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Report:

Optical Data measurement and performance indices calculation of a glass samples with GS25 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 GS25 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 GS25 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
GS25	5.95	0.351	0.084	0.103	0.267	0.063	0.090	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^2K	W/m^2K				W/m^2	Tuv	Tdw-K	Tdw-ISO
GS25	1	6.03	5.49	0.53	0.61	0.27	429	0.001	0.09	0.19

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.

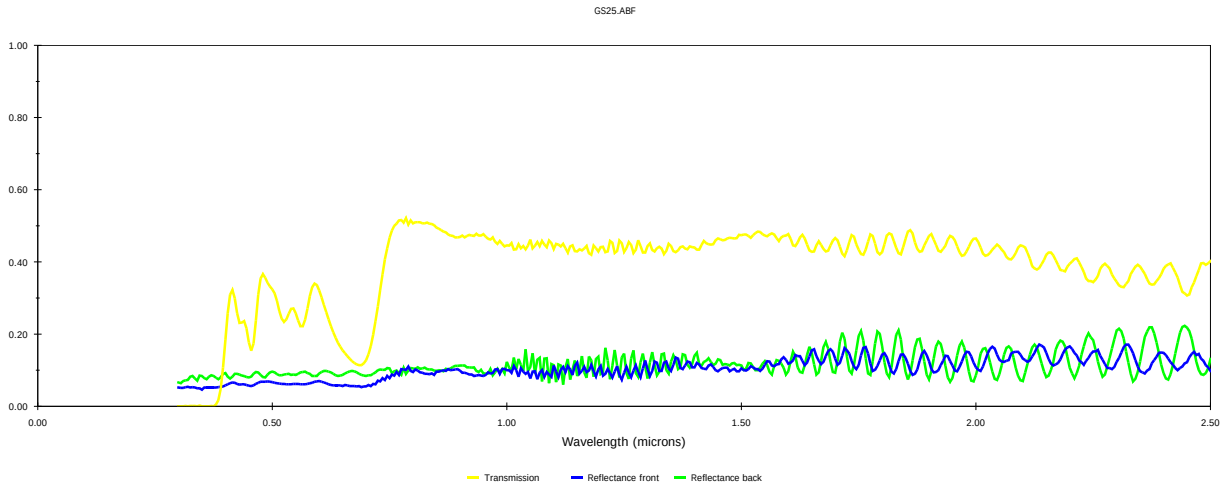

Figure 1: Spectral properties: GS25

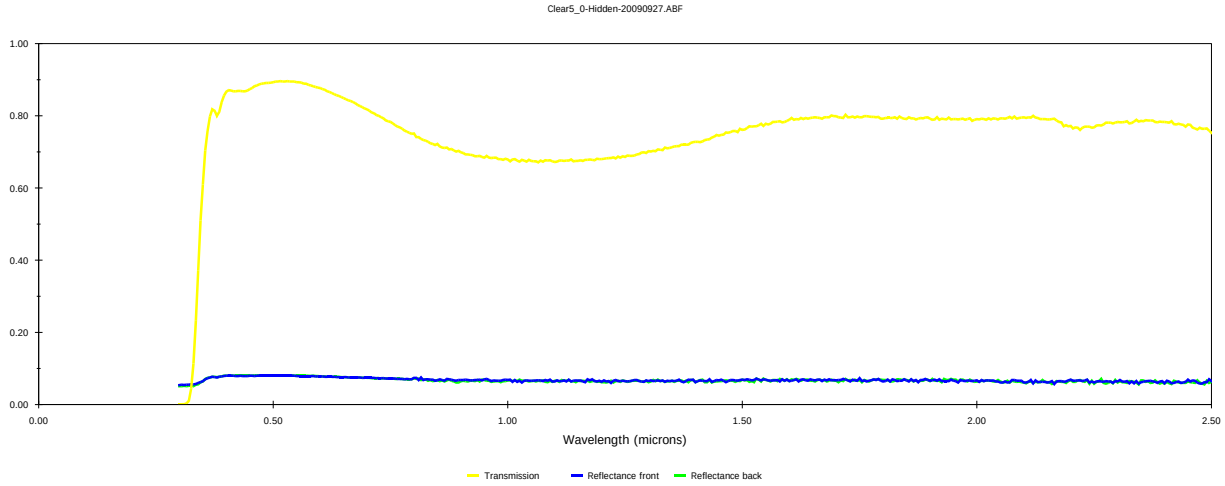

Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
20:41:32

ID      : 10
Name    : GS25
Tilt    : 90.0
Glazings: 1
KEFF    : 0.1000
Width   : 5.950
Uvalue  : 6.03
SHGCc   : 0.53
SCc     : 0.61
Vtc     : 0.27
RHG     : 429.27

Glass and Gas Data for Glazing System '10 GS25'

ID     Name             D(mm) Tsol  1 Rsol 2 Tvis  1 Rvis 2  Tir  1 Emis 2 Keff
------ --------------- ----- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----
Outside
 30009 GS25.ABF       #  5.9 .351 .084 .103 .267 .063 .090 .000 .840 .920 .978
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 '10 GS25'

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

Vtc  : 0.267 0.269 0.265 0.261 0.256 0.247 0.227 0.185 0.111 0.000 0.234
Rf   : 0.063 0.055 0.054 0.057 0.067 0.085 0.120 0.211 0.452 0.999 0.113
Rb   : 0.090 0.082 0.081 0.084 0.094 0.112 0.145 0.233 0.467 0.999 0.138

Tsol : 0.351 0.353 0.349 0.343 0.337 0.325 0.298 0.243 0.146 0.000 0.307
Rf   : 0.084 0.077 0.075 0.078 0.088 0.106 0.140 0.228 0.464 0.999 0.133
Rb   : 0.103 0.096 0.094 0.097 0.107 0.124 0.157 0.244 0.475 0.999 0.150

Abs1 : 0.565 0.570 0.576 0.578 0.575 0.569 0.562 0.529 0.390 0.001 0.550

SHGCc: 0.527 0.531 0.528 0.523 0.516 0.502 0.473 0.407 0.265 0.000 0.478

Tdw-K  :  0.091
Tdw-ISO:  0.185
Tuv    :  0.001



      Temperature Distribution (degrees C)
        Winter         Summer
       Out   In       Out   In
      ----  ----     ----  ----
Lay1 -10.0  -8.5     44.2  44.4
```