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Report:

Optical Data measurement and performance indices calculation of a glass samples with GS10 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 GS10 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 Spectrophometer 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^o and 7^o, 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^o and 7^o, 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 GS10 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
GS10	5.95	0.280	0.092	0.122	0.080	0.057	0.103	0.84	0.9

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^2K	W/m^2K				W/m^2	Tuv	Tdw-K	Tdw-ISO
GS10	1	5.90	5.37	0.48	0.56	0.08	392	0.002	0.03	0.06

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/m2
	1	NFRC 100-2002	21.0	-18.0	24.0	32.0	783

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

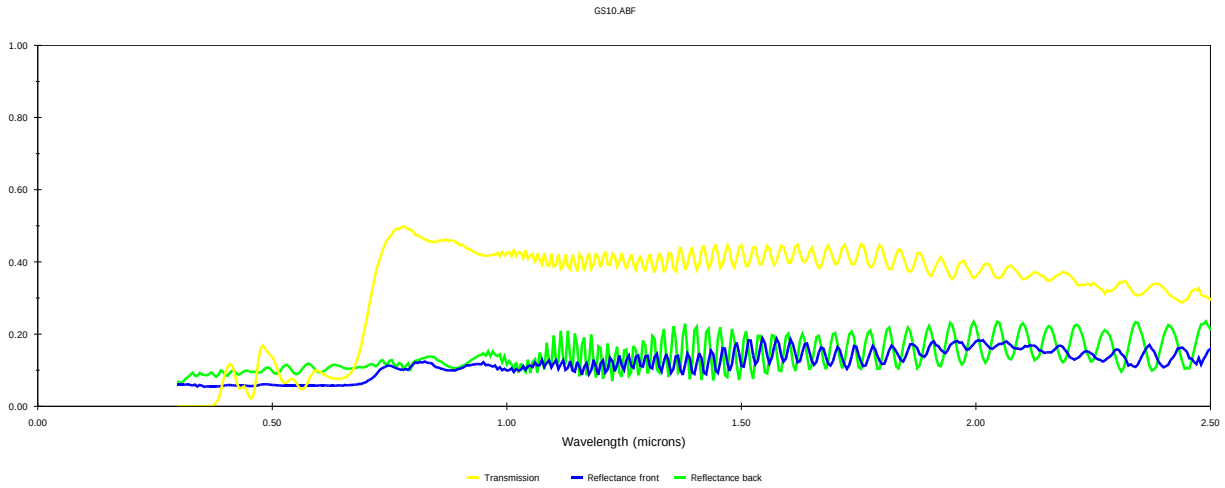

Figure 1: Spectral properties: GS10

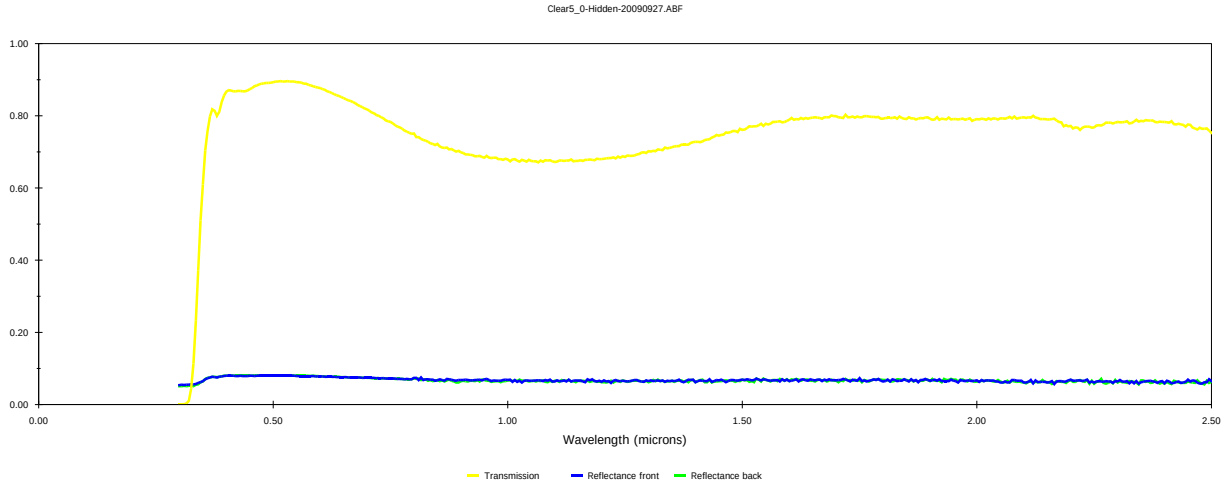

Figure 2: Spectral properties: Reference Glass sample (Substrate)

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

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Window 5.2a  v5.2.17a Glazing System Thermal and Optical Properties 09/27/09
20:41:34

ID      : 12
Name    : GS10
Tilt    : 90.0
Glazings: 1
KEFF    : 0.1000
Width   : 5.950
Uvalue  : 5.90
SHGCc   : 0.48
SCc     : 0.56
Vtc     : 0.08
RHG     : 392.05

Glass and Gas Data for Glazing System '12 GS10'

ID     Name             D(mm) Tsol  1 Rsol 2 Tvis  1 Rvis 2  Tir  1 Emis 2 Keff
------ --------------- ----- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----
Outside
 30011 GS10.ABF       #  5.9 .280 .092 .122 .080 .057 .103 .000 .840 .900 .724
Inside

Environmental Conditions: 1 NFRC 100-2002

          Tout   Tin  WndSpd   Wnd Dir   Solar  Tsky  Esky
          (C)    (C)   (m/s)             (W/m2)  (C)
         -----  ----  ------  --------  ------  ----  ----
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 '12 GS10'

Angle      0    10    20    30    40    50    60    70    80    90 Hemis

Vtc  : 0.080 0.080 0.079 0.078 0.076 0.074 0.068 0.055 0.033 0.000 0.070
Rf   : 0.057 0.050 0.048 0.051 0.062 0.080 0.114 0.206 0.448 0.999 0.108
Rb   : 0.103 0.096 0.094 0.097 0.107 0.124 0.157 0.244 0.475 0.999 0.150

Tsol : 0.280 0.282 0.279 0.274 0.269 0.260 0.238 0.194 0.117 0.000 0.245
Rf   : 0.092 0.085 0.083 0.086 0.097 0.114 0.147 0.235 0.469 0.999 0.140
Rb   : 0.122 0.115 0.114 0.117 0.127 0.143 0.176 0.261 0.486 0.999 0.168

Abs1 : 0.627 0.633 0.638 0.639 0.634 0.626 0.615 0.571 0.415 0.001 0.604

SHGCc: 0.476 0.480 0.478 0.474 0.467 0.455 0.430 0.371 0.243 0.000 0.433

Tdw-K  :  0.033
Tdw-ISO:  0.064
Tuv    :  0.002



      Temperature Distribution (degrees C)
        Winter         Summer
       Out   In       Out   In
      ----  ----     ----  ----
Lay1 -10.1  -8.3     45.8  46.2
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