

**Timbers for window joinery – Part 4:  
Modified Timbers**

**Supplement 3: Kebony® Clear**

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ift - Institut für Fenstertechnik, Rosenheim

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## 1 Introduction

This supplement complements the VFF Guidance Sheet HO.06-4 “Timbers for window joinery – Part 4: Modified timbers” with proven product-specific data. This guidance sheet describes the established modification processes and specifies the property requirements for the production of dimensionally stable exterior joinery as well as suitable test methods for these properties. The properties listed hereinafter are explained by the guidance sheet which also comprises general advice. The guidance sheet also comprises a bibliography.

## 2 Scope

This supplement contains the product description of the modified timber product “Kebony® Clear“, as well as the description of a quick test method (cf. Clause 4), by the aid of which the adherence to the warranted characteristics can be checked (cf. Table B3, Clause 4, fourth line). **This supplement may only be applied in conjunction with a valid version of VFF Guidance Sheet HO.06-4 “Timbers for window joinery – Part 4 modified timbers.”**

This supplement is valid at maximum until the date stated on the cover. If the suitability has not changed, the term of validity will be prolonged correspondingly upon query at the manufacturer of “Kebony® Clear“. If the manufacturer effects any changes to a modified timber products described in a supplement to this guidance sheet, which influence the properties of the product, or should he have gathered new findings respective to individual characteristics listed in the technical description – even within the term of validity of three years – he shall submit these to the Quality Association without delay, including the appropriate proofs (test reports). Taking account of the proofs furnished by the manufacturer, the supplement will be revised accordingly and the published with a new term of validity. This also applies if the modified timber product “Kebony® Clear“ is no longer produced and this supplement has to be withdrawn.

## 3 Product description

“Kebony® Clear” is a modified wood product made from furfurylated Radiata pine (*Pinus radiata*). It is produced by the company Kebony AS, Norway and Belgium.

The assured properties of furfurylated “Kebony® Clear” are listed in Table B3. The property performances quoted in table B3 below are based on pertinent test reports, where products and components customarily used in window production were tested. **Where it is intended to use deviating constructions and/or components, their suitability and/or compatibility shall be proven by corresponding additional tests.**

### GENERAL NOTE:

Special care has to be taken when machining, processing and finishing “Kebony® Clear”. The specifications furnished by the suppliers for adhesives, coating systems, fittings, sealants, gaskets, and insulating glass shall be strictly observed. Different results may be obtained depending on the product used. **Therefore, only products authorized by the supplier may be used.** Due to the reduced wettability, drying and curing periods may need to be extended

Where available, the characteristics of untreated Radiata are quoted in comparison to “Kebony® Clear” in the table below.

According to the indices<sup>(x)</sup> the numerical values given in Table B3 are of the following types:

<sup>1</sup> Mean value, Minimum ... Maximum

<sup>2</sup> Mean value/Maximum

<sup>3</sup> Mean value/characteristic value

<sup>4</sup> Mean value/Minimum

**Table B3: Properties of furfurylated Radiata pine “Kebony® Clear”**

Property	Kebony® Clear		Application advice
<b>1. General characteristics</b>			
Timber specie(s)	Kebony® Clear: <i>Pinus radiata</i> (Radiata pine, Monterey pine: PNRD) Origin: Plantation forests		
Timber quality	For cross sections up to 25 mm x 150 mm: J10 or better. For cross sections from 25 mm x 150 mm to 42 mm x 150 mm: J10 or better on 3 faces, J30 on one face.		
<b>2. Manufacturing process</b>			
Modification process	Kebony® timber materials are initially impregnated with an aqueous solution of furfuryl alcohol (complete impregnation). The furfuryl alcohol polymerizes under the influence of heat (70-120 °C) inside the cell walls. Water uptake is reduced, and dimensional stability and durability are significantly increased by blocking the hydroxyl groups in the cell wall.		
Structure and colour changes caused by modification	The Kebony® wood produced has a higher density, hardness and mechanical resistance than the unmodified wood. It is also significantly darker in colour, which is due to the polymerization of the furfuryl alcohol. The technical properties and workability are not affected.		No impairment of the technical properties and workability of the wood.
Quality assurance	Kebony® is submitted to an internal factory production control as well as third-party supervision by Holzforschung Muenchen (HFM) according to the General Technical Approval (allgemeine bauaufsichtliche Zulassung) abZ Z-9.1-863. Sufficient treatment is ensured by controlling the chemical composition, penetration and equilibrium moisture content (EMC).		
Simple procedure for testing guaranteed properties	Determination of surface swelling on test pieces of the dimensions (20 x 20 x 8) mm after three days' submersion in water. Maximum surface swelling may not exceed 5,5 % for test piece stored under ambient conditions resp. 8 % for oven-dried test pieces.		Cf. also clause 4
<b>3. Material properties</b>			
<b>3.1 Physical properties</b>			
Resistance against wood destroying fungi	Kebony® Clear		Evaluated according to EN 350 and tested according to CEN/TS 15083-1 and -2 Modification includes the complete sapwood area.
	Class 1-2		
Resistance against blue stain	Radiata		Protection against blue stain required.
	Class 4-5		
Resistance against blue stain	Not tested		Protection against blue stain required.
Density <sup>1</sup> (at 20 °C/65 % relative humidity)	g/cm <sup>3</sup>	Kebony® Clear	Checking of density required during receiving inspection and testing.
		0,59 ... 0,63 ... 0,66 g/cm <sup>3</sup>	

Property		Kebony® Clear		Application advice	
Equilibrium wood moisture <sup>2</sup> (at 20 °C/ 65 % relative humidity)	%	Kebony® Clear	Radiata	Estimation of moisture content with electrical resistance meters (EN 13183-2) is not possible due to changed conductivity.	
		6,6 % 6,2 ... 7,0% (Adsorption)	11,3 ... 11,8 %		
		Determination gravimetrically according to EN 13183-1. Estimation by the capacitance method possible. Set the meter to a density of 0,6 g/m <sup>3</sup> .			
Swelling and shrinkage properties <sup>2</sup>		Kebony® Clear	Radiata		
		Swelling from dry to 95 % relative humidity			
Radial	%	2,20	3,86		
Tangential	%	1,90	3,56		
Axial	%	0,28	0,96		
Max. swelling in volume	%	not specified	not specified		
Capillary water uptake <sup>2</sup>		Kebony® Clear	Radiata		
Radial	kg/m <sup>2</sup> .h <sup>0,5</sup>	not specified	not specified		
Tangential	kg/m <sup>2</sup> .h <sup>0,5</sup>	0,06	0,44		
Axial	kg/m <sup>2</sup> .h <sup>0,5</sup>	0,43	7,83		
Resistance to fire		Euroclass D acc. EN 13501-1			
Thermal conductivity (λ <sub>D</sub> -value)	W/mK	0,16			
<b>3.2 Mechanical properties</b>					
Bending strength <sup>3</sup>	N/mm <sup>2</sup>	Kebony® Clear	Radiata		
		52,3 ... <b>71,5</b> ... 90,7	Average: 43,0 Minimum: 25,8		
Modulus of elasticity in bending <sup>3</sup>	N/mm <sup>2</sup>	Kebony® Clear	Radiata		
		9.600 ... <b>12.500</b> ... 15.400	9060 /5200		
Compression strength parallel and perpendicular to grain <sup>3</sup>	N/mm <sup>2</sup>	Kebony® Clear	Radiata		
		Axial	76,4		42,5 / 31,5
		Radial	18,1		5,0 / 4,5
		Tangential	20,2	3,3 / 2,4	
Impact bending <sup>3</sup>	kJ/m <sup>2</sup>	Kebony® Clear	Radiata		
		27,0 / 10,6	48,0 / 20,0		
Resistance to axial withdrawal of screws <sup>4</sup>	kN		Kebony® Clear	Radiata	
		3,5 mm-screw	251,5	173,9	
		4,2 mm-screw	257,8	174,8	
		Measured radially, thickness 22 mm.			
Surface hardness <sup>4</sup> (Janka)	kN	Kebony® Clear	Radiata		
		6,1 ... 7,2 ... 8,3	2,7 / 1,6		
<b>3.3 Chemical properties</b>					
Registration, evaluation and accreditation of chemicals (REACH)		Registered number of furfuryl alcohol: EC202-626-1			
<b>4. Suitability for window construction</b>					
<b>4.1 Suitability as a component for windows</b>					
Suitability for laminated and/or finger-jointed constructions		A proof of suitability of the system used is required. Three-layer scantlings made from Kebony® Clear and spruce, finger-joints, mortice-and-tenon corner joints fulfilled the tests required by the ift-guideline.			
Bonding strength of adhesives		In general, no differences with untreated softwoods		Use products authorized by the manufacturer only.	

Property	Kebony® Clear	Application advice
Compatibility with surface coatings	After 12 months natural weathering, tests according to ISO 4628 showed no damages on the coating systems tested. Treatment with opaque and translucent coatings is possible. Even after testing under an alternating atmosphere, no problematic surface deteriorations were observed. When using opaque coatings, “telegraphing” of the wood surface is possible.	It is recommended to use acrylic-based paints.
Compatibility with fittings and fasteners	Where corrodible metals are used, discoloration of the surfaces may occur.	It is recommended to use stainless-steel fittings and fasteners (A2 or A4 quality).
Compatibility with sealants (adhesion)	WG 1: Neutral silicone: no interference observed WG 2: Alkoxy silicone: no interference observed WG 3: MS sealant: <b>restricted suitability!</b>	No difference in comparison to unmodified spruce.
Compatibility with gaskets (sealing profiles)	WG 1: Polyethylene, polypropylene: no tests carried out WG 2: Silicone rubber: no interference observed WG 3, WG 4: Thermoplastic elastomers: no interference observed WG 5: Soft PVC: <b>unsuitable</b>	Do not use PVC profiles
Compatibility in contact with the insulating glass seal	Polyisobutylene: restricted suitability Polysulfide: restricted suitability Polyurethane: restricted suitability Silicone rubber: no interference observed	Independent on species and modification, the following interferences were observed: Polyisobutylene: interlocking/difficult release between test piece and sealing Polysulfide, Polyurethane: Softening of the coating (opaque/ translucent) Use products authorized by the manufacturer only.
Tips on processing Sawing, moulding, cutting drilling, torque for screwing, etc.	Due to the increase in density, the machining of Kebony® wood materials is comparable to that of high-density hardwoods (e.g. oak, black locust (Robinia))	Sharp cutting tools should be used, because otherwise fibre chip-out is possible.
Development of dust	Due to the brittleness of the material, the amount of dust fines is significantly increased in comparison to non-modified timber.	During comparative measurements of the Timber Employers liability insurance association (Holz-Berufsgenossenschaft) in a manufacturing plant, the maximum workplace concentrations (MAK-values) were not exceeded.
Emissions during woodworking (volatile organic compounds for which MAK-values are in force)	During machining of unfinished Kebony® Clear acetic acid and furfural may be emitted.	During comparative measurements of the Timber Employers liability insurance association (Holz-Berufsgenossenschaft) in a manufacturing plant, the maximum workplace concentrations (MAK-values) were not exceeded.
Recycling of product residues, ordinance on used wood	Untreated Kebony® wood: Used wood category A I Glued and/or coated Kebony® wood (without halogenated organic compounds): Used wood category A II.	Kebony® is exempt from the European Biocide Ordinance and may therefore be treated as untreated wood.

Property	Kebony® Clear	Application advice
Substances of high concern acc. REACH (“candidate list”) hazardous substances acc. TRGS 900	Registration for furfuryl alcohol fulfilled.	
<b>4.2 Suitability as end product (wood window)</b>		
Glueing and corner strength	Tests were carried out on a Kontec corner joint made of Kebony® Clear using a “propeller adhesive”. The corner joint system tested fulfils the requirements of ift guideline FE-08/1 and may be used up to a total casement weight of $G \leq 180$ kg.	It is recommended to use PUR- or “propeller” adhesives
Natural weathering of windows (vertical position)	After 12 months natural weathering, tests according to ISO 4628 showed no damages on the coating systems tested.	
<b>5. Final product</b>		
Emission testing (chamber testing)	Chamber tests carried out on window scantlings made from Kebony® Clear showed increased emissions of furfural and acetic acid. Expected indoor air concentrations are, however, very low	Residual emissions of acetic acid from surface coated Kebony® Clear are in general lower than the odour detection threshold

## 4 Testing procedures

### 4.1 Visual Tests

E.g. specifications on the delivery note, marking of the products/packages (batch no.), date of treatment, etc.

### 4.2 Quick test

#### 4.2.1 Introduction

Procedure for the determination of surface swelling of furfurylated wood in order to determine material quality.

#### 4.2.2 Testing apparatus

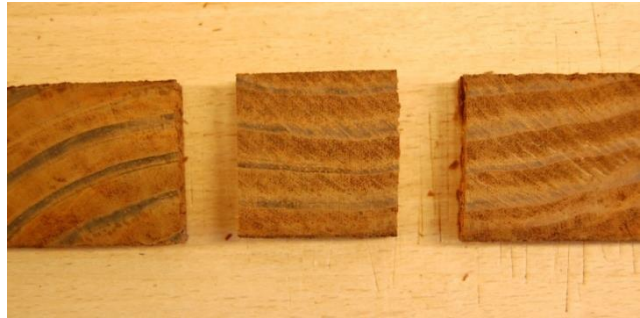
- Dial gauge or sliding calliper with a measuring range of 25 mm, a graduation of 0,01 mm, an accuracy of  $\pm 0,03$  mm and a reproducibility of 0,01 mm.
- Cutting saw
- Sanding machine
- Permanent marker
- Water tank with cold water ( $20 \pm 2$  °C)



#### 4.2.3 Sampling and dimensions of test pieces

For the purposes of this test, a piece of 8 mm thickness is cut from the cross-section of a Kebony® board. In order to achieve a valid result, 20 test pieces shall be prepared.

Test pieces of about 25 × 25 mm are cut from the 8mm thickness board. The test pieces shall be cut from the board in such a way, that the growth rings are parallel to one edge of the 25 × 25 mm test piece, as on the example in the middle of figure B.3.



**Figure B3:** Test pieces with parallel growth rings

The selected test pieces are sanded down to a dimension of 20 × 20 mm on a sanding machine. The measuring points for the measurements of radial and tangential length are marked on the edges of the test pieces. The measuring points must be visible after immersion in water therefore they have to be permanently marked.

#### 4.2.4 Execution of the test

The test pieces are immersed in the water tank, where they are left for three days. Care shall be taken that the test pieces are completely immersed in water.

#### 4.2.5 Measurements and records

Each test piece is measured before and after immersion with the dial gauge or the sliding calliper. The following measurements shall be recorded:

- Radial length before ( $L_r$ ) and after water immersion ( $L_{wr}$ )
- Tangential length before ( $L_t$ ) and after water immersion ( $L_{wt}$ )

#### 4.2.6 Calculations

By multiplication of the respective dimensions ( $L_r \times L_t$ , resp.  $L_{wr} \times L_{wt}$ ), the surface before ( $A_i$ ) and after ( $A_w$ ) water immersion is calculated for each test piece in  $\text{mm}^2$ .

Subsequently, relative surface swelling is calculated in percent for each test piece according to the following equation:

$$\text{Swelling (\%)} = 100 \times ((A_w - A_i) / A_i)$$

Finally, the average relative swelling of all 20 test pieces is calculated according to the following equation:

$$\text{Average swelling (\%)} = \text{sum (individual swelling values (\%))} / 20$$

#### 4.2.7 Requirements

The average swelling determined by this procedure may not exceed 5,5 %. If a value > 5,5 is obtained, this indicates that the product tested does not fulfil the requirements of Kebony®.

NOTE: If there are any doubts about the results of this test or the validity of the procedure, the complete testing procedure may be repeated on oven-dry test pieces. In this case, average swelling may not exceed 8 %.

#### Literature cited

EN 350	Durability of wood and wood-based products. Testing and classification of the durability to biological agents of wood and wood-based materials
CEN/TS 15083-1	Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 1: Basidiomycetes
CEN/TS 15083-2	Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 2: Soft rot fungi



Verband Fenster + Fassade  
Gütegemeinschaft Fenster,  
Fassaden und Haustüren e.V.  
Walter-Kolb-Straße 1-7  
60594 Frankfurt am Main  
Telefon: 069 / 95 50 54 - 0  
Telefax: 069 / 95 50 54 - 11

Homepage <http://www.window.de>  
E-Mail: [vff@window.de](mailto:vff@window.de); [ral@window.de](mailto:ral@window.de)

