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Bericht – Nr.: LP007/13	Gruppe Lackphysik	Seite 1 von 6

## Test report

<b>Client:</b>	Liquisol bv Noorderlaan 147 b9 2030 Antwerp Belgium BE 0648.867.048	<b>important note from the manufacturer:</b>  <b>the test results of 2 layers is only usable with a dubble application.</b> <b>The one layer result in this test is achieved at the correct application of the coating</b>
<b>Order No.:</b>		
<b>Subject of testing:</b>	1 panel with coating labeled “4EVERdark”, to measure on three spots - A: PMMA glass without coating - B: PMMA glass with single layer coating - C: PMMA glass with double layer coating	
	We received the samples on Monday, 8 <sup>th</sup> April 2013	
<b>Objective of testing:</b>	Measurement of transmission and reflection Calculation of TSR, TSA, TST and VLT using solar irradiance data according ASTM G173-03 “Reference Spectra Derived from SMARTS v. 2.9.2”	
<b>Start of tests:</b>	22.04.2013	
<b>End of tests:</b>	26.04.2013	
<b>Investigation method</b>	UV-VIS-NIR- Spectrometer Lambda 900 (Perkin Elmer) Spectral range: 250 to 2200 nm Data interval: 1 nm Slit                    3 nm Calibration (base line): 0% and 100% reflection (white standard)	

## 1. Samples

The area covered by the measurement is about 4 x 11 mm<sup>2</sup> in transmission and 5 x 12 mm<sup>2</sup> in reflection, therefore a statistically relevant area is covered by the measurements.

Sample thickness was measured by scratching away the coating and measuring the step height with a profilometer.

Sample B (1 layer) was 33 ± 4 µm thick, sample C (2 layer) 141 ± 4 µm.

## 2. Reflectance and Transmittance Spectra

Reflectance and Transmittance Spectra are shown in Fig. 1 and 2. The coated side was directed towards the incident beam.

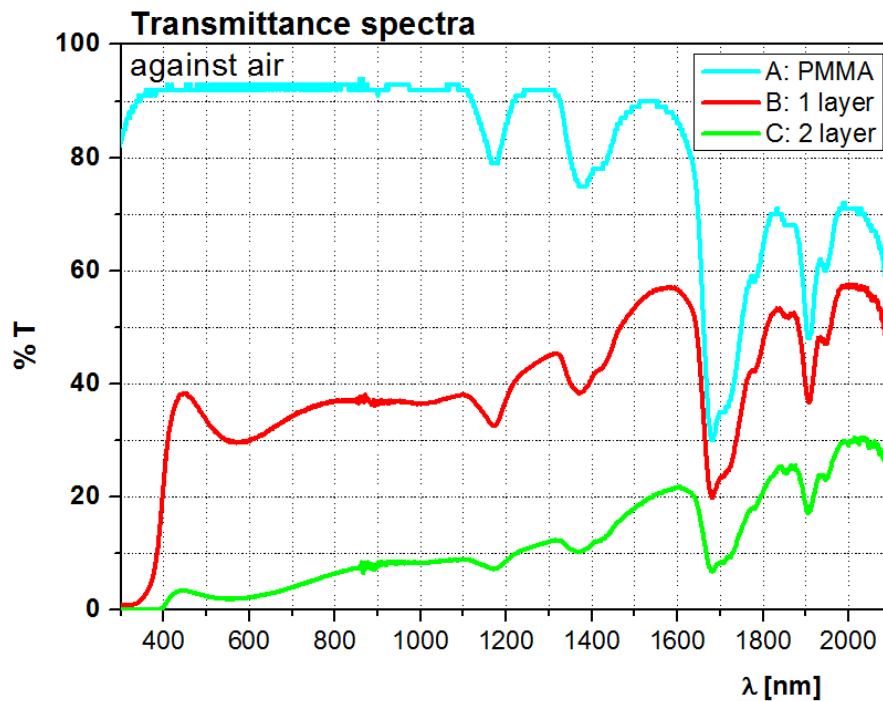


Fig. 1: Transmittance spectra against air

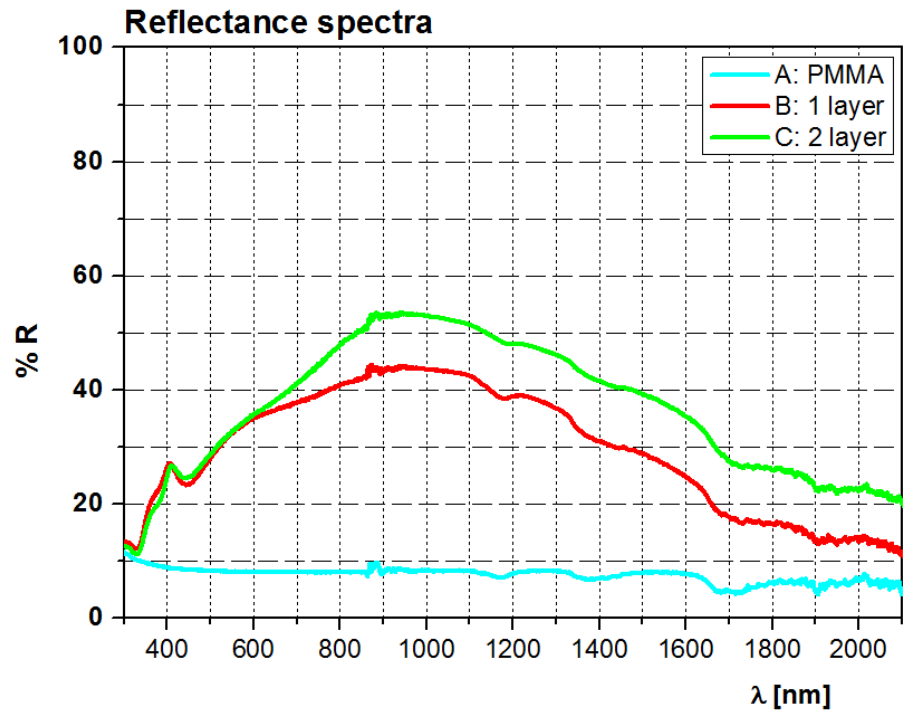


Fig. 2: Reflectance spectra against air

### 3. Calculations

Multiplying the solar irradiance data from “ASTM G173-03 Reference Spectra Derived from SMARTS v. 2.9.2” (Direct+circumsolar) with the measured transmittance (against air) and reflectance spectra, power spectra of the reflected and transmitted radiation can be calculated (Fig. 3 and 4). These spectra were integrated in the full range (300 to 2100 nm) and in the visible light region (380 to 780 nm, shown by the blue dashed lines). Results are listed in table 1 and plotted in Fig. 5.

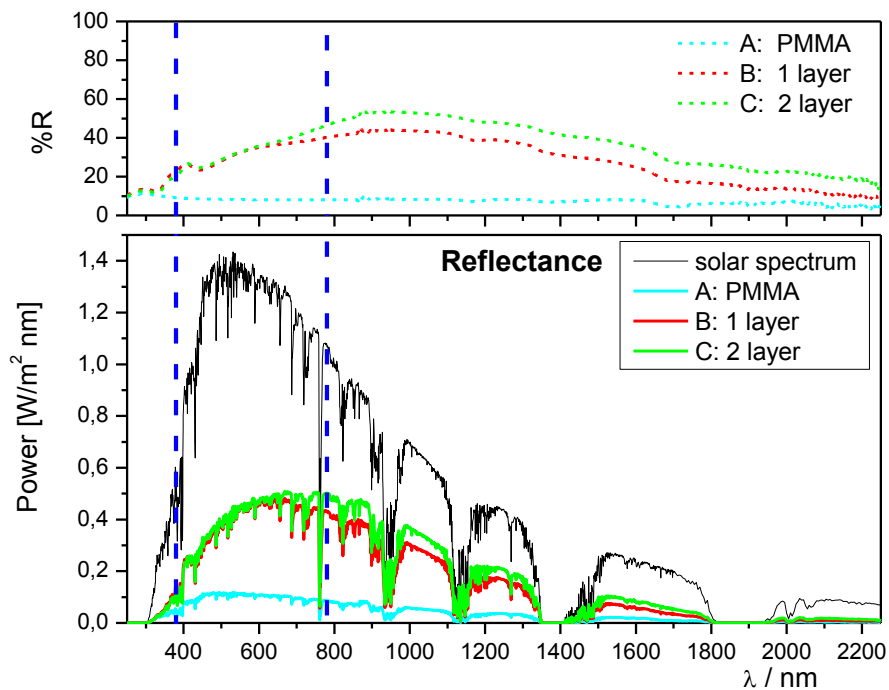


Fig. 3: Power spectrum of reflected radiation

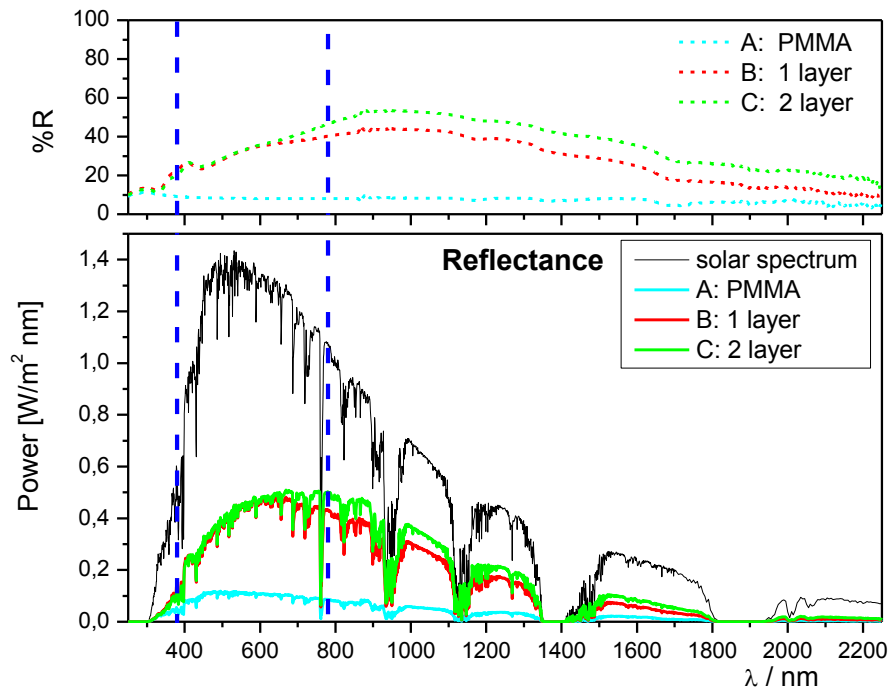


Fig. 4: Power spectrum of transmitted radiation

Table 1: TST, TSR, TSA and VLT

	Trans	Refl	Abs		Trans	Refl	Abs
	[W / m <sup>2</sup> ]				[%]		
total spectrum (300 to 2100 nm)				respect. solar: 870,0 W/m <sup>2</sup>			
PMMA	783,6	70,6	15,8		90,1	8,1	1,8
1 layer	304,6	299,9	265,5		35,0	34,5	30,5
2 layer	<del>53,3</del>	<del>341,8</del>	<del>474,9</del>		<del>6,1</del>	<del>39,3</del>	<del>54,6</del>
vis. spectrum (380 to 780 nm)				respect. solar: 467,8 W/m <sup>2</sup>			
PMMA	432,5	38,5	0		92,5	8,2	0
1 layer	152,9	152,6	162,3		32,7	32,6	34,7
2 layer	<del>13,8</del>	<del>160,0</del>	<del>294,0</del>		<del>3,0</del>	<del>34,2</del>	<del>62,8</del>

The sum of the TST and TSA of PMMA within the visible spectrum results in more than 100%. In consideration the standard deviation the TSA is therefore not negative but zero. In previous reports the TSA was about 2%.

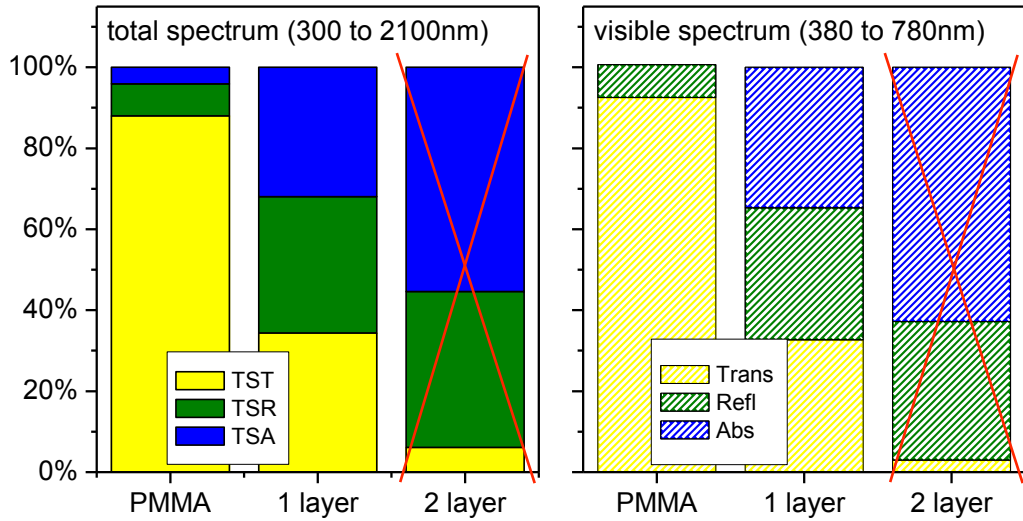


Fig. 5: Reflected, absorbed and transmitted part in percent of the radiation of the whole spectrum (300 to 2100 nm) and in the visual range (380 to 780 nm)

The test results reference to the subjects tested only. Without permission of the IPA the test report may not be published in whole or in extracts.

Stuttgart, 29.04.2013

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