EWFA Technical Paper

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Infrared Energy Rejection for Window Films Application

This Technical Paper was written 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 across the European continent 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 architectural applications include small and large residential buildings, commercial buildings (hotels, restaurants, shopping centres, airports), offices, schools or industrial plants. 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 educate and inform the entire window film supply chain, and notably support regional window film distributors and installers, with the objective of maintaining professional standards and to promote best practises within the industry.
- To provide end-users and consumers with technical information on the solar spectrum, solar energy rejection calculations and infrared radiation.

About Window Films

Important properties imparted by window films applied on glazing include preventing more than 99% of harmful UV radiation from entering a building or vehicle (some are recommended by the Skin Cancer Foundation). Window films enable heat rejection which improves the comfort of occupants and help to reduce cooling energy consumption. Window films can also reduce glare, offer scratch protection and enhance protection from broken glass by holding it together in the event of accidental or intentional breakage. Window films are available in a wide range of colour and shading options, providing privacy and protection for vehicle passengers, building occupants and belongings.

1. What is the Solar Spectrum?

The Sun emits electromagnetic energy which ranges from X-rays to radio waves. Sunlight is a portion of the electromagnetic radiation given off by the sun and it is composed of ultraviolet (UV), visible light (VL) and infrared (IR) radiation (see Figure 1 below). Of the energy we feel from the sun, roughly 6 % is from UV, 44 % from VL, and the remaining 50 % from IR.

Ultraviolet radiation or UV light is invisible to our eyes. UV light waves have shorter wavelengths than visible light and are measured over the 300 - 380 nanometres (nm) wavelength range.

Visible light is the light the human eye can see. Light is a wave and its colour depends on its wavelength. When the wavelengths are shorter, around 380 nm, our eyes perceive them as blue-violets. And when they are longer, around 700 nm, our eyes perceive them as red. A typical human eye can see from 380 to 780 nm.

Infrared light is light that has a wavelength greater than the red light our eyes can see. Infrared light is invisible to the human eye. IR ranges from 780 to 2,500 nm.

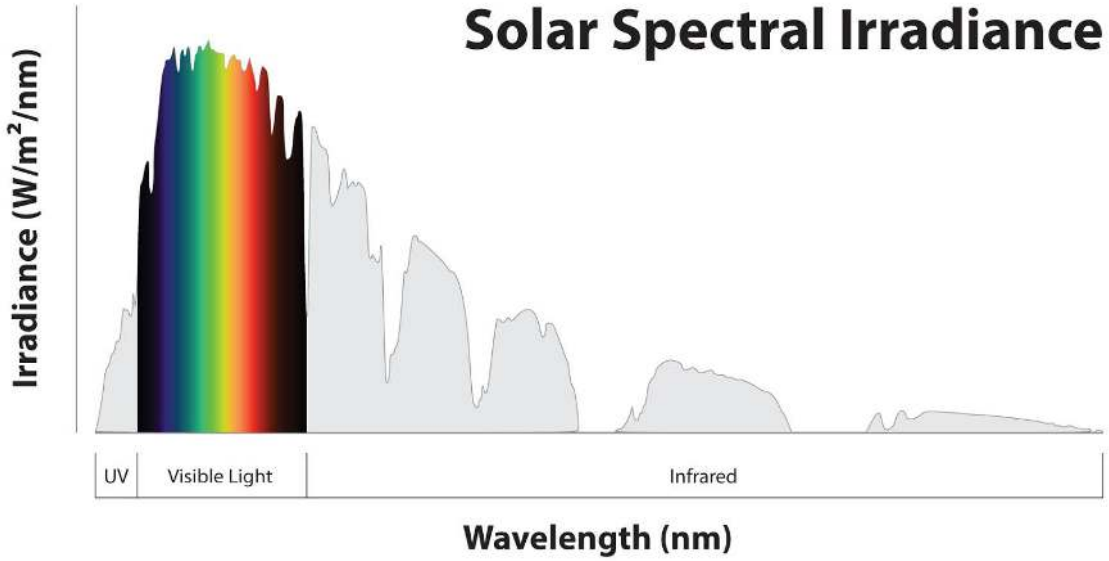

Figure 1: The Solar Spectrum.

Not all the solar energy that enters the atmosphere makes it to the surface of the earth. Depending on factors such as the time of year, location, latitude or weather, this radiation is reflected, scattered or absorbed differently by the earth's atmosphere. Although the amount of solar radiation varies locally, it is generally estimated that approximately 30 - 40 % of incoming radiation will be absorbed or reflected back to space.

2. What is Infrared?

Solar infrared radiation - also known as short-wave infrared, or NIR (near infrared) - has a wavelength ranging between 780 and 2,500 nm. It has the ability to pass through the glass and is converted into heat inside of a vehicle or a building.

Non-solar infrared radiation with longer wavelengths can be generated within vehicles or buildings. These are mid-infrared (MIR, 2,500 - 50,000 nm) and far-infrared (FIR, 50,000 - 1,000,000 nm).

3. How do I know how much heat comes through my windows or glazing?

In the European Union, solar energy coming through glazing is measured according to the European Glass Standard EN 410, while in North America it is measured according to the National Fenestration Ratings Council, NFRC. There are slight differences between the calculations, however, both allow comparison between two or more products. Each of these standards provide a method to calculate the energy that enters through a window.

- G-value/solar factor: The g-value, or solar factor, is a weighted calculation across the entire solar spectrum from 300 to 2,500 nm (which includes the UV, VL, and IR). The North American equivalent is the Solar Heat Gain Coefficient, SHGC. This value is the amount of solar radiation transmitted through a window, door, or skylight, and absorbed and subsequently released as heat inside a building or vehicle. The lower the value, the less solar energy in the vehicle or building.
- Total Solar Energy Rejection, TSER: The TSER is the total amount of solar energy rejected by the glazing. It is calculated directly from the g-value/solar factor. The higher the number, the higher the amount of total solar energy that will be rejected.

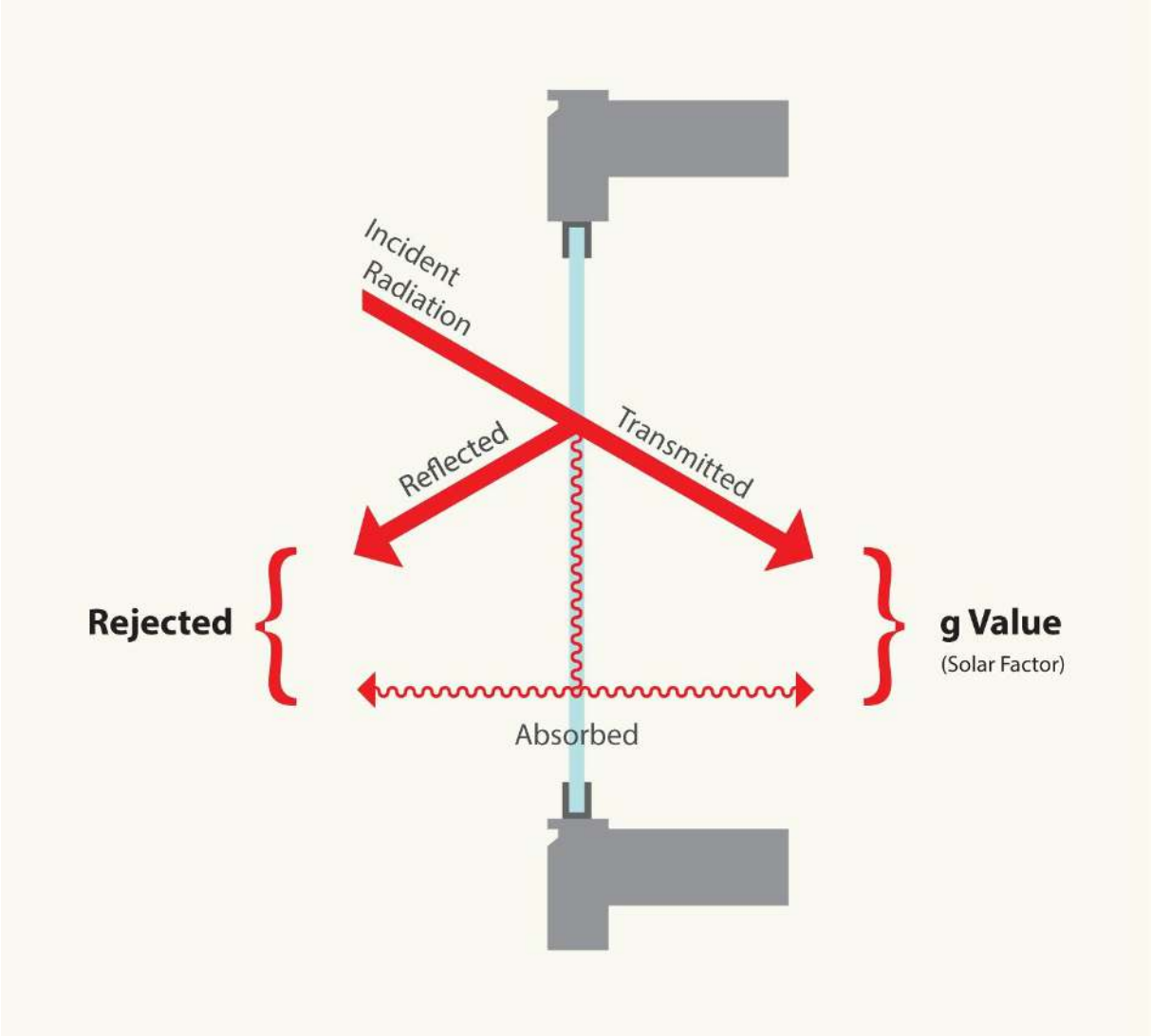

Figure 2: Incident solar energy on a single pane window.

- Infrared Energy Rejection, IRER: IRER is a measurement of infrared rejection over the IR range of 780 - 2,500 nanometres. IRER is similar to Total Solar Energy Rejection (TSER), but only involves the solar infrared range. The IWFA has defined IRER in response to non-standard publication of solar IR rejection specifications in the window film industry.
- Selective IR Rejection, SIRR: SIRR is a measurement over a selected wavelength range (e.g. 900 - 1,000 nanometres) or possibly at a specific wavelength (e.g. 910 nm). SIRR is similar to IRER, however it does not take into consideration the reradiated absorbed energy, but only the directly transmitted energy.

4. How is Infrared Rejection and Infrared Energy Rejection (IRER) Measured?

Window film manufacturers use UV-VIS-NIR spectrophotometers with an integrating sphere to measure the solar properties of their films applied on glass. These instruments are capable of measuring the electromagnetic radiation that is transmitted and reflected at each wavelength across the solar spectrum (300 to 2,500 nm) through a window film and glass. This allows for precise calculation of all solar optical properties including IRER. The measurements made in laboratory conditions are those appearing on product data sheets.

Other stakeholders, such as window film distributors or installers, have the ability to make on-site infrared measurements with smaller, portable or handheld meters. These devices generally measure infrared radiation over a limited 800 - 1,400 nm range or at a specific wavelength (e.g. 940 nm only), enabling one to calculate % SIRR. Since the measurement with these handheld devices is a narrow region or at a specific wavelength, it may not show the same value as laboratory measurements that are conducted over the full infrared range (780 - 2,500 nm). In addition, window film manufacturers measure performance with film applied to glass, while many distributors and installers measure performance of the window film alone. This can lead to significant differences between manufacturer values of IRER and measurements with handheld devices.

5. Recommendations for Measurement and Performance Data Sheets

The EWFA recommends determining the luminous and solar characteristics of window films according to the European standard EN 410, which is widely used in the window film industry. Published data should be in accordance with this norm.

Both the IWFA and EWFA recommend providing the infrared measured data for the full radiation range (780 - 2,500 nm) and display this data as such on the product's data sheets.

Smaller, portable or handheld meters are not designed to provide measurements for the entire infrared range (780 - 2,500 nm), but can be used for selective infrared measurements and reporting.

In order to converge towards common standards for the window film industry, IWFA and EWFA recommend the publishing of window film data sheets including g-value, TSER, IRER, UV and VL data, which will facilitate comparison of different products performances.