



## Report:

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### Optical Data measurement and performance indices calculation of a glass samples with R 35 S 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 R 35 S 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<sup>-1</sup>. 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 R 35 S 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
R 35 S	4.90	0.313	0.334	0.261	0.423	0.295	0.283	0.73	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
R 35 S	1	5.52	4.94	0.43	0.50	0.42	354	0.011	0.187	0.340

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.

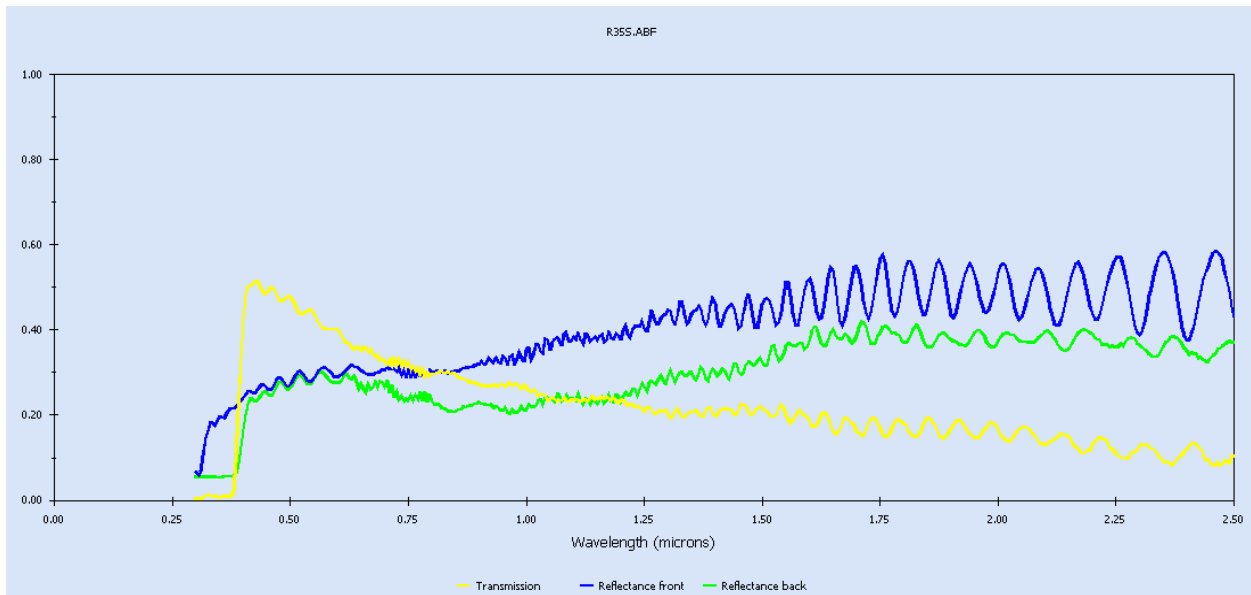


Figure 1: Spectral properties: R 35 S

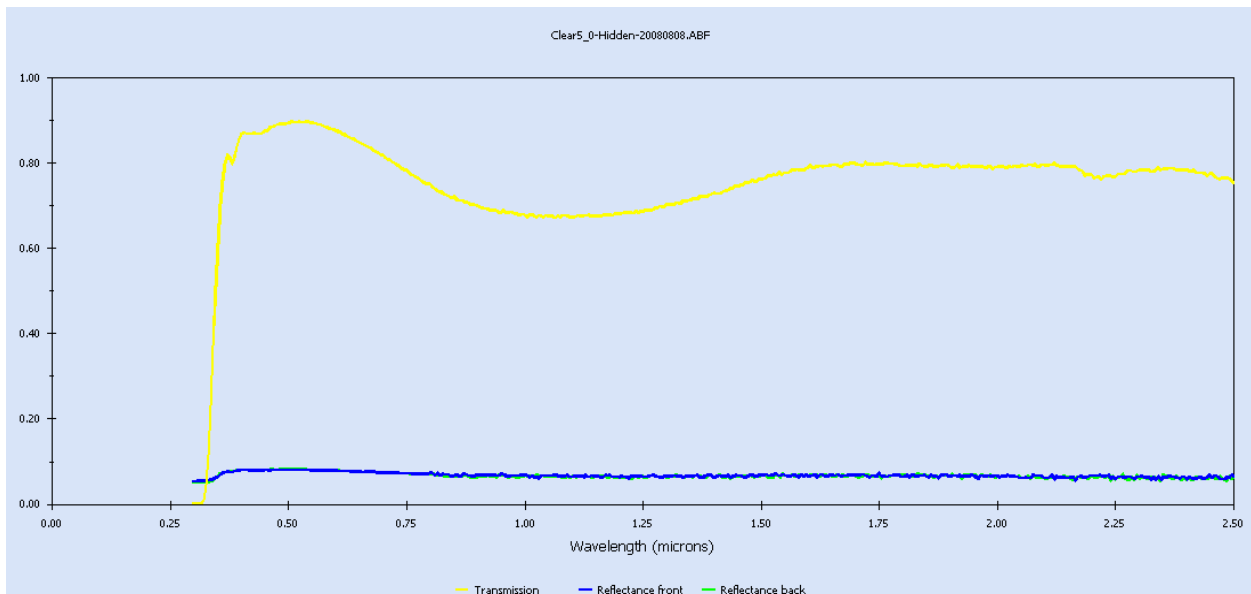


Figure 2: Spectral properties: Reference Glass sample (Substrate)

**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  
15:28:50

ID : 28  
Name : R 35 S  
Tilt : 90.0  
Glazings: 1  
KEFF : 0.1000  
Width : 4.904  
Uvalue : 5.52  
SHGCc : 0.43  
SCc : 0.50  
Vtc : 0.42  
RHG : 354.37

Glass and Gas Data for Glazing System '28 R 35 S'

ID	Name	D(mm)	Tsol	1	Rsol	2	Tvis	1	Rvis	2	Tir	1	Emis	2	Keff
Outside															
	30002FR35S.ABF	# 4.9	.313	.261	.334	.423	.283	.295	.000	.840	.730	.970			
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 '28 R 35 S'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.423	0.426	0.421	0.414	0.406	0.392	0.360	0.293	0.176	0.000	0.370
Rf	: 0.283	0.278	0.276	0.279	0.287	0.301	0.327	0.396	0.581	0.999	0.319
Rb	: 0.295	0.289	0.288	0.290	0.298	0.312	0.337	0.406	0.587	0.999	0.330
Tsol	: 0.313	0.315	0.311	0.306	0.300	0.290	0.266	0.217	0.130	0.000	0.274
Rf	: 0.261	0.255	0.254	0.257	0.265	0.279	0.306	0.378	0.568	0.999	0.299
Rb	: 0.334	0.329	0.328	0.330	0.338	0.350	0.375	0.439	0.610	0.999	0.367
Abs1	: 0.426	0.430	0.435	0.437	0.435	0.431	0.428	0.406	0.302	0.001	0.418
SHGCc	: 0.430	0.434	0.431	0.427	0.420	0.409	0.384	0.328	0.212	0.000	0.389
Tdw-K	: 0.187										
Tdw-ISO	: 0.340										
Tuv	: 0.011										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.7	-9.6	41.5	41.6