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Report:

Optical Data measurement and performance indices calculation of a glass samples with DS 10 BL 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 DS 10 BL 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 DS 10 BL 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
DS 10 BL	4.85	0.096	0.433	0.354	0.081	0.259	0.261	0.76	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
DS 10 BL	1	5.61	5.04	0.25	0.30	0.08	227	0.000	0.057	0.098

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.

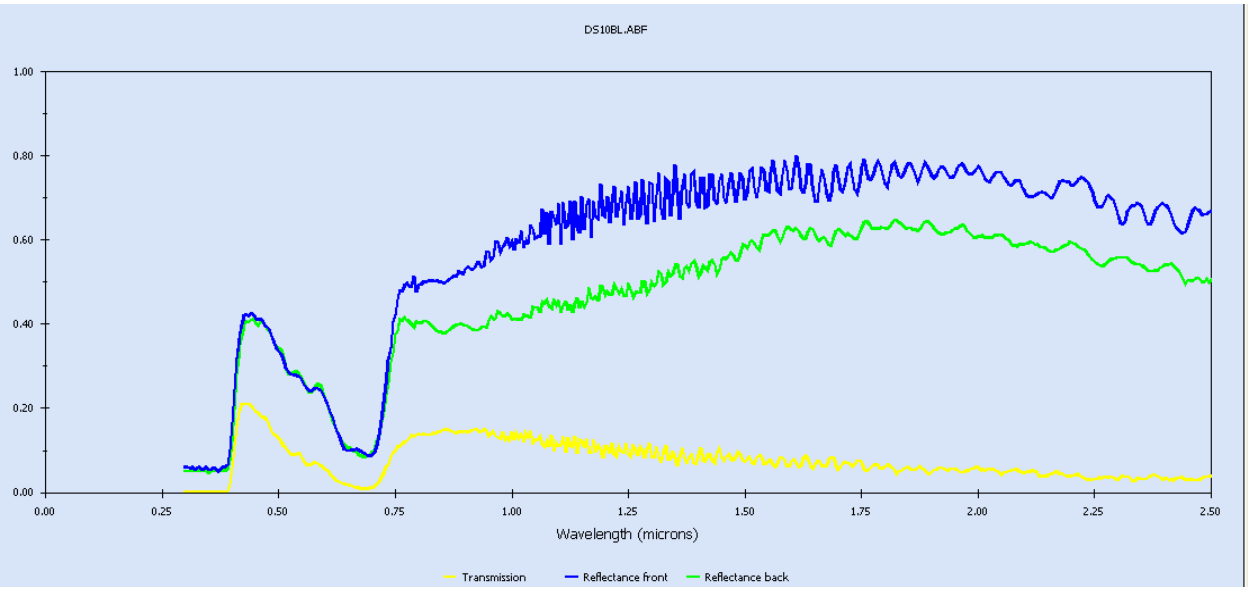

Figure 1: Spectral properties: DS 10 BL

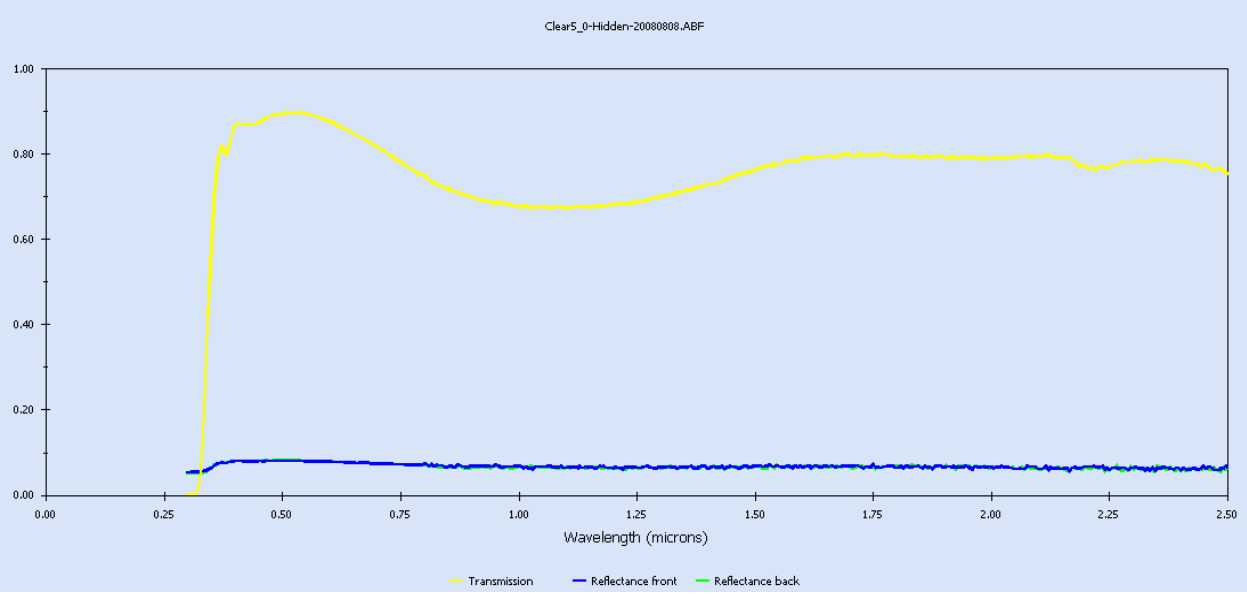

Figure 2: Spectral properties: Reference Glass sample (Substrate)

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 14:20:42

ID : 20
Name : DS 10 BL
Tilt : 90.0
Glazings: 1
KEFF : 0.1000
Width : 4.847
Uvalue : 5.61
SHGCc : 0.25
SCc : 0.30
Vtc : 0.08
RHG : 226.81

Glass and Gas Data for Glazing System '20 DS 10 BL'

ID	Name	D(mm)	Tsol	1 Rsol	2 Rsol	Tvis	1 Rvis	2 Rvis	Tir	1 Emis	2 Emis	Keff
Outside												
30020FDS10BL.ABF	#	4.8	.096	.354	.433	.081	.261	.259	.000	.840	.760	.992
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 '20 DS 10 BL'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc :	0.081	0.082	0.081	0.079	0.078	0.075	0.069	0.056	0.034	0.000	0.071
Rf :	0.261	0.255	0.254	0.256	0.265	0.279	0.306	0.377	0.568	0.999	0.298
Rb :	0.259	0.252	0.251	0.254	0.262	0.276	0.303	0.375	0.566	0.999	0.296
Tsol :	0.096	0.096	0.095	0.094	0.092	0.089	0.081	0.066	0.040	0.000	0.084
Rf :	0.354	0.349	0.348	0.350	0.357	0.370	0.393	0.456	0.622	0.999	0.385
Rb :	0.433	0.428	0.427	0.429	0.436	0.446	0.467	0.522	0.668	0.999	0.459
Abs1 :	0.550	0.555	0.557	0.556	0.551	0.542	0.525	0.478	0.338	0.001	0.521
SHGCc:	0.252	0.254	0.254	0.252	0.249	0.243	0.230	0.201	0.133	0.000	0.231

Tdw-K : 0.057
Tdw-ISO: 0.098
Tuv : 0.000

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.5	-9.5	44.5	44.8