involved breaking the glass and destroying the expensive product either on the processing line as part of manufacturing quality control or doing the same to an IGU already installed on site.

There was no method for measuring the gas fill without tampering with the product and certainly no method available to do this on the production line as part of manufacturing on-line quality control.

SPARKLIKE – THE ENABLE OF FAST QUALITY SAMPLING

Applied research

For a long time, IGU manufacturers have had to be content with the fact that measuring the extent of gas-fill in the IGU was 'difficult' and costly. Therefore producers and quality control specialists were eagerly looking for a solution to the challenge of increasing the quantity of tested samples and to increase the reliability of the results without breaking the IGUs. A unique method was developed through cooperation between university researchers, industrialists and entrepreneurs to address the issue. These efforts resulted in the commercialization of a method for non-invasive measurement of gas fill in insulated glass. The owner of this technology, with several patents and some new patents now pending for the new technology, is the Finnish company Sparklike Ltd., established in 2000. Sparklike is the only supplier on the global market today that can deliver the technology and instruments to perform this task.

Innovative entrepreneurs

The partnering entrepreneurs behind Sparklike, Niklas Törnkvist and Mats Therman, started to pursue their development idea in the year 2000. Earlier contacts with the Chemistry Department of the University of Helsinki had inspired the idea of looking into the possibilities of applying spectrometry and plasma emission spectroscopes as measuring and analyzing tools to the measurement of gas fill in insulated glass windows. The first product, a semi-portable analyzer, was developed by means of cooperation between university researchers and the entrepreneurs as early as 2001. It solved the 'difficult' testing problem.

Sparklike Ltd. was set up to commercialize the idea - take the product to market, introduce it to processors of insulated glass and manufacture it. The same technology was applied in 2006, when Gasglass Handheld was introduced to the market. The new product was portable, and the team had been able to increase the accuracy even further.

The response from IGU manufacturers, testing laboratories and window processors, the natural Sparklike target categories, was encouraging. The technology was solid, application fast and accurate. As a tool for quality control the new technology sto-

od out as both unique and the only one of its kind. It allows fast and accurate non-invasive sampling of the IGU as targeted.

SPARK EMISSION

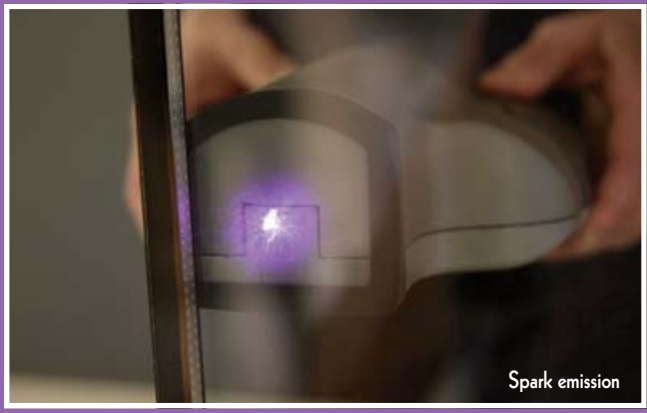
The function of the Gasglass Handheld device is based on high-voltage spark emission into the IGU. This creates a colour spectrum that provides information on the oxygen and gas content within the IGU and displays the result in the form of a colour spectrum and a numerical reading, a percentage of gas content. This reading is compared with the prevailing standard set for a given market, usually over 90 per cent gas content, and that enables manufacturers to support their claim to end-product quality.

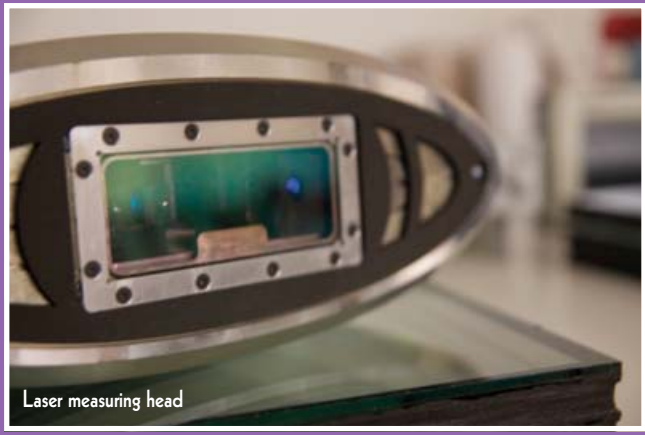
With some 1,500 devices delivered to over 40 countries, Sparklike Ltd. had made a measurable and credible breakthrough with its novel niche technology. What used to be a difficult 'measurement problem' had now been solved by applying the Gasglass Handheld instrument.

GASGLASS LASER – TAKING GAS MEASUREMENT FURTHER

Laser reflection

While the spectrum analysis technology applied in earlier Gasglass instruments solved the issue of measuring the gas content in a unique non-invasive way, it had some limitations once the industry continued to develop. New types of high-performance glass products were introduced and new coating solutions brought substantial savings in energy inflow from solar radiation.


Spark emission


Laser measuring head

The original high-voltage spark technology has hold out well on the market but the increasing use of products with multiple low-E coatings or thick spacer cavities such as many triple-glazed IGUs raised the need for new, additional measuring capabilities. The challenge was to measure through coatings and lamination, as well as triple-glazing with single measurement. Additionally, the team looked to measure a full range of argon from 0 to 100 per cent, as well as including the product as part of the manufacturing process, preferably on-line.

The glass industry and IGU manufacturers in particular had high hopes for new developments in IGU gas-fill measurement and the Sparklike product development team paid close attention to the signals from the market. With the new advanced product developments in view, Sparklike placed specified demands on the criteria for the new product that was needed to meet the measuring challenge.

Breakthrough technology

In 2011, Sparklike set out for a new technology breakthrough in initiating development work based on laser application. That resulted in the new product – Gasglass Laser. The company was able to develop a laser system to meet market demand that focuses on the measurement of oxygen absorption. The technology is based on TDLAS, for Tunable Diode Laser Absorption Spectroscopy, in the 760 nm range. The method is indirect in measuring the oxygen absorption in the IGU and deducing that the rest of the contents consist of gas – argon, krypton, xenon whichever is applicable.

The measuring technology is based on oxygen absorption. A laser beam from a laser diode is focused into the IG and the reflections from the IG surfaces are reflected back and detected. The device is operated from one side of the glass. The measuring time is 15-35 seconds depending on the IGU structure. The maximum IG thickness for this application is 50 mm with minimum pane thickness of 2 mm.

Oxygen absorbance

Oxygen, like other gases, has certain absorption lines (wavelengths). Gasglass Laser utilizes a tunable and narrow-line width (mo-

nochromatic) diode laser. Adjusting the diode laser operation current laser frequency can be turned over an absorption line of interest and measure the variations in transmitted intensity. Techniques for laser modulation are extensively used to improve the performance of the TDLAS-system. A sinusoidal component is added to the diode laser operation current resulting in a sinusoidal wavelength and amplitude modulation of the laser output. Interaction with a wavelength dependent and non-linear transmission (absorption lineshape) results in a periodic but non-sinusoidal transmission signal that consists of the modulation frequency itself as well as its harmonic overtones. The amplitude of the harmonic component is proportional to the absorbance, i.e. amount of oxygen. The reported reading is displayed as the noble gas content percentage. Additionally, this new method permits operator to measure of the thicknesses of glass and spacer cavities as a side product. This information is received with a high accuracy of +/- 50 micro-millimeters.

On-line quality control

The Gasglass Laser consists of three parts, a main unit that includes the power source electronics and does the calculations in the background, a measuring head including the more sensitive electronics and optics, and a screen for user interface. The system has the capability of saving and exporting results as well as identifying data.

In order to make an analysis, the laser needs to penetrate the coating. Therefore the coating transmission sets some boundaries for the signal to be detected. The final limit depends on the full structure, but as guideline transmissions above 40 per cent at 760nm are measurable.

Gasglass Laser permits permanent installation on the insulated glass manufacturing line or measuring station to yield a reading for gas content as part of the manufacturing process. The system is controlled by PC through Ethernet protocol and it is capable of receiving and returning data within production system.

CONCLUSION

Gas fill measurement for the future

The Gasglass Laser technology was launched on the market in Spring 2015. Sparklike intends to follow up its current products Gasglass Handheld and Gasglass Laser with new product developments in line with market needs and the development of glass, coatings and IGU technology. The Sparklike quality commitment 'Sense of certainty' stands on solid footing as instruments are manufactured with great care, and before delivery each device is quality-controlled and calibrated in Finland by Sparklike Ltd. specialists.

In a very short period, Sparklike and its originators have been able to establish themselves as the world industry leaders in their speciality and make their non-invasive gas measurement technology the 'de facto' industry standard. They have penetrated the global market with niche technology in a typical application where market demand and technology development join hands. Sparklike service and maintenance centres in Finland and the US support all customers globally and they stand by to assist the daily users of Sparklike products, IG manufacturers, testing laboratories and window manufacturers, for both calibration and trouble-shooting purposes.

Sparklike Ltd.
Sparklike
Kaivokatu 8 B, 00100 Helsinki, Finland
Tel (business hours): +358 10 387 7701
Mob: +358 40 732 3272
Fax: +358 10 387 7707
E-mail: mikkael.niemi@sparklike.com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