



**Report:**

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**Optical Data measurement and performance indices  
calculation of a glass samples with DS 5 GF applied  
film**

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**Report prepared for:** *A & B Films Pte Ltd  
5, Kim Chuan Terrace  
Singapore 537028*

**Report prepared by:** *Mandari*  
**Mahabir Bhandari, Ph.D.**  
*Senior Energy Analyst*

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**August 12, 2008**

A & B Films Pte Ltd contracted Carli Inc for the optical data measurement and data preparation of a glass samples with DS 5 GF 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<sup>TM</sup> Cary 500E<sup>TM</sup> UV-Vis-NIR Double Beam Spectrophotometer equipped with a 150 mm diameter Labsphere<sup>TM</sup> Spectralon<sup>TM</sup> 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<sup>TM</sup> 9836 G IR Double-Beam IR Spectrophotometer equipped with Perking-Elmer<sup>TM</sup> Specular Reflectance Accessory. The wavelength range is 2 to 56  $\mu\text{m}$ . In reflectance, measurements are made with respect to a protected aluminum specular reflectance reference standard from National Physical Laboratory<sup>TM</sup> [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 10 $\text{cm}^{-1}$ . 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 5 GF applied film**

Product Name	Thick-ness	Solar			Visible			Emissivity	
	mm	Tsol	R <sub>f</sub> sol	R <sub>b</sub> sol	Tvis	R <sub>f</sub> vis	R <sub>b</sub> vis	Front	Back
DS 5 GF	5.07	0.173	0.196	0.170	0.057	0.067	0.096	0.83	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 <sup>2</sup> K	W/m <sup>2</sup> K				W/m <sup>2</sup>	Tuv	Tdw-K	Tdw-ISO
DS 5 GF	1	5.79	5.24	0.37	0.43	0.06	314	0.002	0.028	0.050

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 <sup>2</sup>
1	NFRC 100-2002	21.0	-18.0	24.0	32.0	783

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

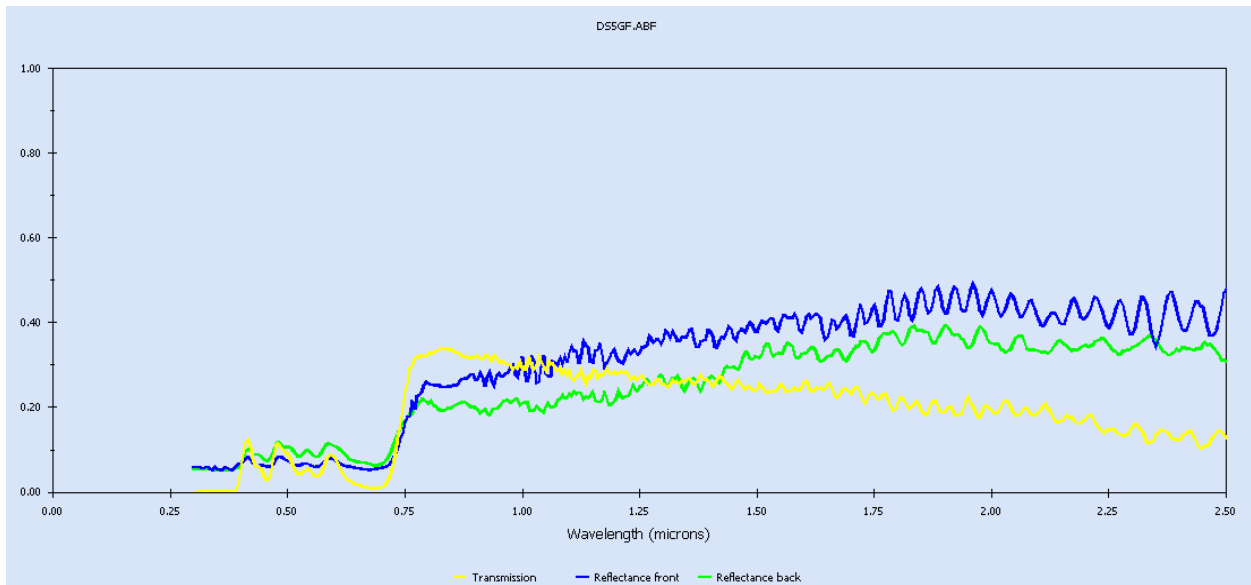


Figure 1: Spectral properties: DS 5 GF

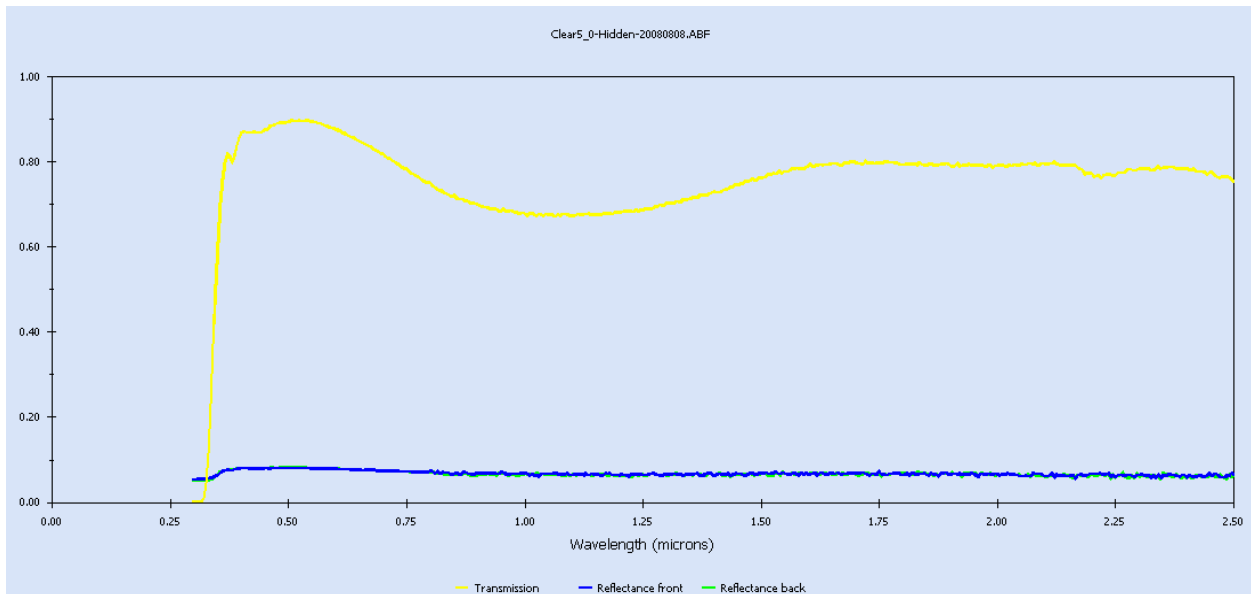


Figure 2: Spectral properties: Reference Glass sample (Substrate)

**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  
14:17:38

ID : 19  
Name : DS 5 GF  
Tilt : 90.0  
Glazings: 1  
KEFF : 0.1000  
Width : 5.070  
Uvalue : 5.79  
SHGCc : 0.37  
SCc : 0.43  
Vtc : 0.06  
RHG : 314.41

Glass and Gas Data for Glazing System '19 DS 5 GF'

ID	Name	D(mm)	Tsol	1	Rsol	2	Tvis	1	Rvis	2	Tir	1	Emis	2	Keff
Outside															
	30021FDS5GF.ABF	# 5.1	.173	.170	.196	.057	.096	.067	.000	.840	.830	.912	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 '19 DS 5 GF'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.057	0.057	0.057	0.056	0.055	0.053	0.048	0.039	0.024	0.000	0.050
Rf	: 0.096	0.089	0.087	0.090	0.100	0.118	0.151	0.238	0.471	0.999	0.144
Rb	: 0.067	0.060	0.058	0.061	0.072	0.090	0.124	0.214	0.454	0.999	0.117
Tsol	: 0.173	0.174	0.172	0.169	0.166	0.160	0.147	0.120	0.072	0.000	0.151
Rf	: 0.170	0.163	0.161	0.164	0.174	0.190	0.220	0.300	0.514	0.999	0.213
Rb	: 0.196	0.189	0.188	0.191	0.200	0.215	0.245	0.323	0.529	0.999	0.237
Abs1	: 0.657	0.663	0.666	0.666	0.660	0.650	0.633	0.580	0.414	0.001	0.626
SHGCc	: 0.370	0.373	0.372	0.369	0.364	0.355	0.336	0.292	0.193	0.000	0.338
Tdw-K	: 0.028										
Tdw-ISO	: 0.050										
Tuv	: 0.002										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.3	-9.0	46.9	47.2