EWFA Technical Paper

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Visible Light Transmittance for Automotive Window Films Application

This Technical Paper has been produced by the European Window Film Association (EWFA). As the European Chapter of the International Window Film Association (IWFA), the EWFA represents the interests of the window film industry in Europe by supporting our members' interests and increasing awareness of window film products in the region.

EWFA members are manufacturers and distributors of window film supplying high performance products for both architectural and automotive applications. Typical automotive applications include passenger cars, light commercial vehicles, commercial and industrial transport as well as service vehicles.

The objectives of this Technical Paper are:

- To raise awareness amongst regulators and law enforcement officers of the advantages of window films and the need for fair, practical, and sustainable legislation in terms of allowed Visible Light Transmission (VLT) for the automotive industry.
- To educate and inform regional window film distributors and installers, with the objective to help maintain professional standards and to promote best practises within the industry.
- To recommend techniques on visible light measurement to stakeholders such as automotive inspection centres and consumers.

Benefits of Window Films

Important properties imparted by window films applied on vehicle glazing include preventing up to 99 % of harmful UV radiation from entering the vehicle (some of them recommended by the Skin Cancer Foundation), heat absorption and/or reflection, glare reduction, scratch prevention, or improving protection by helping holding glass together in the event of accidental or intentional breakage. Window films also come in a wide range of colour and shadings choices, while providing increasing privacy for vehicle passengers and protecting belongings.

1. What is the Solar Spectrum?

The solar spectrum includes notably ultraviolet (UV), visible light (VL) and infrared (IR) radiations (see figure below). Sunlight in space at the top of Earth's atmosphere is composed (by total energy) of about 52 % infrared light, 43 % visible light, and 5 % ultraviolet light.

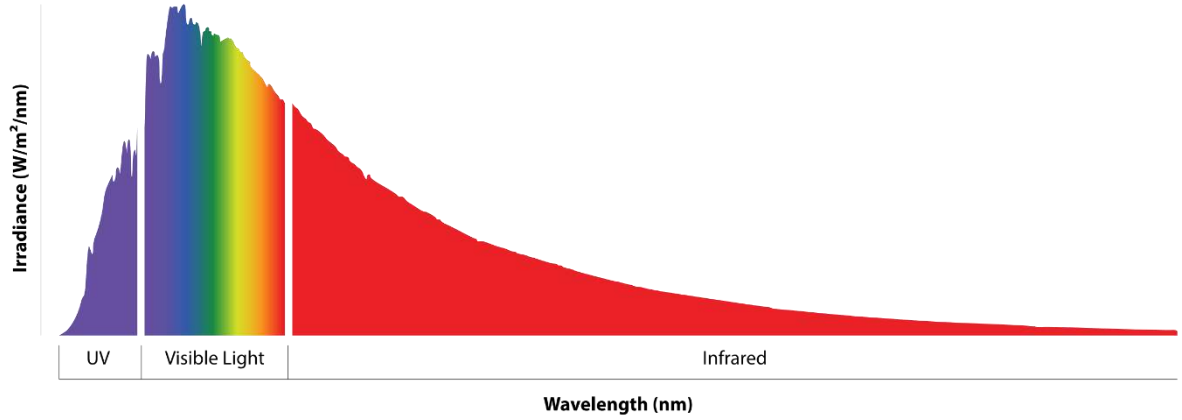


Figure 1: The Solar Spectrum.

Ultraviolet radiations are measured over a 280-380 nanometres (nm) wavelength range, visible light over a 380-780 nm wavelength range, and infrared over a 780-2,500 nm wavelength range.

2. What is Visible Light Transmission?

Visible Light Transmission (VLT) is the percentage of visible light measured when passing through a glazing system. A high VLT percentage means that more visible light is passing through, while a lower VLT percentage reduces the visible light entering a vehicle (see figure below).

Figure 2: Examples of different VLT.

3. How do Window Film Manufacturers Measure VLT in Laboratory Conditions?

A UV-Vis-NIR spectrophotometer, mentioned as desktop measurement system in this Technical Paper, is used to collect spectral data that is used to determine the solar performance characteristics of a window film, resulting on manufacturer published data and product certification according to EN 410 and EN 673 standards for European data or NFRC 300-2010 and ASTM E903 for the United States.

Note that desktop measurement systems are used on laboratory-controlled conditions, therefore there are no expected variances on data collection due to outside conditions or external factors, guaranteeing accuracy on data according to the internationally accepted standards. In addition, laboratory measurements analyse the entire spectrum from 280 to 2,500 nm as shown in the figure above. Commonly available, portable tools will only usually measure one or two wave lengths of the electromagnetic spectrum leading to differences seen sometimes between portable measurements and published technical data sheets.

4. Which Portable Tools to Measure VLT Outside of Laboratory Conditions?

In Europe, automotive legislation is usually defined at the national level. Such legislation sets the regulatory levels for visibility and safety and must be respected in order to enjoy the safety, health and privacy benefits of automotive window films.

In this context, national automotive legislations usually regulate the allowed VLT and how to measure it. These laws are usually based on UN/ECE Regulation No. 43, which is the standard for original automotive glass applied by automotive manufacturers. Regulation No. 43 allows a vehicle's original glazing to have visible light transmittance at a minimum of 75 % for windscreens and 70 % for front side windows (before the B-pillar). In countries where aftermarket detailing and customization of windows is permitted, regulatory or law enforcement agencies can ensure public compliance through measuring visible light transmittance outside of the manufacturer's laboratory conditions, that is, in field.

In field, VLT is therefore usually measured with portable tools named VLT meters, during either vehicle inspections on the road by law enforcement officers or in dedicated inspection centres, as opposed to desktop measurement systems used in the laboratory conditions to obtain window film data according to standards such as EN 410 or NFRC presented in manufacturers product datasheets. It is to be noted that this may result in slightly varying measurements, due to the quality of the portable device, its calibration, measurement conditions, wavelengths analysed, or other external factors.

The desktop measurement systems used to obtain the original product data are not designed for use outside of laboratory conditions.

VLT meters exist in two different shapes: "horseshoe" and "two pieces". The horseshoe device allows measurements up to a limited glazing thickness, while the two-pieces magnetic device allows any type of glazing thickness measurement, including windscreen, rear windows and any other fixed glazing systems (see Table 1 on next page).

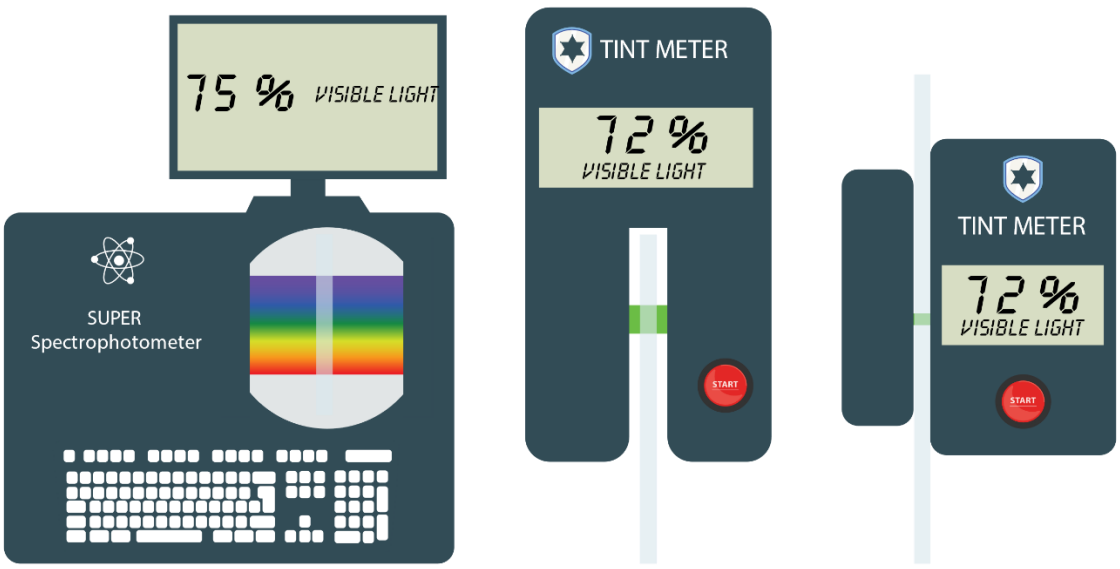
<table>
<tr><td colspan="3"> 
</td></tr>
<tr><td>Representation of a desktop spectrophotometer used by window film manufacturers to collect data.</td><td colspan="2">Representation of portable VLT meters used by authorities outside of laboratory conditions.</td></tr>
<tr><td>Price Range: 500 – 3,000 €</td><td>Price Range: 50 – 200 €</td><td>Price Range: 100 – 200 €</td></tr>
<tr><td>Range: Full spectral range according to EN 410 standard.</td><td colspan="2">Typical Range: Wavelength 550 nm (green light range).</td></tr>
</table>

Table 1: Existing VLT Measurement Devices.

5. Steps for Measurement Outside of Laboratory Conditions

When used outside laboratory conditions, VLT or transmission meters will measure visible light passing through glazing, whether the glazing is only glass or glass and window film combined.

The procedure to properly measure visible light transmission with a meter is composed of different steps:

1. Automatic Meter Checks

When turned on, the meter will automatically perform steps such as battery check, sensor check, factory calibration check and auto-calibration. These are very important, as they ensure the accuracy of the subsequent testing phase.

The calibration check is an especially important step, requiring the meter operator to make sure the meter is correctly performing. Should calibration samples be available for the used meter, calibration must be done before each measurement. A calibration log should also be filled in, in order to detect any measurement differences from the device over time.

As some cases have been reported in which meters with low batteries did not provide such accurate measurements as full-batteries meters, it is of utmost importance to ensure a sufficient level of batteries for the testing phase. The calibration check can help detecting measurement differences due to low batteries in the device.

2. Testing

To measure VLT, the simplest form of meter shines a single beam of light at 550 nanometres (a universal wavelength for optics measurements, which is situated in the middle of the visible light spectrum and corresponds to the green colour) through the glazing (or the combination of glazing and window film), in order to reach the meter's optical sensor on the other side of the glazing and check the amount of light passing through.

Problems Detected During VLT Measurements

Different Readings: As mentioned in this Technical Paper, portable tools readings may vary from certified laboratory measurements systems. As an example, the VLT measurement from a compliant automotive glass with no film applied may already fall under what is reviewed by legislation that can result on an unusual automotive inspection failure.

Dirtiness: The meter sensors and the vehicle windows must be cleaned before measurements, as this parameter may interfere with proper VLT measurement.

Extremely Curved Glass: If the glass is extremely curved, it may be difficult to get an accurate reading as light may enter the area from the sides where the "horseshoe" opening of the meter does not fit to the glass or window. This generally will give a higher reading than is accurate.

3. Testing Recommendations

As explained above, VLT measurement can be influenced by a number of factors, depending on the meter, environment or vehicle or glass state. While the device accuracy proposed by meter manufacturers is of up to +/- 2 percentage points, the vehicle or environment state is not taken into account. EWFA therefore recommends using a reading tolerance of +/-7 percentage points, which would allow all measurement parameters to be taken into account.