SOLAR & THERMAL 5A SPECTRAL & WEIGHTED SOLAR ENERGY ABSORBANCE

When determining the solar energy absorbance of layers within a glazing configuration, and using these values for subsequent solar/thermal or thermal stress assessments, consideration needs to be given to the accuracy based on using either spectral data or weighted data.

Some software used for the determination of thermal stress risk, or thermal and solar properties, will only work based on single performance weighted values, which may lead to discrepancies in the performance characteristics generated.

SPECTRAL DATA

Spectral data refers to measured data obtained using UV/vis-NIR spectrophotometric apparatus, which provides the transmittance and reflectance, and as such the absorbance, at specific wavelengths. Glass types can be split into clear and body tinted, with coatings split into neutral and spectrally selective.

The spectral profile of 4 mm SGG PLANICLEAR is shown below, and as can be seen from the plot, both reflectance and transmittance are relatively flat, resulting in a relatively uniform absorbance across the wavelength range.

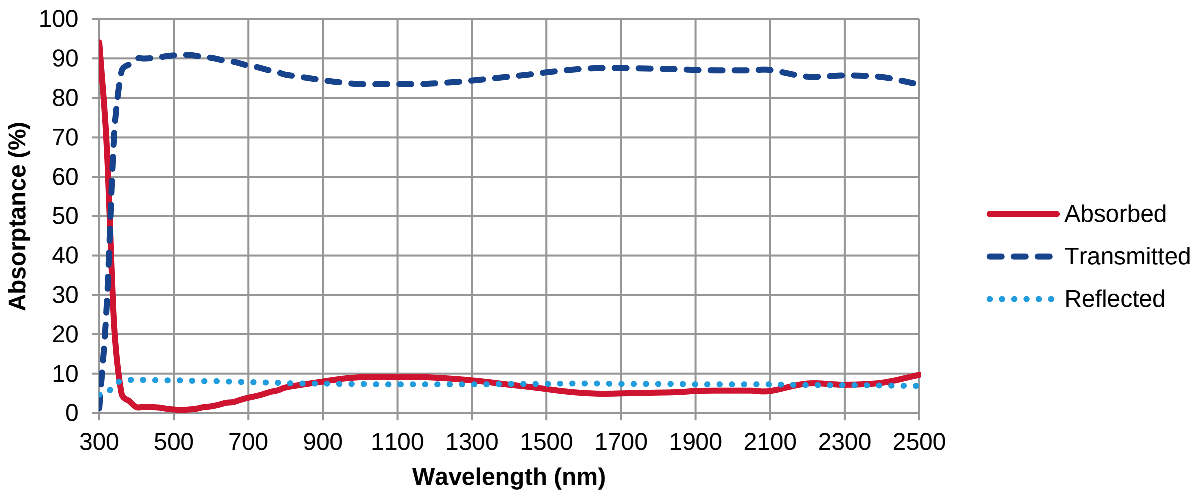

Figure 1 - Spectral Data for 4 mm SGG PLANICLEAR

Body tinted glasses show some spectral variation, the following plot for 4 mm SGG PARSOL GREEN shows reduced absorbance in areas of the visible wavelength range, and increased absorbance in the near infrared range.

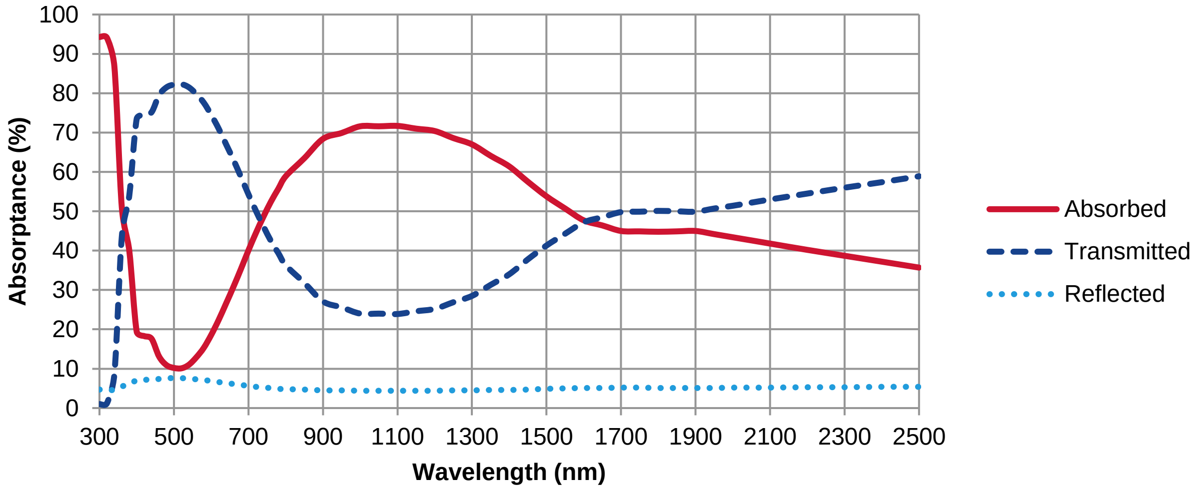

Figure 2 - Spectral Data for 4 mm SGG PARSOL GREEN

Low emissivity coatings, such as 4 mm SGG PLANITHERM TOTAL+ are designed for high light transmittance and high solar gain. The below spectral data, measured from the glass side, shows low absorbance across the visible region and relatively uniform absorbance across the near infrared region.

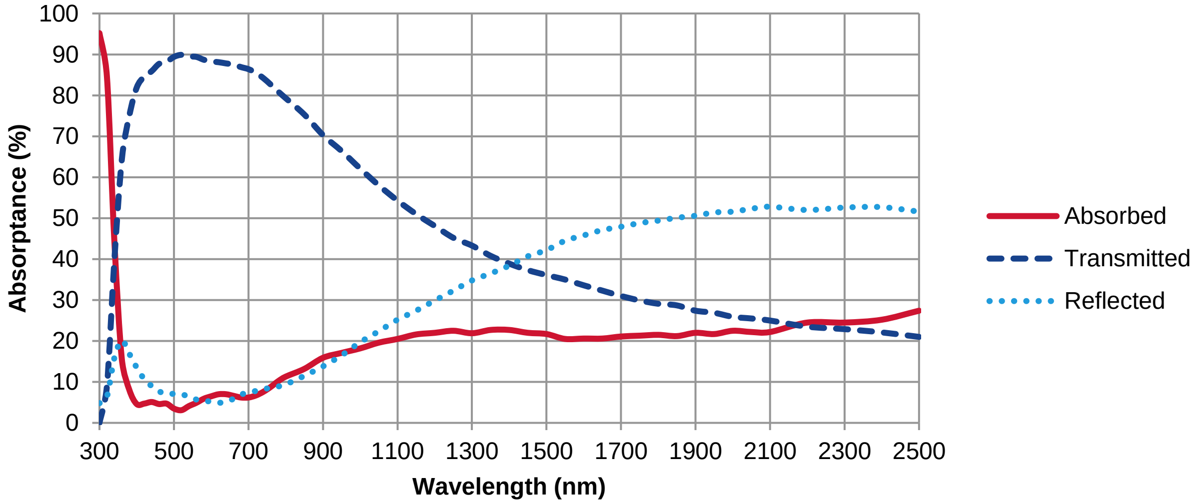

Figure 3 - Spectral Data for 4 mm SGG PLANITHERM TOTAL+

Solar control coatings, such as 6 mm SGG COOL-LITE SKN 176 II are designed for high light transmittance and low solar gain. The below spectral data, measured from the glass side, shows low absorbance across the visible range, with high absorbance in some regions of the infrared range.

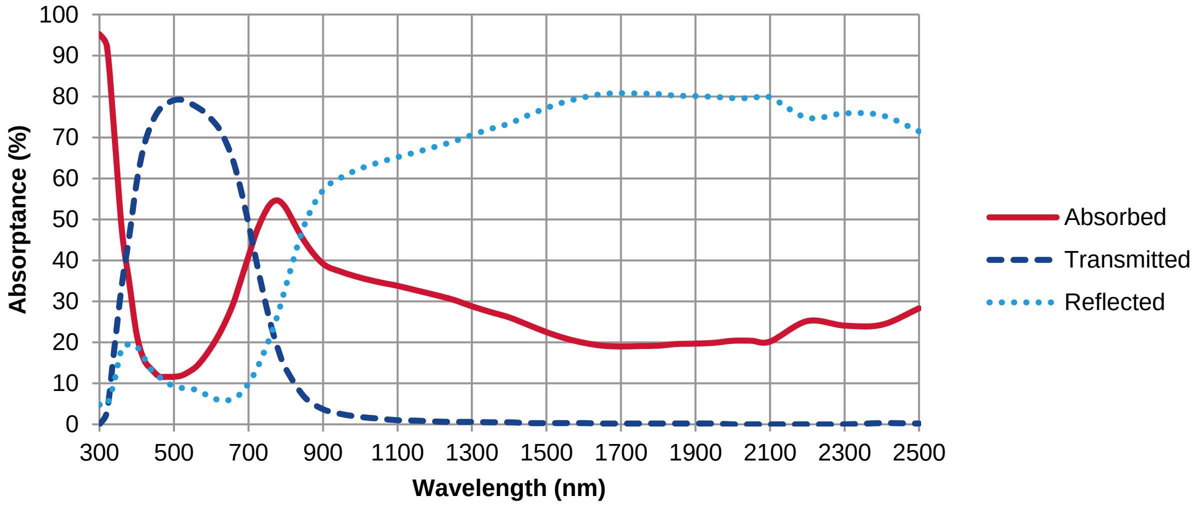

Figure 4 - Spectral Data for 6 mm SGG COOL-LITE SKN 176 II

WEIGHTED VALUES FROM SPECTRAL DATA

Weighted values, are determined from this spectra data, and calculated based on pre-defined spectra for visible light or solar energy. For comparative purposes, the absorbance for each of these 4 products can be factored against the normalised spectral distribution for global solar radiation [1], to provide the effective solar energy absorbance;

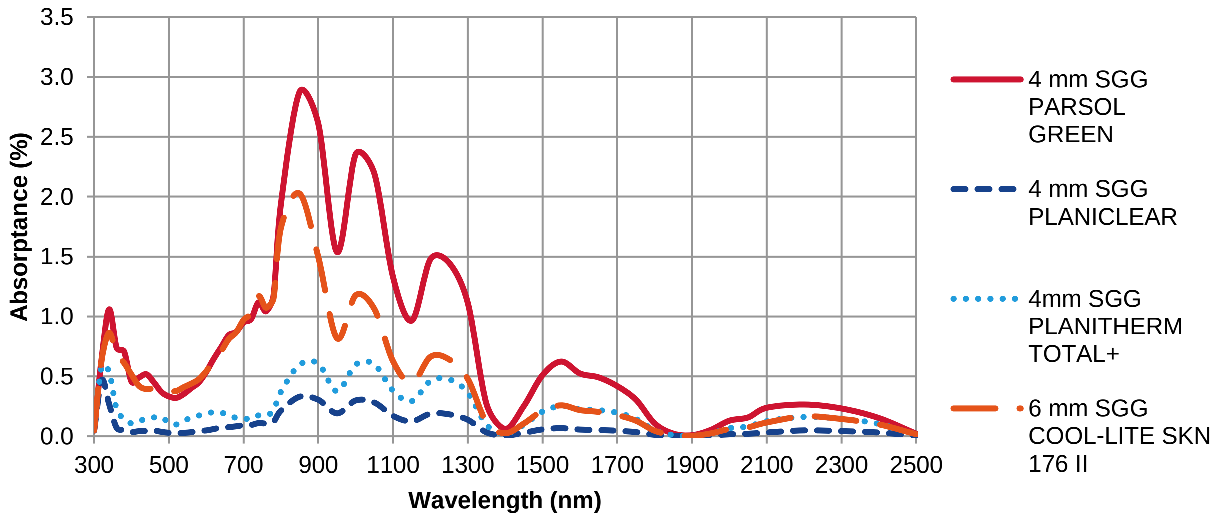

Figure 5 - Comparative Effective Solar Energy Absorbance for Selected Products

The overall weighted solar energy absorbance is shown in the following table;

Product	Total Weighted Solar Energy Absorbance (%)
4 mm SGG PLANICLEAR	5.2
4 mm SGG PARSOL GREEN	40.9
4 mm SGG PLANITHERM TOTAL+	12.1
6 mm SGG COOL-LITE SKN 176 II	29.4

PERFORMANCE WITHIN AN INSULATING GLASS UNIT

Solar energy absorbance of panes within an insulating glass unit will be dependent on the transmittance and reflectance of all panes within the configuration. For example, energy will be transmitted, reflected or absorbed by the first pane, and then transmitted, reflected or absorbed by the second pane. Some of the reflected energy from the second pane will then be transmitted, reflected or absorbed by the first pane.

These relationships are defined for insulating glass units within EN 410 [1], and calculations allow the solar energy absorbance to be determined for all panes within the configuration. The absorbance value can then be used for further calculations.

Some examples follow for varying configurations using the products already discussed, and allow a comparison between the use of spectral data, and weighted values.

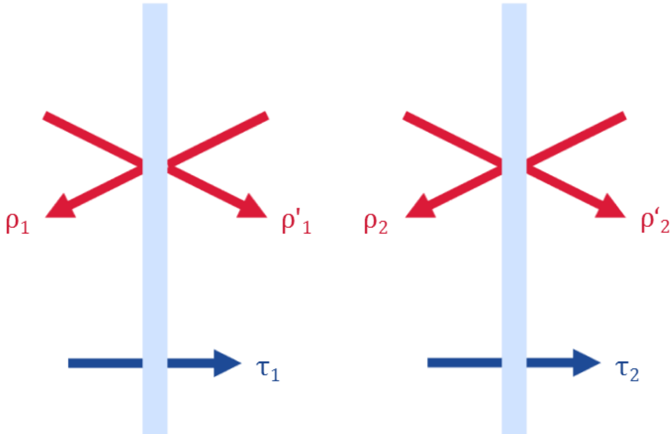

Figure 6 - Transmittance and Reflectance within an IGU

WEIGHTED & SPECTRAL COMPARISONS

The following data shows the absorbance based on weighted and spectral values for 4 configurations. As can be seen, there is a small absolute difference for the outer pane, with a larger absolute difference for the inner pane.

EFFECT ON SOLAR ENERGY ABSORBANCE

For the configurations comprising SGG PLANICLEAR & SGG PLANITHERM TOTAL+, and SGG PLANICLEAR & SGG PLANICLEAR, which would typically not be considered spectrally selective, the difference is relatively low for the inner pane.

For configurations containing the SGG PARSOL GREEN and SGG COOL-LITE SKN 176 II, which are used to control solar energy whilst maintaining visible light, and so are considered spectrally selective, the difference on the inner panes is much greater.

Table 1 - Energy Absorbance Comparison for Weighted vs. Spectral Determinations

Configuration	Solar Energy Absorbance (%)			
	Spectral		Weighted	
	Pane 1	Pane 2	Pane 1	Pane 2
4 mm SGG PLANICLEAR & 4 mm SGG PLANICLEAR	5.5	4.1	5.5	4.5
4 mm SGG PLANICLEAR & 4 mm SGG PLANITHERM TOTAL+	6.1	9.4	5.9	9.8
4 mm SGG PARSOL GREEN & 4 mm SGG PLANICLEAR	42.2	1.8	42.7	2.8
6 mm SGG COOL-LITE SKN 176 II & 4 mm SGG PLANICLEAR	30.0	0.9	29.9	2.1

If we consider this as a percentage difference as per the table below, then with the spectrally selective coatings, the difference is significantly greater when compared with the non-spectrally selective coatings.

Table 2 - Energy Absorbance Difference Between Weighted and Spectral Determinations

Configuration	Solar Energy Absorbance Percentage Difference	
	Pane 1	Pane 2
4 mm SGG PLANICLEAR & 4 mm SGG PLANICLEAR	0.0%	9.3%
4 mm SGG PLANICLEAR & 4 mm SGG PLANITHERM TOTAL+	3.3%	4.2%
4 mm SGG PARSOL GREEN & 4 mm SGG PLANICLEAR	1.2%	43.5%
6 mm SGG COOL-LITE SKN 176 II & 4 mm SGG PLANICLEAR	0.3%	80.0%

EFFECT ON TEMPERATURE CALCULATIONS

The relevant values can be used to determine the expected pane temperatures under set climatic conditions, as below;

Solar Flux: 775 W/m^2

External Temperature: 20 ^{o}C

External Heat Transfer Coefficient: 12 W/m^{2}K

Internal Temperature: 20 ^{o}C

Internal Heat Transfer Coefficient: 8 W/m^{2}K

This shows, small changes, predominantly for the inner pane, however, as the inner pane in all cases has a relatively low solar energy absorbance, the differences are relatively small.

Table 3 – Pane Temperatures Between Weighted and Spectral Determinations (Monolithic Glasses)

Configuration	Pane Temperature (^{o}C)			
	Spectral		Weighted	
	Pane 1	Pane 2	Pane 1	Pane 2
4 mm SGG PLANICLEAR & 4 mm SGG PLANICLEAR	23.6	23.8	23.7	24.1
4 mm SGG PLANICLEAR & 4 mm SGG PLANITHERM TOTAL+	24.4	28.3	24.4	28.7
4 mm SGG PARSOL GREEN & 4 mm SGG PLANICLEAR	42.0	29.7	42.4	30.5
6 mm SGG COOL-LITE SKN 176 II & 4 mm SGG PLANICLEAR	37.9	23.1	37.9	24.2

If we consider laminated glass types, which, due to the presence of the interlayer, tend to absorb a greater amount of solar energy, using the same conditions, for a configuration comprising 6 mm SGG COOL-LITE SKN 176 II and 8.8 mm SGG STADIP PROTECT;

Table 4 – Pane Temperatures Between Weighted and Spectral Determinations (Including Laminated Glass)

6 mm SGG COOL-LITE SKN 176 II 8.8 mm SGG STADIP PROTECT	Spectral		Weighted	
	Pane 1	Pane 2	Pane 1	Pane 2
Solar Energy Absorbance (%)	30.0	3.4	29.9	6.8
Pane Temperature (^{o}C)	38.1	25.3	38.3	28.1

Although a temperature difference on the inner pane of 3^{o}C may not seem significant, for thermal stress calculations, this could readily be the difference between a pass and a fail.

TRIPLE GLAZED UNITS

The greater the number of panes within a configuration, the greater the potential for error to be carried over by the weighted values. The following data is for a triple glazed configuration, and shows greater error transferred to the centre and inner panes through the use of weighted values.

Table 5 – Absorbance and Pane Temperatures Between Weighted and Spectral Determinations

6 mm SGG COOL-LITE SKN 176 II 4 mm SGG PLANICLEAR 8.8 mm SGG STADIP PROTECT	Spectral			Weighted		
	Pane 1	Pane 2	Pane 3	Pane 1	Pane 2	Pane 3
Solar Energy Absorbance (%)	30.5	1.0	3.0	30.3	2.3	6.1
Pane Temperature (°C)	38.7	29.1	25.4	39.0	33.6	29.0

REFERENCES

[1] European Committee for Standardization, *EN 410:2011 - Glass in building. Determination of luminous and solar characteristics of glazing,* CEN, 2011.