

A & B Films Pte Ltd contracted Carli Inc for the optical data measurement and data preparation of a glass samples with DS 15 NE 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 DS 15 NE 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
DS 15 NE	4.91	0.240	0.197	0.154	0.195	0.114	0.112	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 ² K	W/m ² K				W/m ²	Tuv	Tdw-K	Tdw-ISO
DS 15 NE	1	5.81	5.25	0.42	0.49	0.20	351	0.000	0.063	0.133

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.

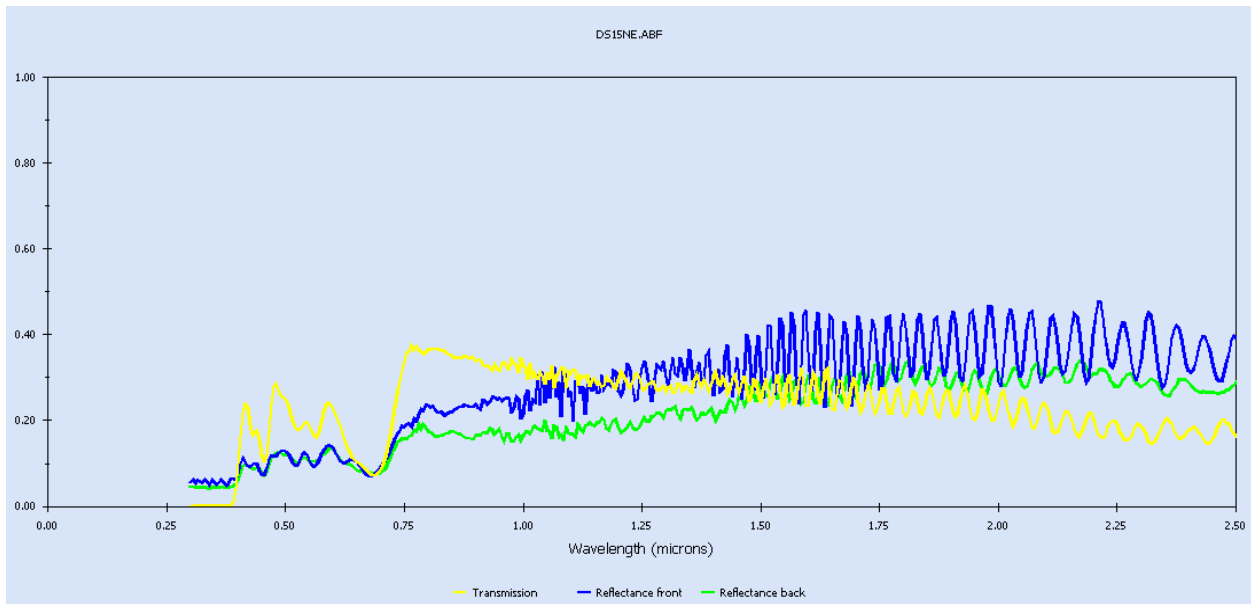


Figure 1: Spectral properties: DS 15 NE

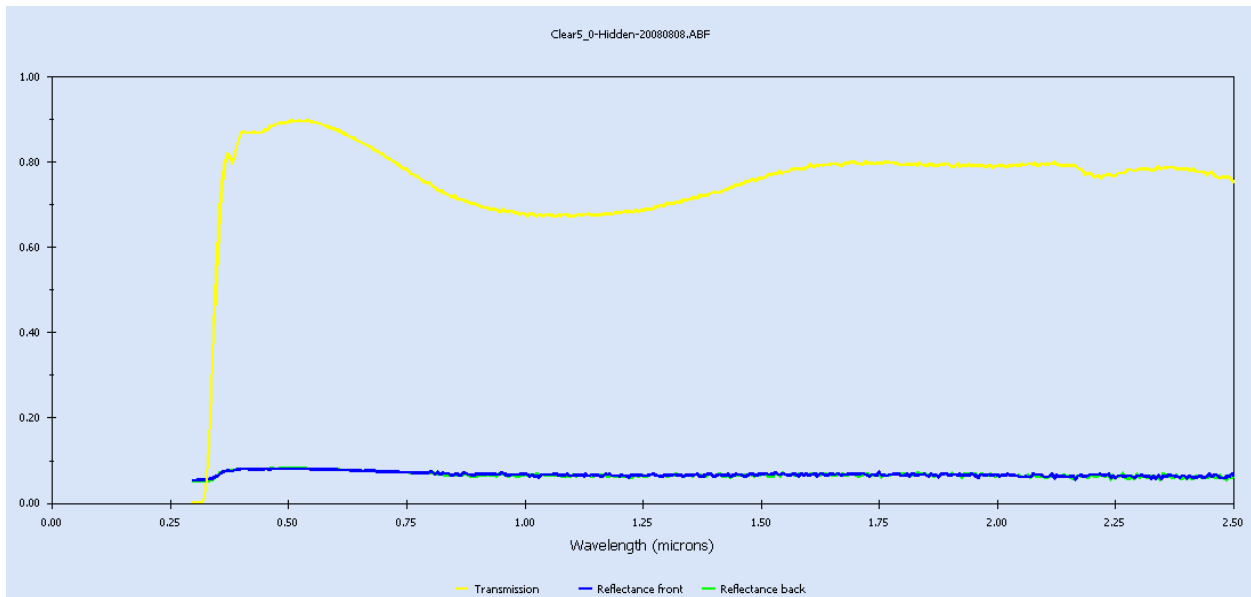


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
14:43:25

ID : 22
 Name : DS 15 NE
 Tilt : 90.0
 Glazings: 1
 KEFF : 0.1000
 Width : 4.909
 Uvalue : 5.81
 SHGCc : 0.42
 SCc : 0.49
 Vtc : 0.20
 RHG : 350.56

Glass and Gas Data for Glazing System '22 DS 15 NE'

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

Outside															
	30018FDS15NE.ABF	#	4.9	.240	.154	.197	.195	.112	.114	.000	.840	.830	.968		
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 '22 DS 15 NE'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.195	0.196	0.194	0.191	0.187	0.181	0.166	0.135	0.081	0.000	0.171
Rf	: 0.112	0.105	0.103	0.106	0.116	0.133	0.166	0.252	0.480	0.999	0.159
Rb	: 0.114	0.107	0.105	0.108	0.118	0.135	0.168	0.253	0.481	0.999	0.161
Tsol	: 0.240	0.242	0.239	0.235	0.230	0.222	0.204	0.166	0.100	0.000	0.210
Rf	: 0.154	0.147	0.146	0.149	0.158	0.175	0.206	0.288	0.505	0.999	0.198
Rb	: 0.197	0.191	0.189	0.192	0.201	0.216	0.246	0.324	0.530	0.999	0.238
Abs1	: 0.605	0.611	0.615	0.616	0.611	0.603	0.590	0.546	0.395	0.001	0.581
SHGCc	: 0.420	0.423	0.422	0.418	0.412	0.402	0.379	0.328	0.215	0.000	0.382
Tdw-K	: 0.063										
Tdw-ISO	: 0.133										
Tuv	: 0.000										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.3	-9.1	45.6	45.9