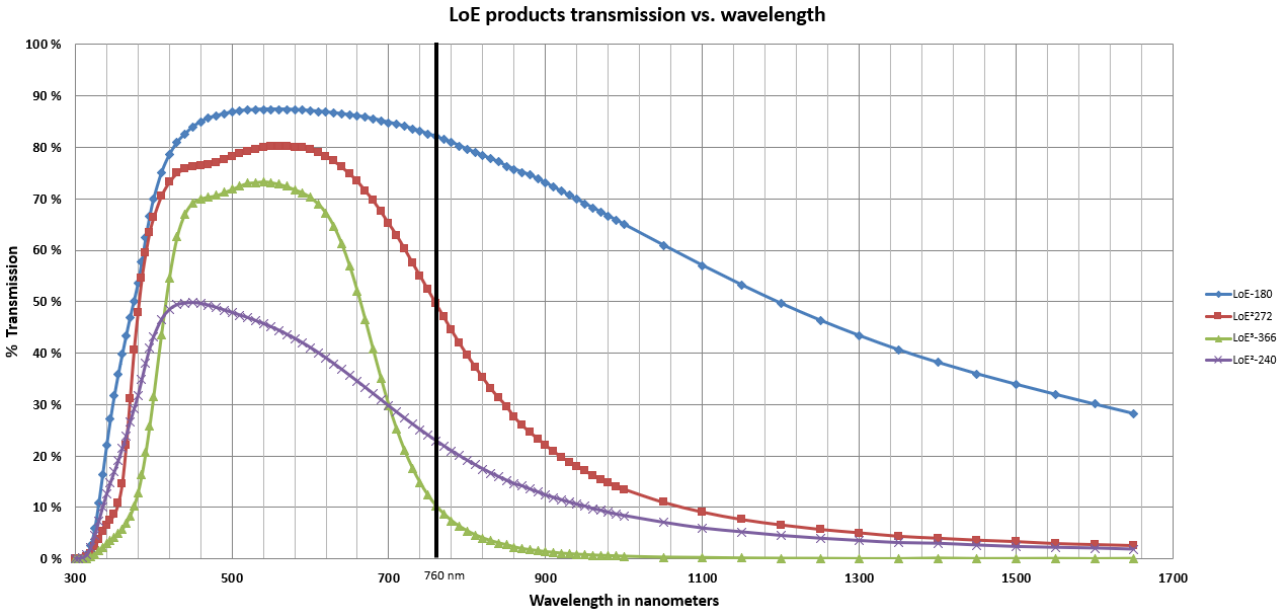
Guide for Sparklike Laser Users – How to measure?

1. Introduction

The Sparklike Laser (SL) allows measurement of most commercial Insulating Glass Units (IGUs) from at least one side. This guide helps users avoid common pitfalls.

SL is laser absorption spectrometry. Laser absorption spectrometry is a technique used to analyze the composition of gases, liquids, or solids by measuring how much light a sample absorbs at specific wavelengths. SL sends a laser light through a sample and reflects it back to the laser detector what measure the intensity of the light and calculates how much light was absorbed by comparing the initial and final light intensities.

SL operates at a wavelength of 760nm (Near-Infrared light) what is an oxygen specific wavelength. It is different what are used in insulating glass unit (IGU) specs. IGUs range is 380-750nm and it is visible to the human eye. Discussing the properties and transmission characteristics of insulating glass in terms of the human eye visible spectrum is crucial because it directly impacts vision, comfort, and energy efficiency in buildings. While near-infrared light is used in specialized applications that leverage its deeper penetration and different interaction properties. Below is shown some Cardinals LoE products transmissions in different wavelengths. The only wavelength what matters when measuring with Sparklike Laser devices is 760 nm (the black line).



Sparklike Laser device actually measures residual oxygen content and measurement result is converted to insulating gas content (usually argon). Therefore, it is easier to say that Sparklike laser is a non-invasive oxygen meter.

2. Quality perspective

Using a SL enhances the reliability and accuracy of measurements while preserving the integrity of the sample. This allows for multiple, non-invasive measurements, ensuring that the data is precise and

dependable. The principle of “measure twice, cut once” is particularly applicable here, as it emphasizes the value of verification and careful measurement to avoid errors and ensure the best possible outcomes.

When measuring with spectrometry, various sources of error can affect the accuracy and precision of the results. Here are some of the main error sources:

- **Dirty Surfaces:** Dirty or scratched measuring head window can scatter light or cause additional absorption, distorting the measurement.
- **Improper Attachment:** Not securing the measuring head properly against the glass can lead to light leakage or improper alignment, resulting in inaccurate readings.
- **Human Error:** Mistakes in operating the device, such as improper flushing of the measuring head, improper glass placement (such as back glass against other unit, or errors in preset values, can lead to significant inaccuracies.
- **Insufficient laser light to detector:** It is not recommended to measure through low transmission glasses (below 35 %).

To minimize these above-mentioned errors, consider the following best practices:

1. **Regular Calibration:** Ensure that the laser device is annually calibrated.
2. **Minimize Measuring Through Coatings:** Coatings act as mirrors to the laser beam, causing high signal loss if the signal passes through coated glass to reach the detector.
3. **Proper Sample Handling:** Prepare and handle samples consistently and avoid contamination. If measured glasses are laminated or toughened use presets.
4. **Clean Equipment:** Ensure that measuring head window is free of dirt and scratches.
5. **Secure Setup:** Attach the measuring head securely to the sample to avoid light or air leakage and misalignment.
6. **Training:** Ensure that all operators are well-trained in the use of the laser device and understand the importance of each step in the measurement process.
7. **Quality Control:** Implement a robust quality control system to detect and correct errors in data processing and interpretation.
8. **Environmental Control:** Conduct measurements in a controlled environment where temperature and humidity are according to the given operational area of Sparklike Laser.

"Measure twice, cut once" is a classic adage emphasizing the need for accuracy in quality assurance measurements. Ensure results are correct before taking any costly actions.

3. What should users know before measurements?

When measuring insulating glass, it is crucial to select the preferred side to obtain the most accurate and repeatability results. The following points highlight the key considerations for choosing the correct side:

Avoid measuring through coatings: Always try to measure from the side of the glass that does not have coatings. Coatings can interfere with the laser's accuracy and affect the measurement results.

Identify coating types: Before measurement, identify the presence of coatings and type on the glass. Use the manufacturer's specifications, coating detectors or visual inspection techniques to determine the coated side.

4. Measurement procedure

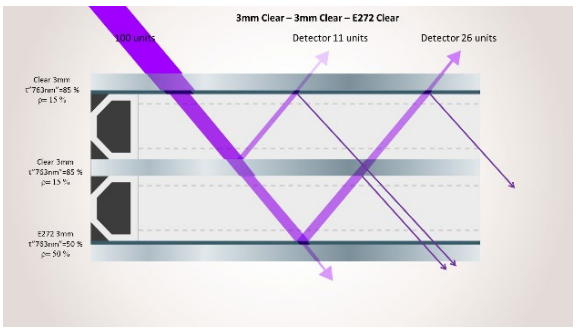
For triple glass units, the SL measures the overall value of both cavities first, then the 1st cavity. Based on these results, it calculates the gas content of the 2nd cavity. The 2nd cavity results are more indicative because deviation of the second cavity measurements is 4 times higher than average results. To minimize the error the user, listed things should be considered:

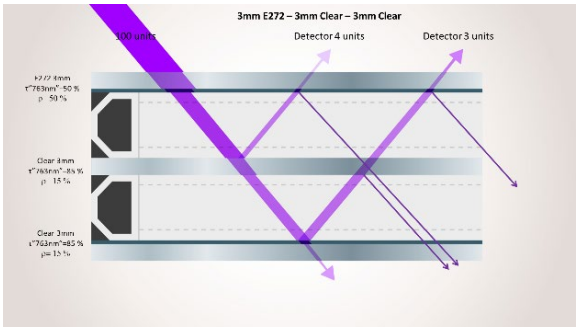
1. Type of IGU being measured (Double/Triple unit)
2. Identify any coatings and, importantly, any solar coatings. Solar coatings often make it impossible to measure through but help when measuring against them.
3. Know at least roughly the thickness of the glasses and spacers.
4. Laminations and/or toughened glass?
    - Laminations and toughened glass could also affect measurements, but it is more related to thickness measurements. When measuring especially through laminated glasses, it is recommendable to use preset values (If user don't know what presets are check the manual). Then possible fault reflection and scattering from lamination doesn`t affect thickness measurements.

Best practices

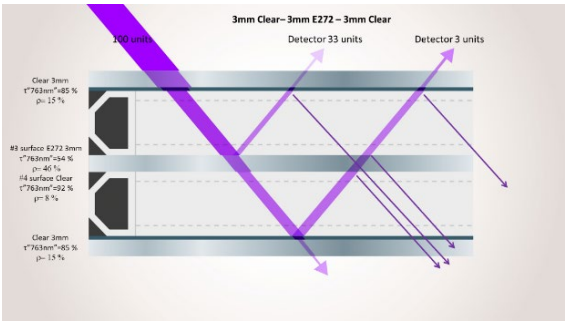
Minimize Measuring Through Coatings: Coatings act as mirrors to the laser beam, causing high signal loss if the signal passes through coated glass to reach the detector.

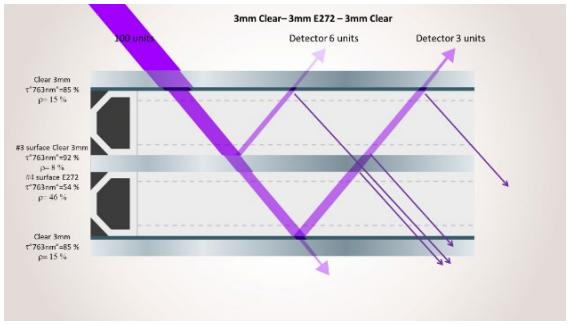
Preferred Measuring Sides: The left picture shows the preferred side for measurement, while the right side shows the non-recommended side. The number of units detected from the initial 100 units will help determine the preferred side.



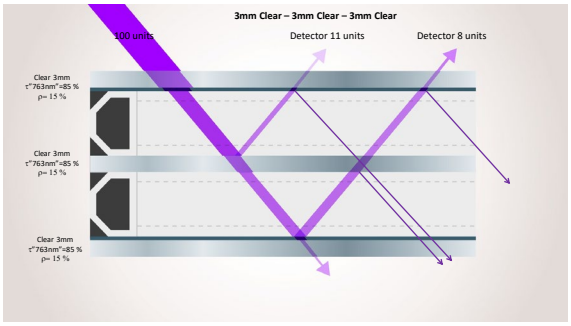


Coatings on Middle Glass: Know the surface where the coating is located. If it's on the #3 surface (left picture), measuring the 1st cavity gas concentration is easier from this side compared to the #4 surface (right picture). When measuring the average of the triple units, measurement side doesn't matter.





It is important to recognize that if all glass panes are clear, this is also not ideal. In such cases, there is minimal reflection, resulting in the loss of most of the initial signal (see picture below). However, it is important to note that despite the challenging setup, the glass measurements can still be conducted reliably, particularly when considering the average values.



5. Results

Repeated measurements are fundamental in achieving high-quality, reliable, and accurate results in any technical measurement instrument. They help identify and reduce errors, enhance precision, ensure reproducibility, and provide confidence in the data, ultimately supporting robust and valid conclusions.

When measuring 100 % of production on-line following trend of the results is often enough. When taking measurement sampling it is highly recommended to take at least 2 measurements from each measured IGU.

In industrial and manufacturing processes, repeated measurements are essential for quality control. Multiple measurements help monitor and ensure that processes remain within specified tolerances and standards.

At the end of the day, the extra measurements ensure that the gas press works as it should be and the company fulfils the customer's promises.

6. Validation process

Accurate recording of measurement results in a spreadsheet is a critical final step in the measurement process using the Sparklike Laser. This section of the guide details how to effectively document the data to ensure its reliability and usability in a production setting. Each IGU should be validated as itself or at least at the factory level most produced IGUs. "Best practices" guide users to do it as easily and timesaving as possible.

Validation process overview:

1. **Data Collection**: Each IGU should be measured from both sides, taking 30 readings per side. This approach helps in identifying which side yields more consistent and reliable results.
2. **Data Analysis**: After collecting the readings, calculate the average gas content value from the measurements and standard deviation. This helps determine whether the IGU is within the specified tolerance levels.
3. **Decision Making**: Based on the calculated results, decide the most appropriate side for ongoing production measurements. This decision is crucial as it impacts the ease and reliability of future measurements.

Importance of proper documentation:

1. **Consistency and Accuracy**: Keeping a detailed record in a spreadsheet ensures that all measurements are documented systematically, which aids in tracking and analyzing trends over time.
2. **Quality Control**: Spreadsheet records help in maintaining quality control by providing a historical data trail that can be reviewed to ensure the production process remains within specified tolerances.
3. **Decision Support**: Documented data supports decision-making processes by providing clear evidence of trends and averages, which are essential for making informed choices about production adjustments.

In summary, thorough documentation in a validated spreadsheet is not just about record-keeping; it is a fundamental part of the quality assurance process in the production of high-quality insulating glass units. This systematic approach ensures that each unit meets both regulatory standards and customer expectations, thereby safeguarding the manufacturer's reputation and reducing the risk of costly recalls or reworks.