



Report:

Optical Data measurement and performance indices calculation of a glass samples with Nature Green 50 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 Nature Green 50 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 Nature Green 50 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
Nature Green 50	4.87	0.423	0.188	0.150	0.549	0.160	0.149	0.86	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
Nature Green 50	1	5.90	5.35	0.55	0.64	0.55	443	0.016	0.192	0.391

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.

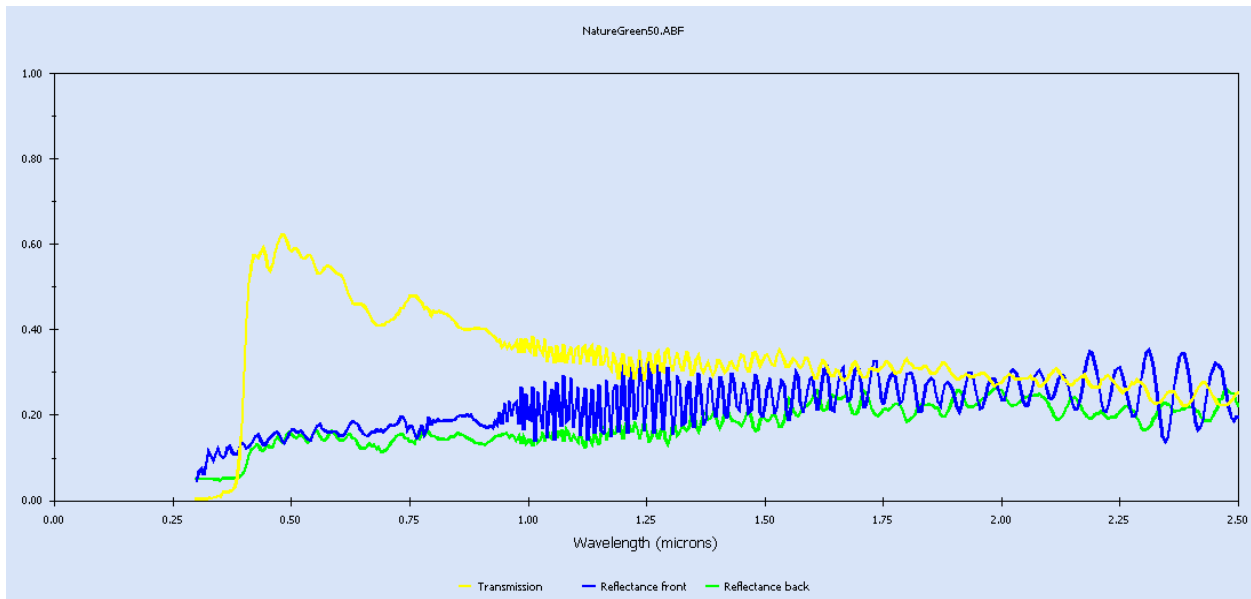


Figure 1: Spectral properties: Nature Green 50

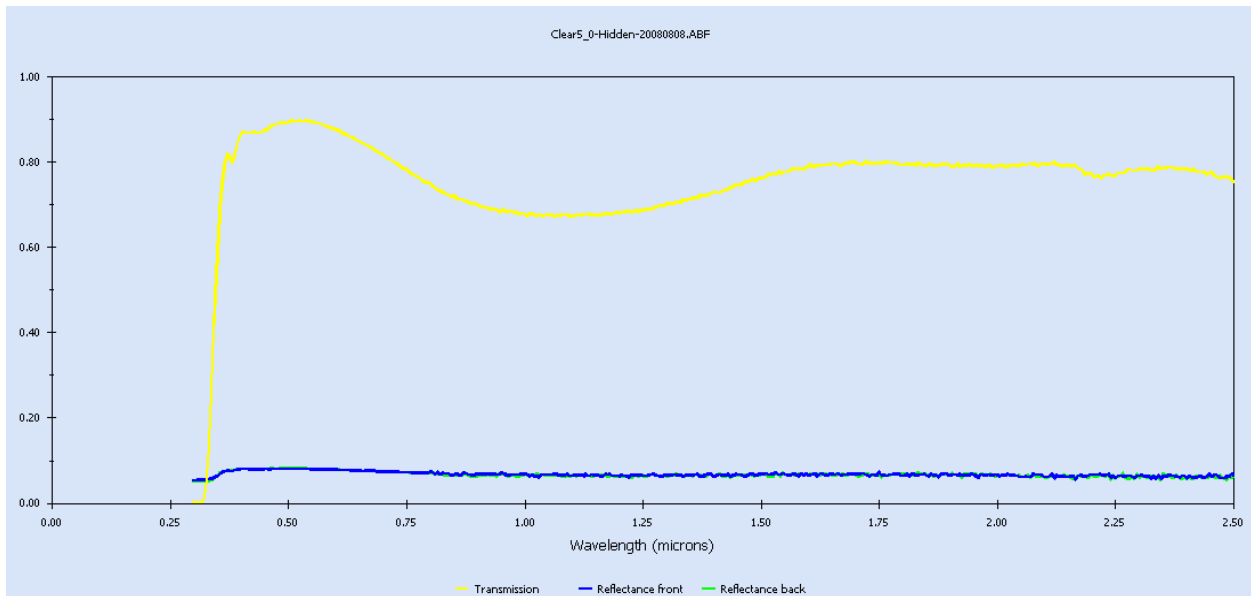


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
12:12:38

ID : 12
 Name : Nature Green 50
 Tilt : 90.0
 Glazings: 1
 KEFF : 0.1000
 Width : 4.869
 Uvalue : 5.90
 SHGCc : 0.55
 SCc : 0.64
 Vtc : 0.55
 RHG : 443.49

Glass and Gas Data for Glazing System '12 Nature Green 50'

ID	Name	D(mm)	Tsol	1	Rsol	2	Tvis	1	Rvis	2	Tir	1	Emis	2	Keff
Outside															
	30008FNatureGreen50.A#	4.9	.423	.150	.188	.549	.149	.160	.000	.840	.860	.983	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 '12 Nature Green 50'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.549	0.552	0.545	0.537	0.527	0.508	0.466	0.380	0.228	0.000	0.480
Rf	: 0.149	0.142	0.140	0.143	0.153	0.169	0.200	0.283	0.502	0.999	0.193
Rb	: 0.160	0.153	0.152	0.155	0.164	0.180	0.211	0.293	0.509	0.999	0.204
Tsol	: 0.423	0.425	0.420	0.413	0.406	0.391	0.359	0.292	0.176	0.000	0.369
Rf	: 0.150	0.143	0.142	0.145	0.154	0.171	0.202	0.284	0.503	0.999	0.195
Rb	: 0.188	0.181	0.180	0.182	0.191	0.207	0.237	0.316	0.524	0.999	0.229
Abs1	: 0.427	0.431	0.438	0.442	0.440	0.438	0.439	0.423	0.321	0.001	0.426
SHGCc	: 0.549	0.553	0.550	0.544	0.536	0.521	0.489	0.418	0.270	0.000	0.495
Tdw-K	: 0.192										
Tdw-ISO	: 0.391										
Tuv	: 0.016										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.1	-9.0	41.0	41.1