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Report:

Optical Data measurement and performance indices calculation of a glass samples with Jasper Gold 50 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 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 Jasper Gold 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
Jasper Gold 50	4.89	0.429	0.197	0.179	0.540	0.175	0.175	0.85	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 50	1	5.87	5.32	0.54	0.63	0.54	439	0.002	0.163	0.358

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.

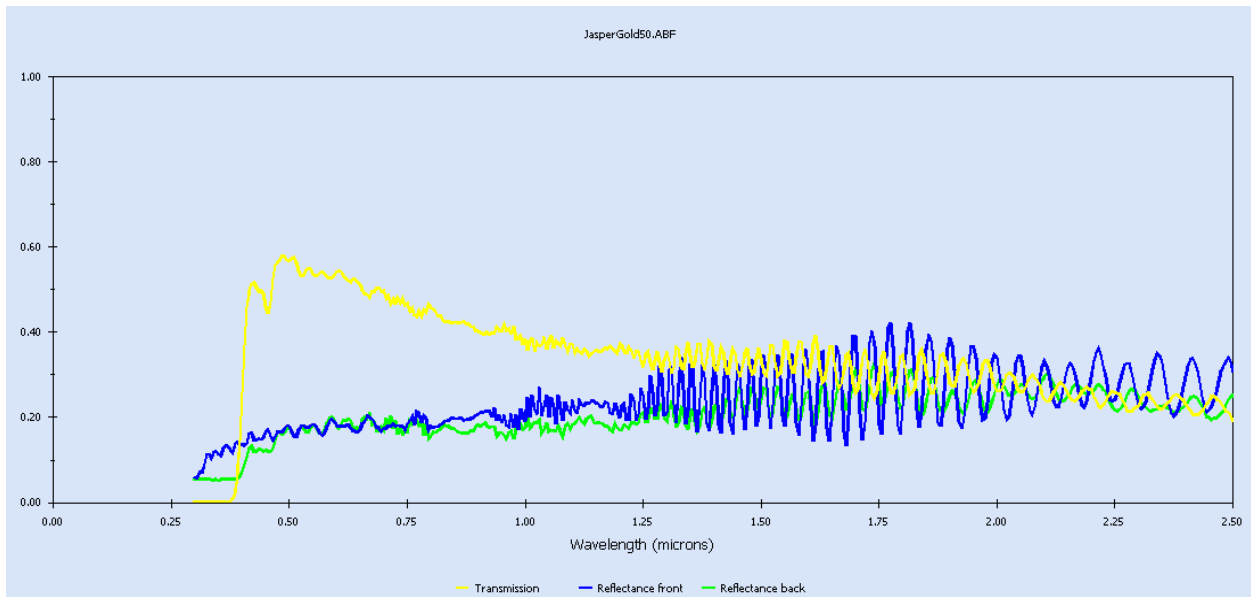


Figure 1: Spectral properties: Jasper Gold 50

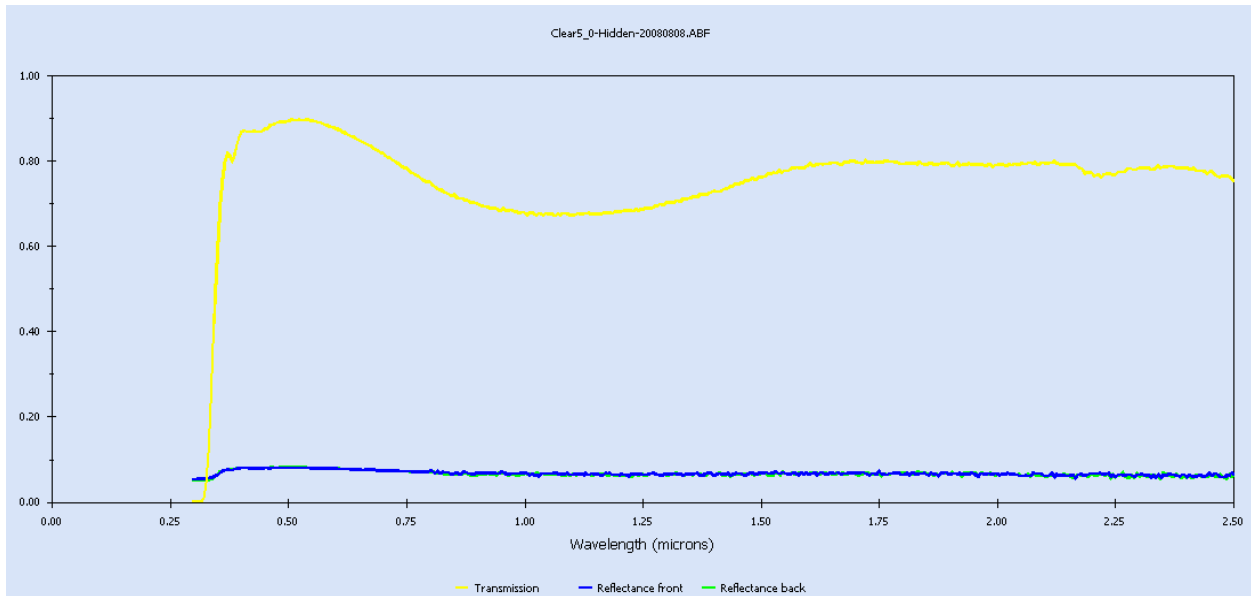


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
12:05:10

ID : 9
Name : Jasper Gold 50
Tilt : 90.0
Glazings: 1
KEFF : 0.1000
Width : 4.891
Uvalue : 5.87
SHGCc : 0.54
SCc : 0.63
Vtc : 0.54
RHG : 439.27

Glass and Gas Data for Glazing System '9 Jasper Gold 50'

ID	Name	D(mm)	Tsol	1 Rsol	2 Tvis	1 Rvis	2 Tir	1 Emis	2 Keff			
Outside												
	30013FJasperGold50.AB#	4.9	.429	.179	.197	.540	.175	.175	.000	.840	.850	.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 '9 Jasper Gold 50'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.540	0.544	0.537	0.529	0.519	0.500	0.459	0.374	0.225	0.000	0.473
Rf	: 0.175	0.168	0.167	0.169	0.179	0.194	0.225	0.305	0.517	0.999	0.217
Rb	: 0.175	0.168	0.167	0.170	0.179	0.195	0.225	0.305	0.517	0.999	0.218
Tsol	: 0.429	0.431	0.426	0.419	0.411	0.397	0.364	0.297	0.178	0.000	0.375
Rf	: 0.179	0.172	0.170	0.173	0.183	0.198	0.228	0.308	0.519	0.999	0.221
Rb	: 0.197	0.190	0.189	0.192	0.201	0.216	0.246	0.323	0.530	0.999	0.238
Abs1	: 0.393	0.397	0.404	0.407	0.406	0.405	0.407	0.395	0.302	0.001	0.394
SHGCc	: 0.544	0.548	0.544	0.539	0.531	0.516	0.484	0.413	0.266	0.000	0.490
Tdw-K	: 0.163										
Tdw-ISO	: 0.358										
Tuv	: 0.002										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.2	-9.0	40.2	40.3