



Report:

**Optical Data measurement and performance indices
calculation of a glass samples with Lite Pearl 60
applied film**

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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 Lite Pearl 60 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 Lite Pearl 60 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
Lite Pearl 60	4.93	0.491	0.145	0.145	0.610	0.132	0.140	0.88	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
Lite Pearl 60	1	5.95	5.40	0.60	0.69	0.61	480	0.003	0.191	0.411

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.

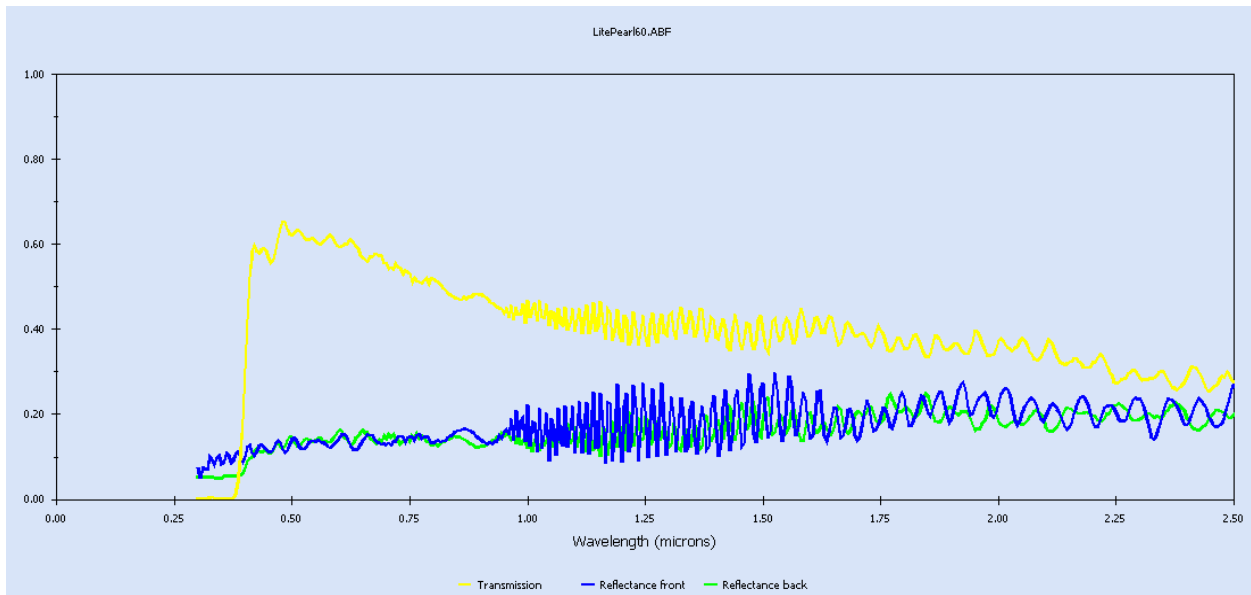


Figure 1: Spectral properties: Lite Pearl 60

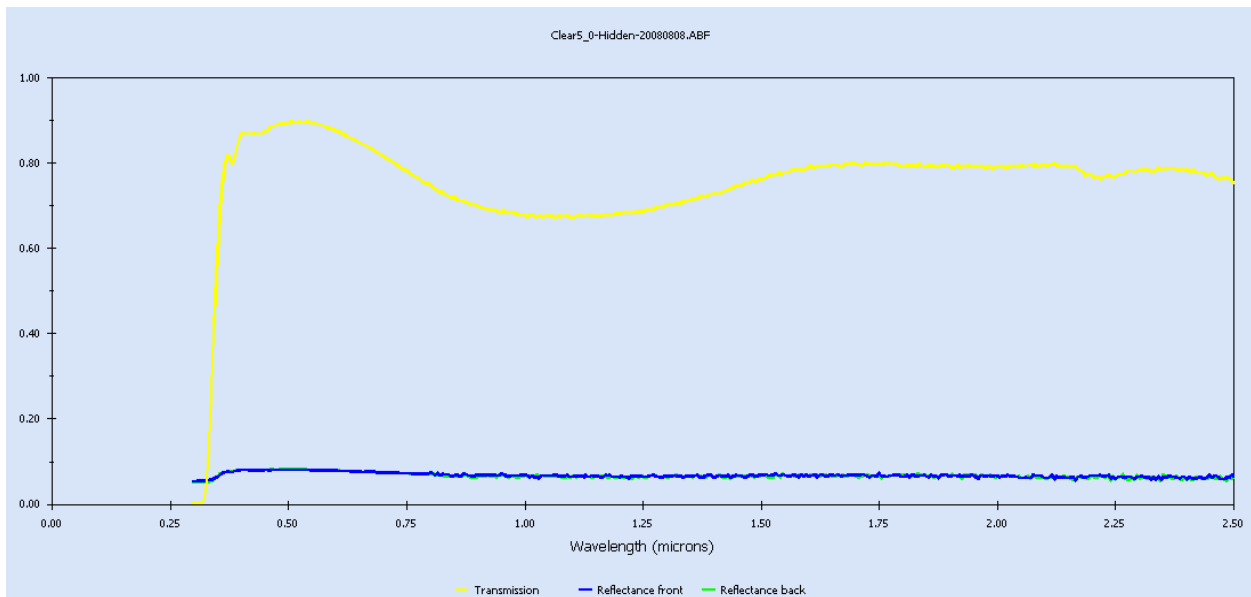


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
12:10:11

ID : 11
 Name : Lite Pearl 60
 Tilt : 90.0
 Glazings: 1
 KEFF : 0.1000
 Width : 4.930
 Uvalue : 5.95
 SHGCc : 0.60
 SCc : 0.69
 Vtc : 0.61
 RHG : 479.94

Glass and Gas Data for Glazing System '11 Lite Pearl 60'

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

Outside															
	30011FLitePearl60.ABF#	4.9	.491	.145	.145	.610	.140	.132	.000	.840	.880	.960			
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 '11 Lite Pearl 60'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.610	0.610	0.607	0.602	0.593	0.577	0.544	0.468	0.288	0.000	0.549
Rf	: 0.140	0.140	0.140	0.141	0.145	0.157	0.188	0.270	0.481	1.000	0.185
Rb	: 0.132	0.140	0.140	0.141	0.145	0.157	0.188	0.270	0.481	1.000	0.185
Tsol	: 0.491	0.490	0.488	0.483	0.475	0.461	0.434	0.375	0.233	0.000	0.439
Rf	: 0.145	0.145	0.145	0.145	0.149	0.160	0.188	0.264	0.463	1.000	0.186
Rb	: 0.145	0.145	0.145	0.145	0.149	0.160	0.188	0.264	0.463	1.000	0.186
Abs1	: 0.364	0.365	0.368	0.372	0.376	0.379	0.377	0.361	0.304	0.000	0.365
SHGCc	: 0.599	0.599	0.597	0.593	0.587	0.574	0.546	0.482	0.322	0.000	0.548
Tdw-K	: 0.191										
Tdw-ISO	: 0.411										
Tuv	: 0.003										

Temperature Distribution (degrees C)				
	Winter		Summer	
	Out	In	Out	In
Lay1	-10.1	-8.9	39.4	39.4