

A & B Films Pte Ltd contracted Carli Inc for the optical data measurement and data preparation of a glass samples with GS35 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 GS35 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
GS35	5.93	0.393	0.091	0.106	0.369	0.074	0.096	0.84	0.92

Note: Subscript f and b represent front and back respectively. Films are applied at the back 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
GS35	1	5.96	5.43	0.55	0.64	0.37	448	0.001	0.13	0.26

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.

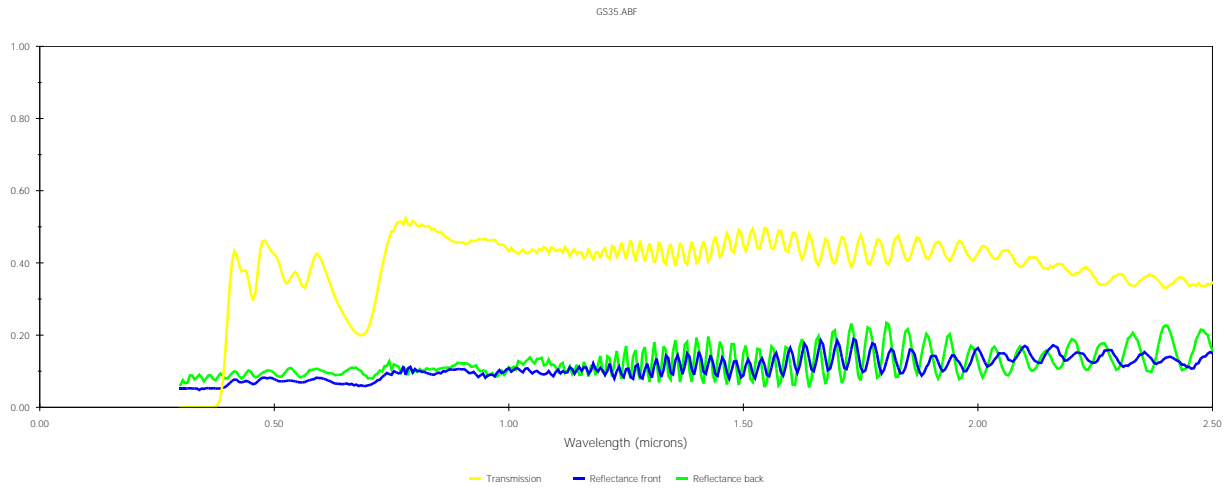


Figure 1: Spectral properties: GS35

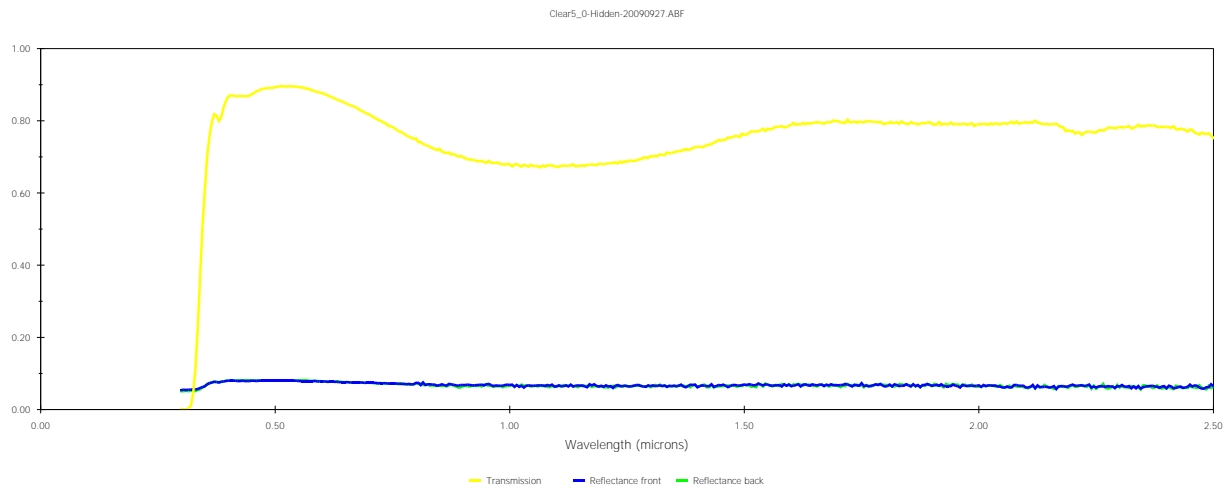


Figure 2: Spectral properties: Reference Glass sample (Substrate)

Appendix 2.: Detailed glazing data of a single glazed unit with film

Window 5.2a v5.2.17a Glazing System Thermal and Optical Properties 09/27/09
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ID : 9
 Name : GS35
 Tilt : 90.0
 Glazings: 1
 KEFF : 0.1000
 Width : 5.930
 Uvalue : 5.96
 SHGCc : 0.55
 SCc : 0.64
 Vtc : 0.37
 RHG : 448.11

Glass and Gas Data for Glazing System '9 GS35'

ID	Name	D (mm)	Tsol	1	Rsol	2	Tvis	1	Rvis	2	Tir	1	Emis	2	Keff
30008	GS35.ABF	# 5.9	.393	.091	.106	.369	.074	.096	.000	.840	.920	.726			

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 GS35'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.369	0.372	0.367	0.361	0.354	0.342	0.314	0.255	0.154	0.000	0.323
Rf	: 0.074	0.066	0.064	0.068	0.078	0.096	0.130	0.219	0.458	0.999	0.123
Rb	: 0.096	0.089	0.087	0.091	0.101	0.118	0.151	0.239	0.471	0.999	0.144
Tsol	: 0.393	0.395	0.390	0.384	0.377	0.364	0.334	0.272	0.163	0.000	0.344
Rf	: 0.091	0.083	0.082	0.085	0.095	0.112	0.146	0.234	0.468	0.999	0.139
Rb	: 0.106	0.099	0.097	0.100	0.110	0.127	0.160	0.247	0.477	0.999	0.153
Abs1	: 0.516	0.521	0.528	0.531	0.528	0.524	0.521	0.494	0.369	0.001	0.508
SHGCc	: 0.554	0.558	0.555	0.550	0.542	0.527	0.496	0.426	0.276	0.000	0.502
Tdw-K	: 0.131										
Tdw-ISO	: 0.265										
Tuv	: 0.001										

	Temperature Distribution (degrees C)			
	Winter		Summer	
	Out	In	Out	In
Lay1	-10.1	-8.2	43.0	43.2