



Report:

**Optical Data measurement and performance indices
calculation of a glass samples with MX 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 MX 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 VarianTM Cary 500ETM UV-Vis-NIR Double Beam Spectrophotometer equipped with a 150 mm diameter LabsphereTM SpectralonTM 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-ElmerTM 9836 G IR Double-Beam IR Spectrophotometer equipped with Perking-ElmerTM 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 LaboratoryTM [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 10 cm^{-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 MX 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
MX 20	4.89	0.256	0.212	0.215	0.214	0.091	0.214	0.78	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
MX 20	1	5.67	5.10	0.41	0.48	0.21	340	0.001	0.081	0.159

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.

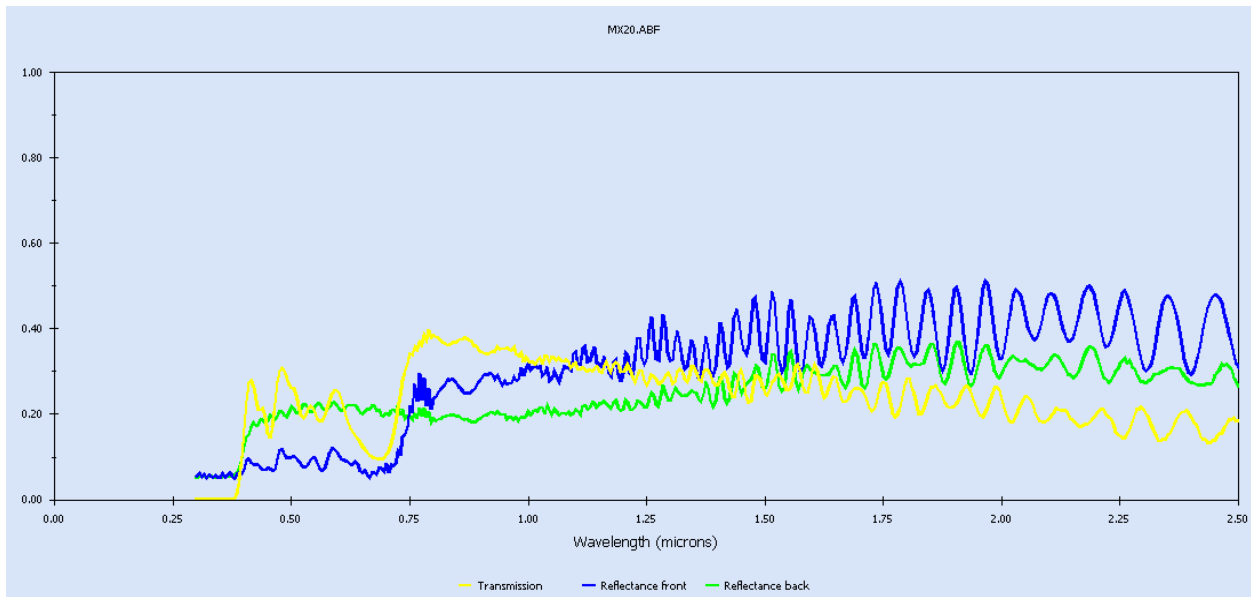


Figure 1: Spectral properties: MX 20

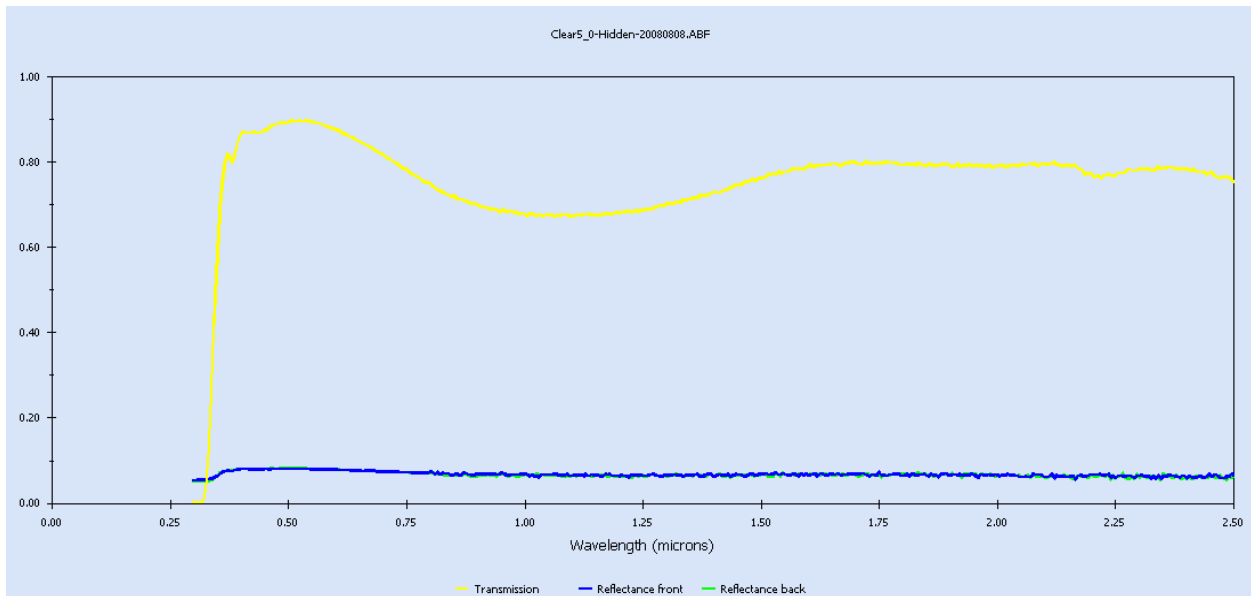


Figure 2: Spectral properties: Reference Glass sample (Substrate)

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
15:09:47

ID : 25
Name : MX 20
Tilt : 90.0
Glazings: 1
KEFF : 0.1000
Width : 4.894
Uvalue : 5.67
SHGCc : 0.41
SCc : 0.48
Vtc : 0.21
RHG : 340.10

Glass and Gas Data for Glazing System '25 MX 20'

ID	Name	D(mm)	Tsol	1 Rsol	2 Tvis	1 Rvis	2 Tir	1 Emis	2 Keff			
Outside												
	30010FMX20.ABF	# 4.9	.256	.215	.212	.214	.214	.091	.000	.840	.780	.974
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 '25 MX 20'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc	: 0.214	0.214	0.212	0.210	0.207	0.203	0.198	0.183	0.129	0.000	0.197
Rf	: 0.214	0.214	0.214	0.215	0.217	0.224	0.241	0.290	0.440	1.000	0.240
Rb	: 0.091	0.214	0.214	0.215	0.217	0.224	0.241	0.290	0.440	1.000	0.240
Tsol	: 0.256	0.256	0.254	0.252	0.249	0.245	0.238	0.220	0.155	0.000	0.237
Rf	: 0.215	0.223	0.223	0.223	0.225	0.231	0.248	0.297	0.449	1.000	0.248
Rb	: 0.212	0.223	0.223	0.223	0.225	0.231	0.248	0.297	0.449	1.000	0.248
Abs1	: 0.529	0.521	0.523	0.525	0.526	0.524	0.513	0.483	0.397	0.000	0.505
SHGCc	: 0.408	0.405	0.404	0.402	0.400	0.395	0.385	0.358	0.267	0.000	0.381
Tdw-K	: 0.081										
Tdw-ISO	: 0.159										
Tuv	: 0.001										

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-10.5	-9.4	43.9	44.1