



Report:

Optical Data measurement and performance indices calculation of a glass samples with Emerald 60 applied film

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A & B Films Pte Ltd contracted Carli Inc for the optical data measurement and data preparation of a glass samples with Emerald 60 applied film. The films were mounted on a 5 mm clear reference glass sample.

Test Methods and Procedures

Optical data Measurements

UV-Vis-NIR Measurements:

Total transmittance and total reflectance factor measurements were performed with ODA's Varian™ Cary 500E™ UV-Vis-NIR Double Beam Spectrophotometer equipped with a 150 mm diameter Labsphere™ Spectralon™ reference standard. Baselines are measured before and after the sample measurements, a zeroline is measured after the sample measurements and a didymia transmittance standard is measured during each set of measurements to verify the wavelength scale. For transmittance and reflectance factor, the angle of incidence is 0° and 7°, respectively. The typical wavelength interval is 5nm.

IR Measurements:

Specular transmittance and specular reflectance factor measurements are performed with ODA's Perking-Elmer™ 9836 G IR Double-Beam IR Spectrophotometer equipped with Perking-Elmer™ Specular Reflectance Accessory. The wavelength range is 2 to 56 μm. In reflectance, measurements are made with respect to a protected aluminum specular reflectance reference standard from National Physical Laboratory™ [NPL] in the United Kingdom. Baselines are measured before and after the sample measurements, a zeroline is measured after the sample measurements, and a polystyrene transmittance standard is measured during each set of measurements to verify the wavelength scale. For transmittance and reflectance factor, the angle of incidence is 0° and 7°, respectively. The wavelength interval is 10cm⁻¹. This is the method adopted by the Lawrence Berkeley National Laboratory [LBNL].

The optical properties of glasses with films are summarized in Table 1 and the graphical details are shown in Appendix 1.

Table 1: Optical properties of the glass with Emerald 60 applied film

Product Name	Thick-ness	Solar			Visible			Emissivity	
	mm	Tsol	R _f sol	R _b sol	Tvis	R _f vis	R _b vis	Front	Back
Emerald 60	5.06	0.418	0.380	0.283	0.627	0.236	0.215	0.73	0.84

Note: Subscript f and b represent front and back respectively. Films are applied at the front side. T and R denote transmittance and reflectance respectively.

Optical Data Calculations

The centre of glass U factor, SHGC (Solar Heat Gain Coefficient), Shading Coefficient, Visible Transmittance and Relative heat gains of the glass with applied film, assuming it as a single glazed unit, was calculated using WINDOW5 and the values are given in Table 2 below: **The film side of the glass faces the indoor environment.**

Table 2: Thermal and optical properties of single glazing unit

Product Name	# of glass layer	Winter U-Factor	Summer U- Factor	SHGC	SC	Tvis	Relative Heat Gain	UV Indices		
		W/m ² K	W/m ² K				W/m ²	Tuv	Tdw-K	Tdw-ISO
Emerald 60	1	5.50	4.93	0.50	0.58	0.63	403	0.003	0.189	0.415

The NFRC standard boundary conditions given below were used for the calculations in Table 2:

ID	Name	U-factor Tin	U-factor Tout	SHGC Tin	SHGC Tout	SHGC Solar
		C	C	C	C	W/m ²
1	NFRC 100-2002	21.0	-18.0	24.0	32.0	783

Appendix 1.: Spectral properties of the glass sample with film.

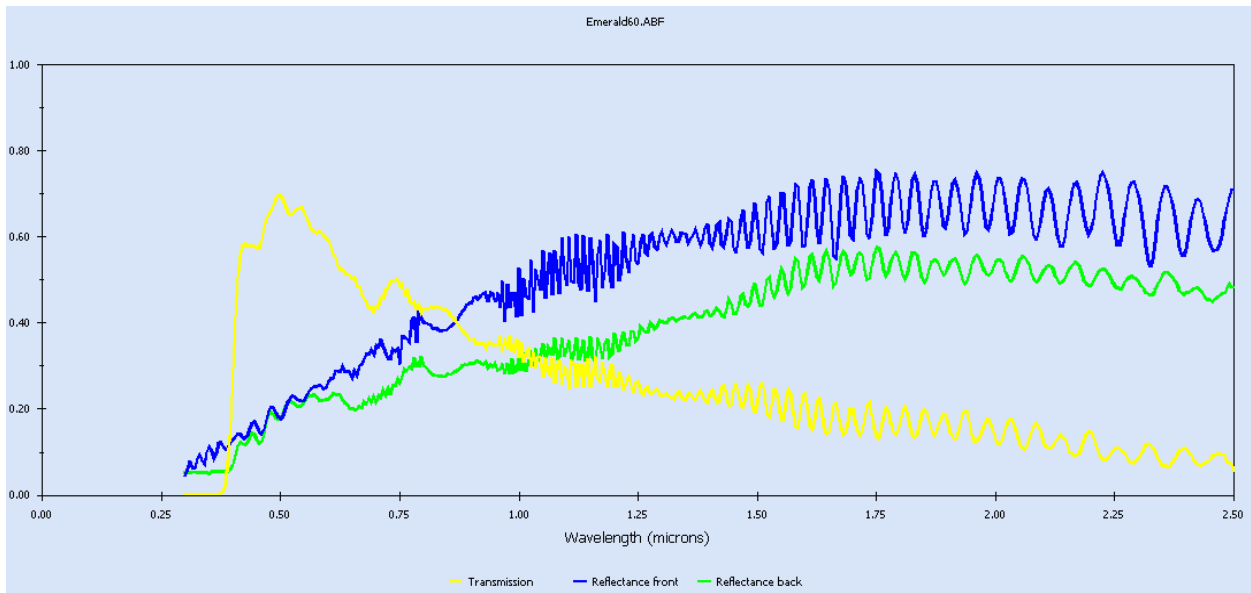


Figure 1: Spectral properties: Emerald 60

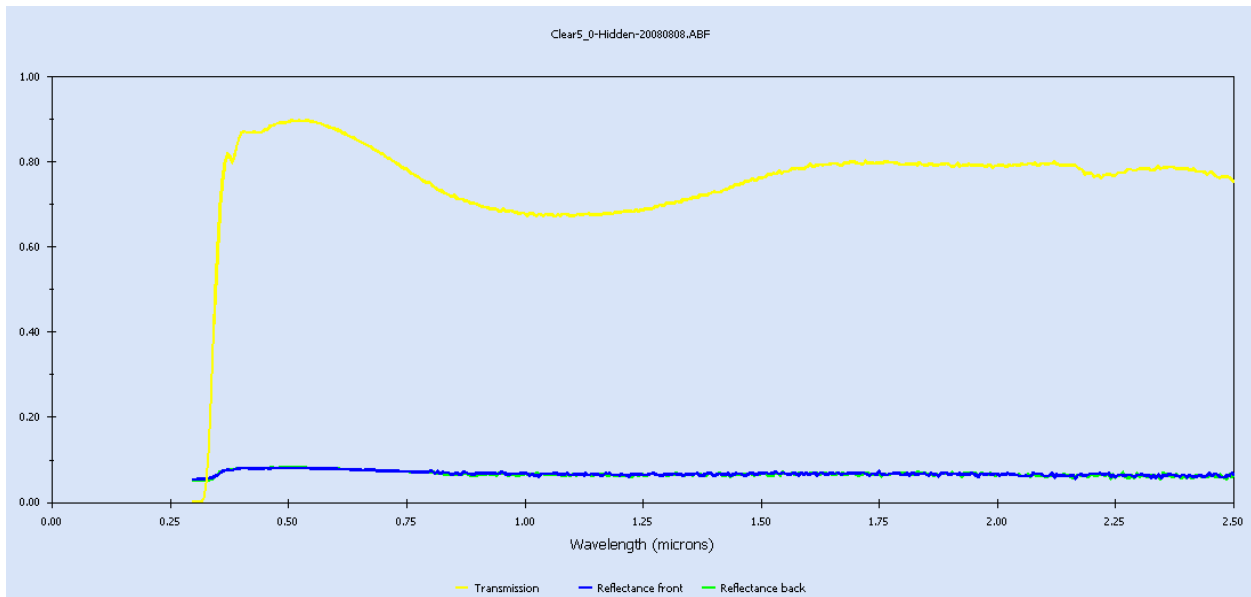


Figure 2: Spectral properties: Reference Glass sample (Substrate)

Appendix 2.: Detailed glazing data of a single glazed unit with film

Window 5.2a v5.2.17a Glazing System Thermal and Optical Properties 08/12/08
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ID : 7
Name : Emerald 60
Tilt : 90.0
Glazings: 1
KEFF : 0.1000
Width : 5.058
Uvalue : 5.50
SHGCc : 0.50
SCc : 0.58
Vtc : 0.63
RHG : 403.13

Glass and Gas Data for Glazing System '7 Emerald 60'

ID	Name	D(mm)	Tsol	1 Rsol	2 Tvis	1 Rvis	2 Tir	1 Emis	2 Keff			
Outside												
30016F	Emerald60.ABF #	5.1	.418	.283	.380	.627	.215	.236	.000	.840	.730	.916
Inside												

Environmental Conditions: 1 NFRC 100-2002

	Tout (C)	Tin (C)	WndSpd (m/s)	Wnd Dir	Solar (W/m2)	Tsky (C)	Esky
Uvalue	-18.0	21.0	5.50	Windward	0.0	-18.0	1.00
Solar	32.0	24.0	2.80	Windward	783.0	32.0	1.00

Optical Properties for Glazing System '7 Emerald 60'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.627	0.631	0.623	0.613	0.602	0.581	0.533	0.434	0.261	0.000	0.548
Rf	: 0.215	0.209	0.207	0.210	0.219	0.234	0.263	0.339	0.541	0.999	0.255
Rb	: 0.236	0.230	0.228	0.231	0.240	0.254	0.282	0.356	0.553	0.999	0.275
Tsol	: 0.418	0.421	0.415	0.409	0.401	0.387	0.355	0.289	0.174	0.000	0.365
Rf	: 0.283	0.277	0.276	0.278	0.286	0.300	0.326	0.396	0.580	0.999	0.319
Rb	: 0.380	0.375	0.374	0.376	0.383	0.395	0.418	0.478	0.637	0.999	0.410
Abs1	: 0.299	0.302	0.309	0.313	0.313	0.313	0.319	0.315	0.246	0.001	0.306
SHGCc	: 0.499	0.503	0.499	0.494	0.486	0.472	0.442	0.375	0.240	0.000	0.448
Tdw-K	: 0.189										
Tdw-ISO	: 0.415										
Tuv	: 0.003										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.7	-9.5	38.2	38.2