IQ-TEST

Comparison of properties of clear glass from different origins

Second comparison

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1. Aim of the test

During the summer 2000, a first comparison of properties of 11 clear floatglass samples from different origins occurred in the framework of the IQ-TEST thematic network.

During this first comparison major differences were observed for a few samples of glass.

At the Plenary meeting in Athens, November 2000, it was concluded that the teams whose samples were quite away from the average should choose and use another glazing. It was decided to carry out again the spectral measurements for the glazing samples used in the window experiments.

Goal of this report is to evaluate whether or not the properties of simple float glass are sufficiently uniform, independent of the origin of the material in Europe.

For that purpose each of the participants was requested to send a sample of the clear glass that they will use for the tests.

2. Procedure

In a first step, the clear float glass samples of all participants were tested in the UV/VIS/NIR spectrophotometer of the BBRI, using a double beam integrating sphere accessory. For all samples, the normal transmittance and the near normal (8°) reflectance at both sides were measured over a range from 280 to 2500 nm.

In a second step τ_e , ρ_e , τ_v, ρ_v and τ_{UV} were calculated according to EN 410.

Finally, the double glazing properties U, g, τ_e , ρ_e , τ_v, ρ_v and τ_{UV} were calculated by the WIS (Window Information System) and a comparison was made in order to evaluate the difference in properties due to the difference in base materials.

3. Participants

1. BBRI: Gilles Flamant: 1 sample
2. BRE: Paul Baker: 1 sample
3. BTUC: Olaf Gutschker: same as 1st comparison
4. CIEMAT: Maria-José Jiménez: same as 1st comparison
5. CRES: Andreas Androutsopoulos: 1 sample
6. JRC: Hans Bloem: 2 samples
7. EMPA: Hans Simmler: 1 sample
8. TNO: Dick van Dijk; Richard Versluis: 1 sample
9. VTT: Ismo Heimonen: 1 sample
10. FGTUP: Eduardo Maldonado: 1 sample
11. Un Athens: Aris Tsangrassoulis: 3 samples

4. Pane properties

4.1 Spectral properties

4.1.1 Spectral transmittance

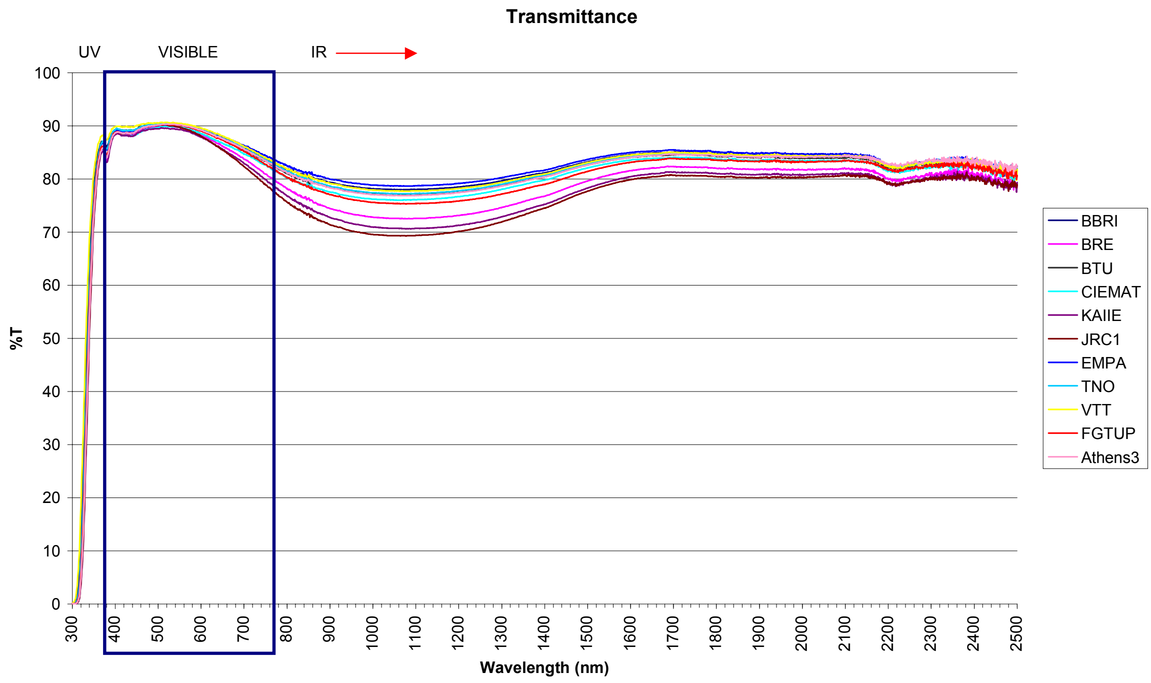


Figure 1: Transmittance, all samples

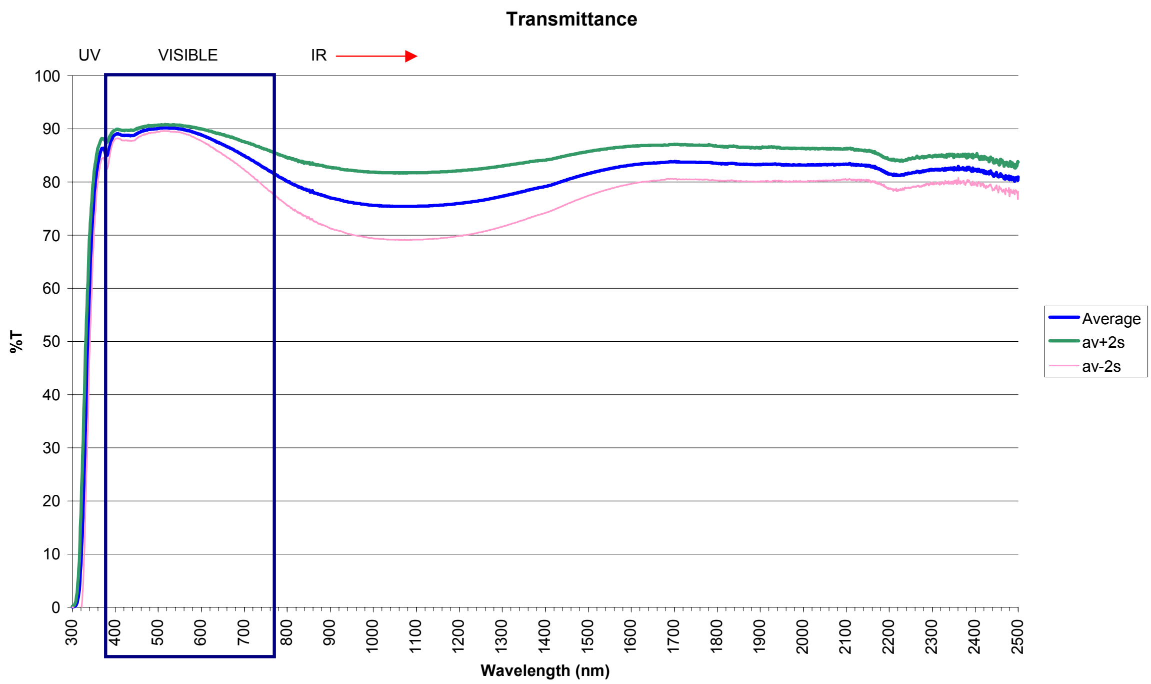


Figure 2: Transmittance, average characteristic and 2sigma curves

4.1.2 Spectral reflectance

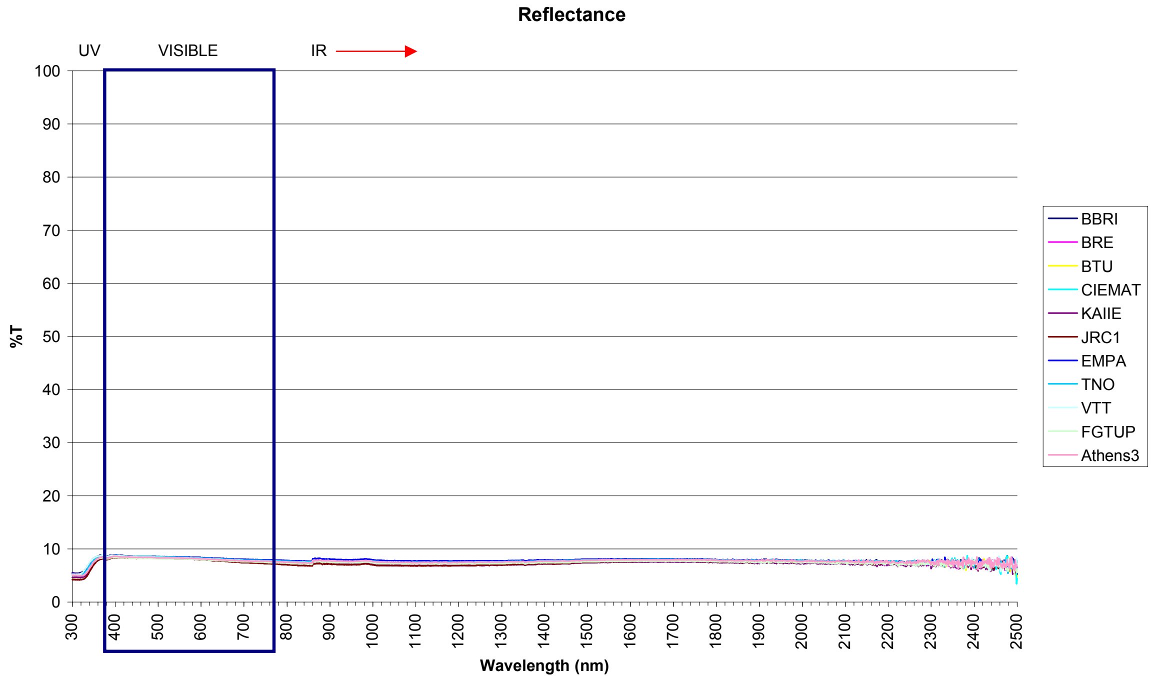


Figure 3: Reflectance, all samples

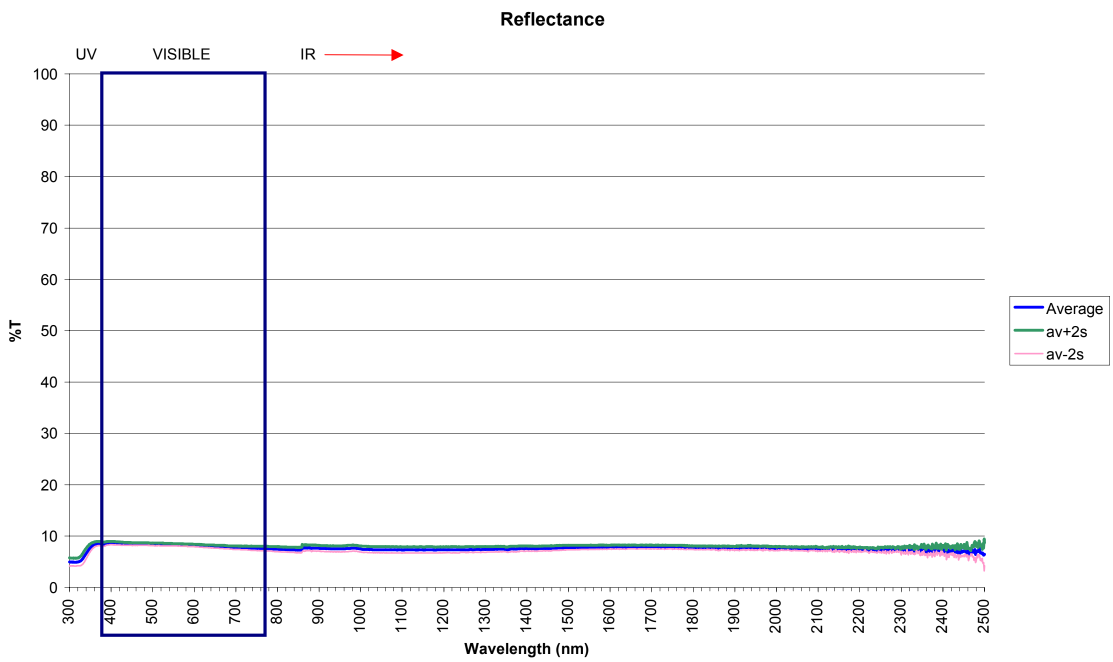


Figure 4: Reflectance, average characteristic and 2sigma curves

4.1.3 Comparison spectral data

Table 1 shows the deviations between glass samples during the previous comparison and the second comparison.

There are still relatively significant differences in the spectral behaviour of the clear glazing samples.

Although the reflectance are quite similar for all samples, the transmittance still shows relatively large deviations between samples as can be seen from Figure 1. Nevertheless the deviations in the visible and the infrared regions are lower than during the first comparison. **Figure 2** shows the average transmittance curve and the curves at -2σ and +2σ. From this curve it can be concluded that the main differences occur in the infrared region. But also the red visible light and the UV show relatively large deviations. The difference in the UV is not clear on the graph due to the steep curves, but the average 2σ in the UV is as big as that in the IR region, as can be seen in Table 1.

	1st Comparison		2nd Comparison	
	Reflectance 2*sigma (%R)	Transmittance 2*sigma (%T)	Reflectance 2*sigma (%R)	Transmittance 2*sigma (%T)
UV	0.9	4.8	0.8	4.9
VIS	0.6	1.9	0.3	1.6
IR	0.5	5.2	0.5	4.1

Table 1: average 2σ in the three spectral regions

4.2 Solar energetic and visual characteristics

Table 2 gives an overview of the measured solar and energetic characteristics of the single glass panes.

As we could expect from the spectral data differences mainly occur in the solar energetic transmittance (80,3 to 84,5 %). The visual transmittance values are much closer (88,8 to 90,2%), while the differences are most pronounced in the UV (57,1 to 67,5 %).

Participant	Sample code	Thick mm	τ_e %	ρ_e %	α_e %	τ_V %	ρ_v %	τ_{UV} %
BBRI	BBRI	4.0	84.1%	8.0%	7.9%	89.6%	8.4%	64.3%
BRE	BRE	3.84	81.6%	7.8%	10.6%	89.2%	8.3%	57.7%
BTU Cottbus	BTU	3.9	83.8%	7.9%	8.3%	89.8%	8.2%	63.3%
CIEMAT	CIEMAT	3.95	83.0%	7.9%	9.1%	89.3%	8.3%	59.2%
CRES	KAIIE	3.87	80.6%	7.7%	11.7%	88.8%	8.3%	57.1%
JRC	JRC1	3.82	80.3%	7.5%	12.2%	89.2%	8.1%	57.7%
	JRC2	*3.82*	*80.3%*	*7.6%*	*12.1%*	*89.1%*	*8.2%*	*57.6%*
EMPA	EMPA	3.83	84.4%	8.1%	7.5%	89.8%	8.5%	61.9%
TNO	TNO	3.82	83.9%	8.0%	8.1%	89.9%	8.4%	61.7%
VTT	VTT	3.82	84.5%	7.9%	7.6%	90.2%	8.3%	67.5%
Un. Porto	FGTUP	3.84	83.0%	7.7%	9.3%	89.7%	8.1%	59.9%
Un. Athens	*Sisecam*	*3.84*	*82.3%*	*7.7%*	*10.0%*	*89.3%*	*8.2%*	*58.6%*
	Salavat	*3.87*	*86.0%*	*8.0%*	*6.0%*	*90.3%*	*8.2%*	*67.6%*
	Saint-Gobain	3.88	83.6%	7.9%	8.5%	89.8%	8.2%	58.6%
	All samples							
	Min		80.3%	7.5%	7.5%	88.8%	8.1%	57.1%
	Max		84.5%	8.1%	12.2%	90.2%	8.5%	67.5%
	Average		83.0%	7.9%	9.2%	89.6%	8.3%	60.8%

Table 2: Overview of solar energetic and visual properties of the clear glass panes

Only 1 sample per team is considered (the samples indicated in italic are not considered).

4.3 Thermal properties

For all panes we supposed a similar corrected emissivity of 0.84 as prescribed for uncoated glass panes according to prEN 12898.

Thermal conductivity was assumed to be 0.8 W/mK for all samples.

5. Double Glazing Properties

In order to determine how much impact the differences on pane level would have on the double glazing reference components, the properties of a double glazing with 12 mm dry air cavity were calculated by WIS for each tested component (see Table 3).

The calculation results might be slightly different compared to the ones obtained by the European standards EN 410 and EN 673. This is mainly due to the fact that WIS uses other definitions for the outdoor and indoor environment and that it calculates the outdoor and indoor radiation exchange coefficients. The environment settings used here were:

- Temperature outdoor : 0 °C
- Temperature indoor : 20 °C
- Solar radiation : 500 W/m²
- Convection coeff. outdoor : 15 W/(m².K)
- Convection coeff. indoor : 3 W/(m².K)

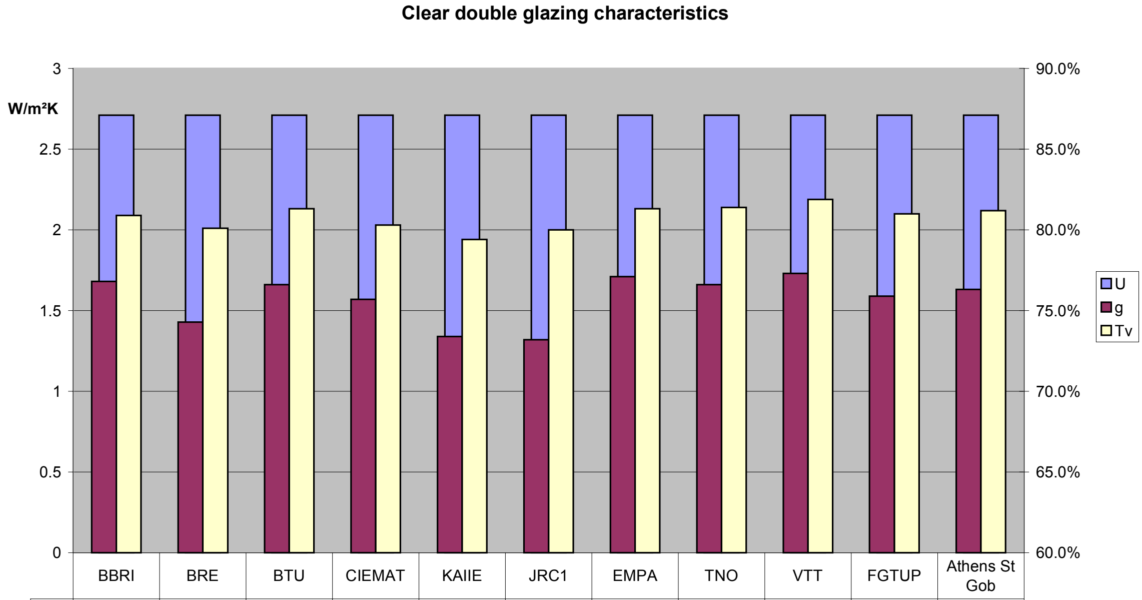
	U		τ_e	ρ_e	τv	ρ_v	τ_{UV}		g	τ_e	$T_{conv.}$	$T_{rad.}$
BBRI	2.71		71.9%	13.9%	80.9%	15.2%	49.2%		76.8%	71.9%	1.9%	2.9%
BRE	2.71		67.9%	13.1%	80.1%	14.9%	42.8%		74.3%	67.9%	2.5%	3.8%
BTU	2.71		71.4%	13.5%	81.3%	14.9%	48.3%		76.6%	71.4%	2.1%	3.1%
CIEMAT	2.71		70.0%	13.4%	80.3%	14.9%	44.1%		75.7%	70.0%	2.2%	3.4%
KAIIE	2.71		**66.5%**	12.9%	79.4%	14.9%	42.0%		**73.4%**	66.5%	2.7%	4.2%
JRC	2.71		**66%**	12.6%	80.0%	14.6%	42.7%		**73.2%**	66%	2.9%	4.3%
EMPA	2.71		72.5%	14.1%	81.3%	15.3%	46.9%		77.1%	72.5%	1.8%	2.8%
TNO	2.71		71.7%	13.8%	81.4%	15.2%	46.8%		76.6%	71.7%	2.0%	3.0%
VTT	2.71		72.6%	13.7%	81.9%	15.1%	52.7%		77.3%	72.6%	1.9%	2.8%
FGTUP	2.71		70.2%	13.1%	81.0%	14.6%	44.9%		75.9%	70.2%	2.3%	3.4%
Athens	2.71		71.1%	13.5%	81.2%	14.9%	43.5%		76.3%	71.1%	2.1%	3.1%

Table 3: Properties of a double clear glazing (WIS result)

In the first column of table 3 we can see that the central U-value is the same for all glazings, which is quite logical, due to the suppositions made about emissivity and thermal conductivity. The only difference between the panes is their real thickness (not all panes were exactly 4.0 mm), but the influence thereof is very small.

The evaluation of the solar and visual properties of the double glass leads to the same conclusion as already discussed for the individual panes. Although all glazings have similar visual properties, some differences may occur in the energetic transmittance (66 to 72.6 %).

This leads consequently to differences in the g-value (73.2 to 77.3 %) of the double glazing units. The split-up of the g-value in its directly transmitted (τ_e), convective ($T_{conv.}$) and radiative ($T_{rad.}$) component shows that the differences in direct transmittance are somewhat compensated by the indirect heat transfer. This is logical, because the differences in transmittance were mainly caused by the differences in absorptance in the mass of the glass.



	BBRI	BRE	BTU	CIEMAT	KAIIE	JRC1	EMPA	TNO	VTT	FGTUP	Athens St Gob
U	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71
g	76.8%	74.3%	76.6%	75.7%	73.4%	73.2%	77.1%	76.6%	77.3%	75.9%	76.3%
Tv	80.9%	80.1%	81.3%	80.3%	79.4%	80.0%	81.3%	81.4%	81.9%	81.0%	81.2%

Figure 5: Double clear glazing properties

The two glazings with the biggest deviation from the average value are indicated in bold (see table 3). The others find themselves in a range of g-values between 74.3 and 77.3 %. This means that 9 institutes have sent samples with g-values within a range of about 4%.

6. Conclusion

The spectrophotometric tests have shown that not negligible differences in properties of clear single and double glazing can occur, depending on the origin of the glazing. These differences are mainly due to the transmittance in the infrared region. Due to these effects, the g-value of a double clear glazing might vary between 73,2 and 77,3 %.

These differences must be taken into account when performances of test components are compared between different teams.