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Report:

Optical Data measurement and performance indices calculation of a glass samples with Crystal Blue 55 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 Crystal Blue 55 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 Spectrophometer 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^o and 7^o, 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^o and 7^o, 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 Crystal Blue 55 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
Crystal Blue 55	5.07	0.476	0.127	0.117	0.579	0.118	0.120	0.88	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^2K	W/m^2K				W/m^2	Tuv	Tdw-K	Tdw-ISO
Crystal Blue 55	1	5.94	5.39	0.60	0.69	0.58	479	0.009	0.217	0.430

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/m2
	1	NFRC 100-2002	21.0	-18.0	24.0	32.0	783

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

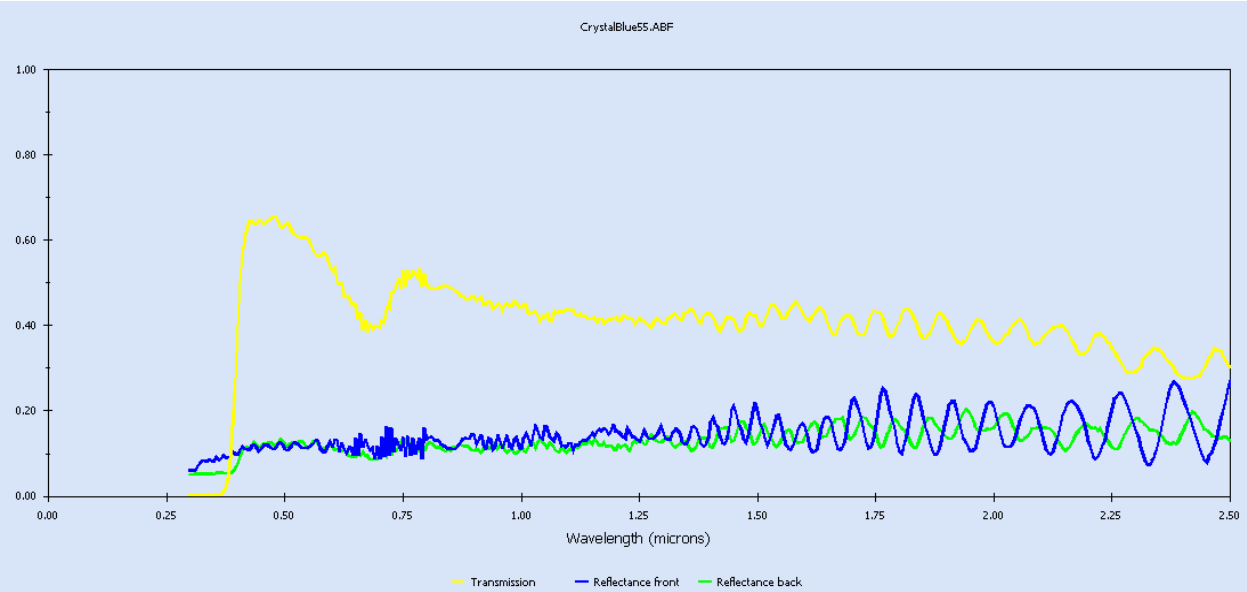

Figure 1: Spectral properties: Crystal Blue 55

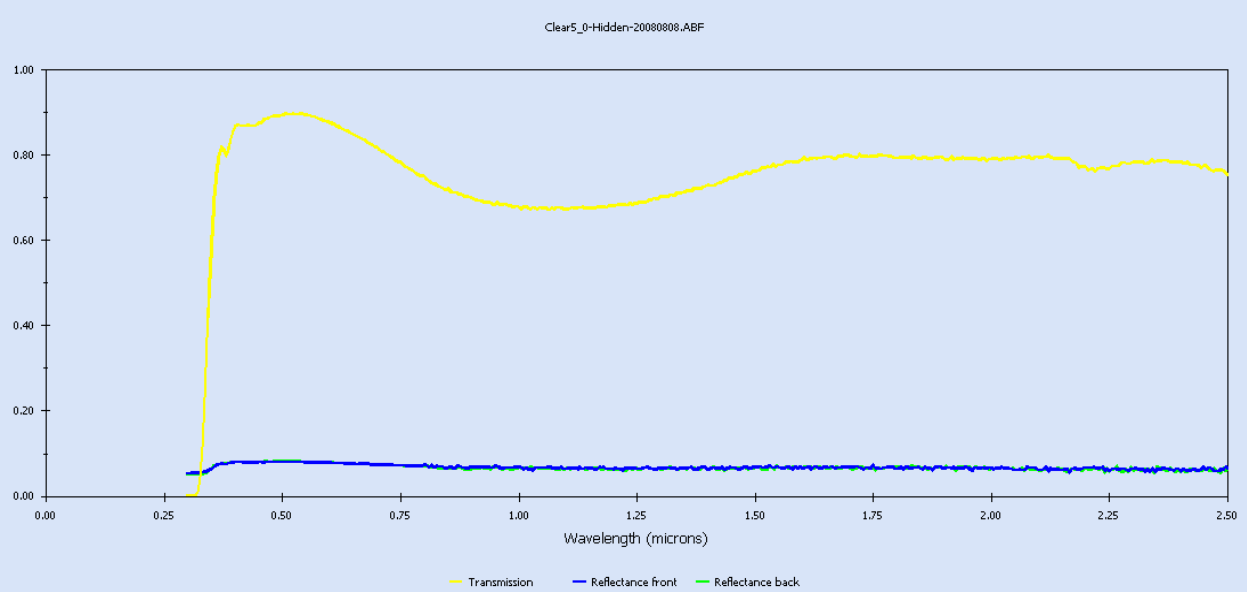

Figure 2: Spectral properties: Reference Glass sample (Substrate)

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 11:56:24

ID : 6
Name : Crystal Blue 55
Tilt : 90.0
Glazings: 1
KEFF : 0.1000
Width : 5.073
Uvalue : 5.94
SHGCc : 0.60
SCc : 0.69
Vtc : 0.58
RHG : 478.87

Glass and Gas Data for Glazing System '6 Crystal Blue 55'

ID	Name	D(mm)	Tsol	1 Rsol	2 Rsol	Tvis	1 Rvis	2 Rvis	Tir	1 Emis	2 Emis	Keff
Outside												
30025	FCrystalBlue55.A#	5.1	.476	.117	.127	.579	.120	.118	.000	.840	.880	.911
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 '6 Crystal Blue 55'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc :	0.579	0.582	0.575	0.566	0.555	0.536	0.492	0.401	0.241	0.000	0.506
Rf :	0.120	0.112	0.111	0.114	0.124	0.141	0.173	0.258	0.485	0.999	0.166
Rb :	0.118	0.110	0.109	0.112	0.122	0.139	0.171	0.257	0.484	0.999	0.164
Tsol :	0.476	0.479	0.473	0.465	0.457	0.441	0.404	0.329	0.198	0.000	0.416
Rf :	0.117	0.110	0.108	0.111	0.121	0.138	0.170	0.256	0.483	0.999	0.163
Rb :	0.127	0.119	0.118	0.121	0.131	0.147	0.179	0.264	0.489	0.999	0.172
Abs1 :	0.407	0.411	0.419	0.423	0.422	0.421	0.425	0.415	0.319	0.001	0.410
SHGCc:	0.597	0.602	0.598	0.592	0.583	0.567	0.532	0.453	0.292	0.000	0.539

Tdw-K : 0.217
Tdw-ISO: 0.430
Tuv : 0.009

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.1	-8.8	40.5	40.6