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Report:

Optical Data measurement and performance indices calculation of a glass samples with Black Chrome 20 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 Black Chrome 20 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 Black Chrome 20 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
Black Chrome 20	5.06	0.237	0.220	0.208	0.275	0.220	0.248	0.91	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^2K	W/m^2K				W/m^2	Tuv	Tdw-K	Tdw-ISO
Black Chrome 20	1	6.03	5.48	0.41	0.48	0.28	343	0.001	0.086	0.187

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.

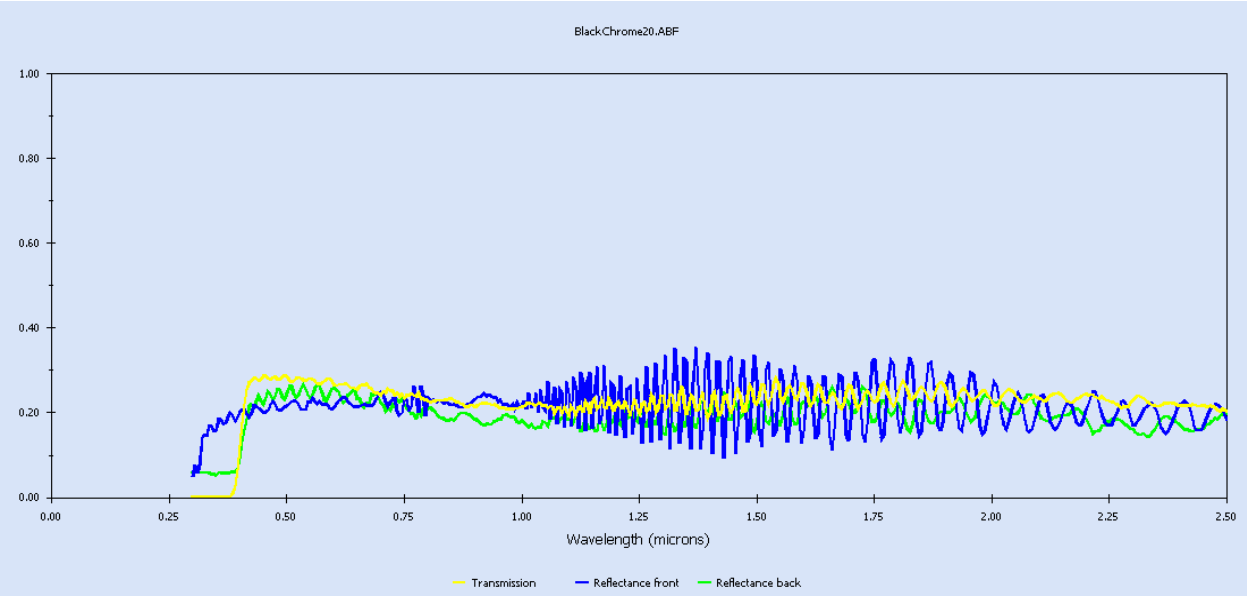

Figure 1: Spectral properties: Black Chrome 20

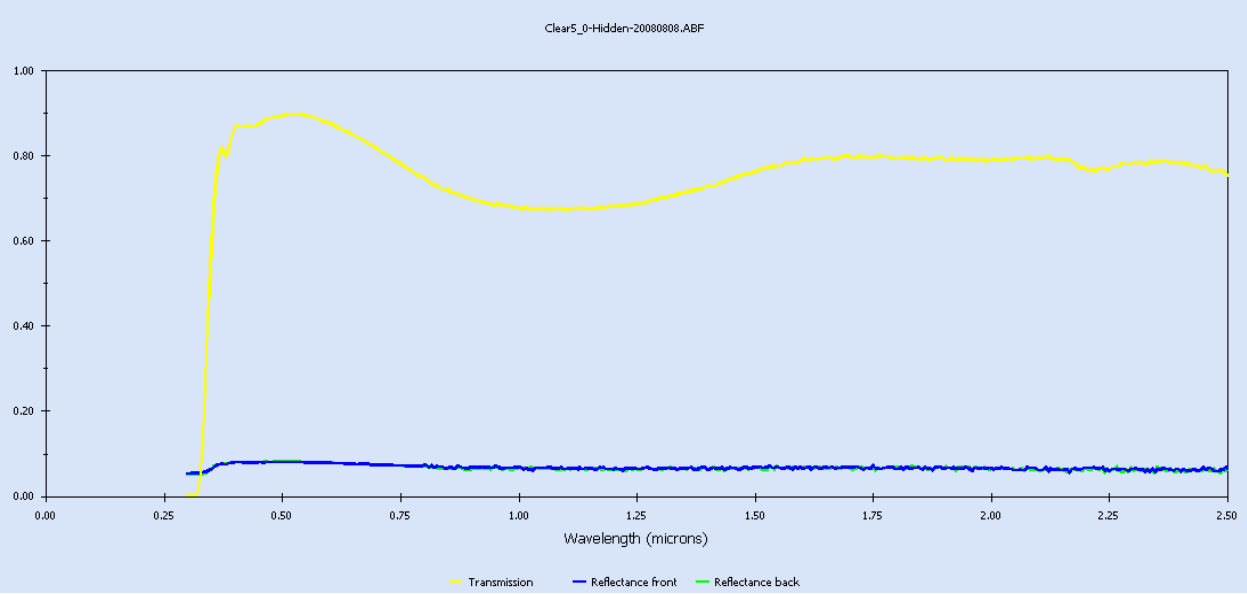

Figure 2: Spectral properties: Reference Glass sample (Substrate)

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 08/12/08
11:45:44

ID      : 2
Name    : Black Chrome 20
Tilt    : 90.0
Glazings: 1
KEFF    : 0.1000
Width   : 5.062
Uvalue  : 6.03
SHGCc   : 0.41
SCc     : 0.48
Vtc     : 0.28
RHG     : 343.39

Glass and Gas Data for Glazing System '2 Black Chrome 20'

ID     Name             D(mm) Tsol  1 Rsol 2 Tvis  1 Rvis 2  Tir  1 Emis 2 Keff
------ ---------------- ----- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----
Outside
 30028FBlackChrome20.A#  5.1 .237 .208 .220 .275 .248 .220 .000 .840 .910 .914
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 '2 Black Chrome 20'

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

Vtc  : 0.275 0.277 0.274 0.269 0.264 0.255 0.234 0.191 0.115 0.000 0.241
Rf   : 0.248 0.241 0.240 0.243 0.251 0.266 0.293 0.366 0.560 0.999 0.286
Rb   : 0.220 0.214 0.212 0.215 0.224 0.239 0.267 0.343 0.544 0.999 0.260

Tsol : 0.237 0.239 0.236 0.232 0.228 0.220 0.202 0.164 0.099 0.000 0.207
Rf   : 0.208 0.201 0.200 0.203 0.211 0.227 0.256 0.332 0.536 0.999 0.248
Rb   : 0.220 0.214 0.212 0.215 0.224 0.239 0.267 0.343 0.543 0.999 0.260

Abs1 : 0.555 0.560 0.564 0.565 0.561 0.554 0.543 0.503 0.365 0.001 0.534

SHGCc: 0.408 0.412 0.410 0.407 0.401 0.390 0.369 0.319 0.209 0.000 0.372

Tdw-K  :  0.086
Tdw-ISO:  0.187
Tuv    :  0.001



      Temperature Distribution (degrees C)
        Winter         Summer
       Out   In       Out   In
      ----  ----     ----  ----
Lay1 -10.0  -8.7     44.0  44.2
```