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Report:

Optical Data measurement and performance indices calculation of a glass samples with Jasper Gold 30 applied film

Report prepared for: ***A & B Films Pte Ltd
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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 Jasper Gold 30 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 Jasper Gold 30 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
Jasper Gold 30	4.89	0.283	0.366	0.301	0.375	0.322	0.305	0.77	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
Jasper Gold 30	1	5.64	5.07	0.40	0.47	0.37	333	0.003	0.127	0.265

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.

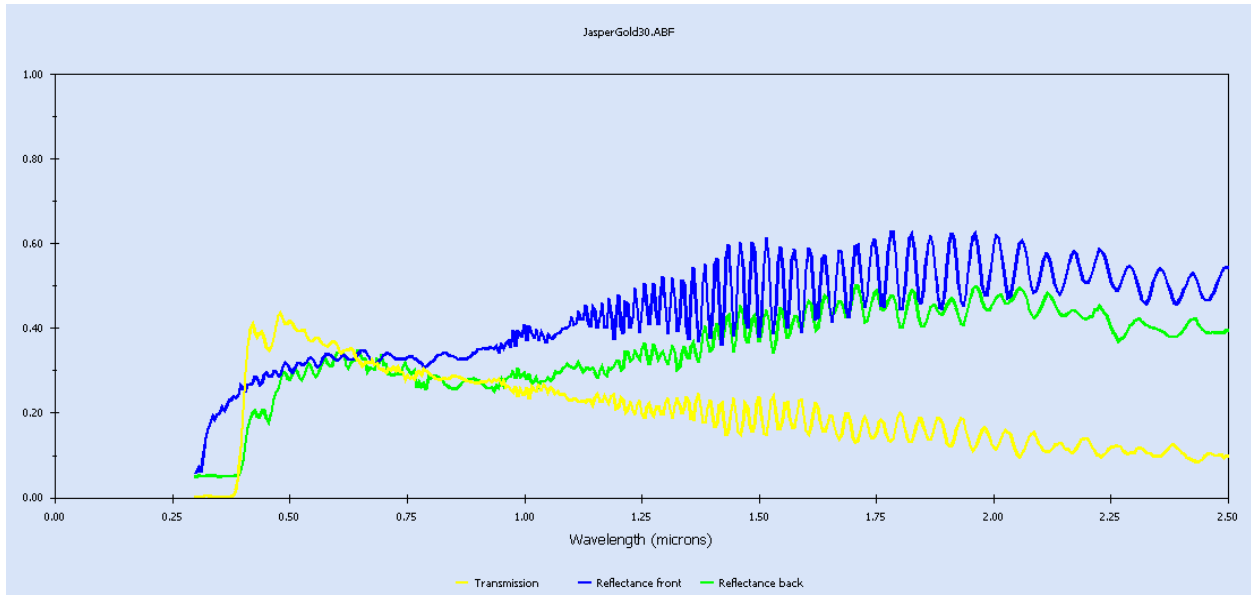


Figure 1: Spectral properties: Jasper Gold 30

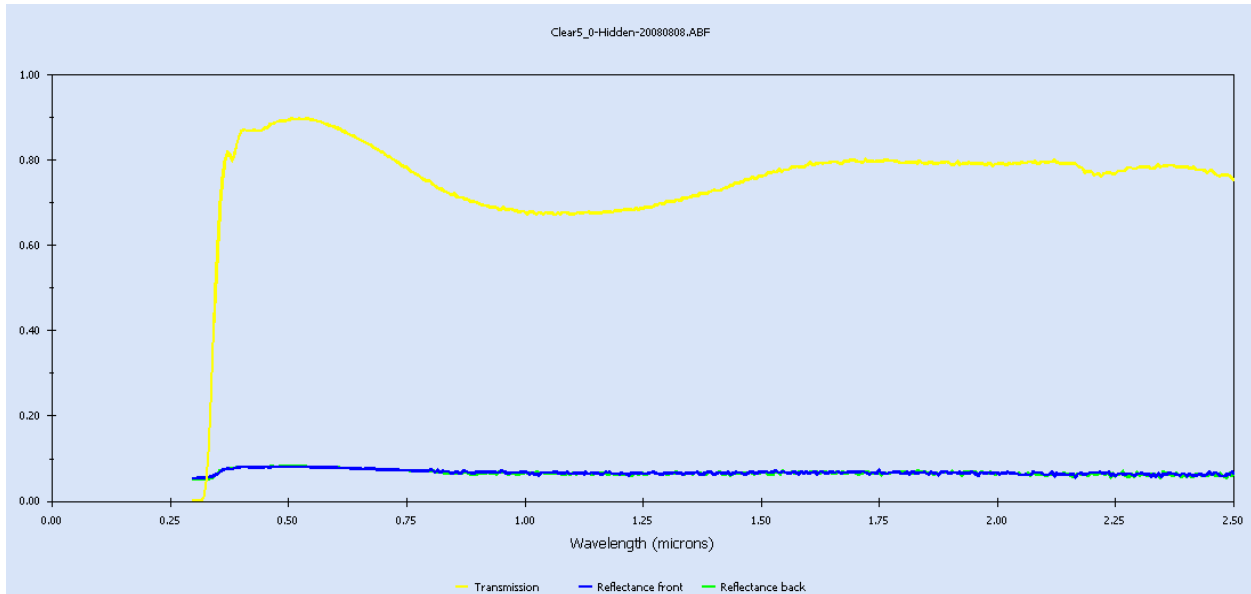


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
12:02:47

ID : 8
 Name : Jasper Gold 30
 Tilt : 90.0
 Glazings: 1
 KEFF : 0.1000
 Width : 4.891
 Uvalue : 5.64
 SHGCc : 0.40
 SCc : 0.47
 Vtc : 0.37
 RHG : 333.47

Glass and Gas Data for Glazing System '8 Jasper Gold 30'

ID	Name	D(mm)	Tsol	1	Rsol	2	Tvis	1	Rvis	2	Tir	1	Emis	2	Keff

Outside															
	30014FJasperGold30.AB#	4.9	.283	.301	.366	.375	.305	.322	.000	.840	.770	.975			
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 '8 Jasper Gold 30'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.375	0.377	0.373	0.367	0.360	0.347	0.318	0.259	0.156	0.000	0.328
Rf	: 0.305	0.300	0.298	0.301	0.309	0.322	0.347	0.415	0.593	0.999	0.340
Rb	: 0.322	0.317	0.315	0.318	0.325	0.338	0.363	0.429	0.603	0.999	0.355
Tsol	: 0.283	0.285	0.281	0.277	0.272	0.262	0.240	0.196	0.118	0.000	0.247
Rf	: 0.301	0.295	0.294	0.296	0.304	0.318	0.343	0.411	0.591	0.999	0.335
Rb	: 0.366	0.361	0.360	0.362	0.369	0.381	0.404	0.466	0.629	0.999	0.396
Abs1	: 0.416	0.420	0.425	0.427	0.424	0.420	0.416	0.393	0.292	0.001	0.407
SHGCc	: 0.400	0.403	0.401	0.397	0.391	0.381	0.358	0.306	0.198	0.000	0.362
Tdw-K	: 0.127										
Tdw-ISO	: 0.265										
Tuv	: 0.003										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.5	-9.4	41.1	41.2