Title: Paintability of Accoya™ wood

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SHR Timber Research
"Het Cambium"
Nieuwe Kanaal 9b
PO Box 497
6700 AL Wageningen

Tel: + 31 317 467366
Fax: + 31 317 467399

E-mail: n.lutkeschipholt@shr.nl

Principal: Titan Wood B.V.
PO Box 2147
6802 CC Arnhem

Appendices: 2

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Authors:

N. Lutke Schipholt, M.Sc
Project manager

Mr. W.N.H. Cobben
Research Assistant

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Summary

Titan Wood B.V. commissioned SHR Timber Research to determine the paintability of Accoya™ wood according to SKH Publication 97-04. The technology behind Accoya™ wood is based on wood acetylation. In this investigation Accoya™ wood was tested as part of the research scheme for KOMO certification BRL 0605 “Modified Timber”.

Based on the results, it can be concluded that the paintability of Accoya™ wood is good for the tested coating formulations based on alkyd emulsion (transparent) and acrylic dispersion (opaque). For the tested hybrid coating system (opaque) the wet adhesion is considered to be critical.

In general Accoya™ wood can be successfully finished with opaque and transparent alkyd emulsion and acrylic dispersion coating systems. For hybrid coating systems, wet adhesion might be critical in some joinery applications. However, since only a few coating systems were tested in this investigation, it is strongly recommended that the dry and wet adhesion of the coating layer on Accoya™ wood should be systematically determined for each “new” coating product.

Contents

1 Assignment

Titan Wood B.V. appointed SHR Timber Research to determine the paintability of Accoya™ wood. The technology behind Accoya™ wood is based on wood acetylation, a chemical modification process that improves the dimensional stability, UV-stability and durability of wood. The process modifies the wood without the addition of toxic chemicals. Accoya™ wood's durability and dimensional stability can be determined after the acetylation process has taken place by analysing the wood's acetyl content.

In co-operation with the Dutch certification body, SKH, and research institute, SHR Timber Research, Titan Wood has established a research scheme to independently prove the quality of Accoya™ wood. This scheme consists of:

1. KOMO certificate BRL 0605 "Modified Timber". Here the emphasis is on the uniformity and reproducibility of the production process, as well as on Titan Wood's quality system.

2. Fulfilment of the requirements for materials in certified Dutch joinery as listed (SKH Publication 97-04). Emphasis is on material properties, such as durability, dimensional stability and paintability.

In this research the paintability of Accoya™ wood was tested as part of the research scheme described above.

2 Materials and test method

2.1 Identification and description of the samples

Accoya™ wood samples (original wood species Radiata Pine) were taken from 2 batches produced in Titan Wood's pilot plant (13 - 14 samples per batch), originating from different boards. In total, 27 samples of Accoya™ wood were tested, each with a dimension of 12 x 75 x 500 mm (thickness x width x length). The codes of the samples and the correlating batch numbers can be found in appendix 1. When required for a specific test, the samples were cross cut to dimensions of 12 x 75 x 150 mm after paint application and the end grains were sealed with a two component sealer.

2.2 Procedure

The paintability of Accoya™ in respect to opaque and transparent film forming coatings was tested according to SKH Publication 97-04. The tests were performed with an opaque hybrid system, an opaque acrylic dispersion and a transparent (in a critical color) alkyd emulsion coating system that are admitted for use in the production of KOMO certified joinery products. These paints have been extensively tested according to SKH Publication 99-02 (opaque coating systems) or SKH Publication 00-01 (transparent coating systems) in respect to laboratory and outdoor performance on Spruce or Oregon pine.

The opaque paint systems were applied in two layers using airless spraying, with a total dry layer thickness of 100 µm, according to appendix 5: “Praktijkrichtlijn: grondlaksysteem I” of BRL 0801.
The transparent paint system was applied in three layers using airless spraying, with a total dry layer thickness of 140 µm, according to appendix 5: “Praktijkrichtlijn: voorlaksysteem II” of BRL 0801.
All samples were dried according to appendix 5: “Praktijkrichtlijn: grondlaksysteem I of voorlaksysteem II” of BRL 0801.

Finished Accoya™ panels were subjected to the following tests:

- Dry and wet adhesion: adhesion of the coating layer to the wood substrate was tested according to SKH Publication 05-01 after the finished samples were conditioned at 23 °C and 50% RH for one week. The dry adhesion was determined on three samples for each coating system and each batch, whereas the wet adhesion was tested on 16 to 18 separate samples where up to eight replicates were tested.
- Discharging of volatile deposits: three samples (end grains were sealed) for each coating system and each batch were irradiated by infrared radiation to a surface temperature of 70 °C for 48 hours. After exposure the samples were visually evaluated for bleeding of wood extractives and other volatile extractives and coating defects. After exposure the dry adhesion was also determined according to SKH Publication 05-01.
- Blistering test: three samples (end grains were sealed) for each coating system and each batch were placed in a blistering cabinet for ten days. The coated surface was exposed to a climate of 23 °C and 50% RH, whereas the unfinished side was exposed to a water bath of 40°C. After exposure the samples were visually evaluated on the degree of blistering according to ISO 4628-2, as well as other (possible) coating defects. The amount of water uptake was determined by weighing the samples before and after the test.

3 Results and Discussion

3.1 Dry and wet adhesion

In table 1, the dry and wet adhesion of the coating layer to the Accoya™ wood substrate per coating system and per batch are summarized, expressed in percentages for samples with good, critical and bad adhesion. All individual values can be found in appendix 2.

Table 1. The dry and wet adhesion of Accoya™ wood per coating system and per batch. The results are expressed in percentage of samples with good, critical and bad adhesion.

Coating system	Batch	Dry adhesion*			Wet adhesion*		
		good	critical	bad	good	critical	bad
Hybrid primer opaque	LG 110	100%	0%	0%	60%	40%	0%
	LG 127	100%	0%	0%	89%	11%	0%
Alkyd emulsion transparent	LG 110	100%	0%	0%	100%	0%	0%
	LG 127	100%	0%	0%	100%	0%	0%
Acrylic dispersion opaque	LG 110	100%	0%	0%	100%	0%	0%
	LG 127	100%	0%	0%	100%	0%	0%

** adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. A good adhesion is class 0 and 1, a critical adhesion is class 2 and 3, a bad adhesion is class 4 and 5.*

3.2 Discharging of volatile deposits

In table 2 the results of the discharging of volatile deposits are shown. None of the samples showed bleeding or other coating defects at all. The dry adhesion was good for all coating systems. In appendix 3 all individual data is shown.

Table 2. Discharging of volatile deposits of Accoya™ wood and dry adhesion per coating system and per batch after infrared radiation.

Coating system	Batch	Discharging of volatile deposits	Dry adhesion*
Hybrid primer opaque	LG 110	none	good
	LG 127	none	good
Alkyd emulsion transparent	LG 110	none	good
	LG 127	none	good
Acrylic dispersion opaque	LG 110	none	good
	LG 127	none	good

** adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5.*

3.3 Blistering test

In table 3 the results of the blistering test are summarized. In appendix 3 all individual data is shown. None of the samples showed blisters, discoloration or other coating defects. The water uptake was measured by weighing the individual panels before and directly after the blistering test. In the standard no demands are set for the maximum water uptake during the test. The detailed results for the water uptake are shown in appendix 4.

Table 3. Blistering, other visual defects and water uptake of Accoya™ wood per coating system and per batch

Coating system	**Batch**	**Blistering***	**Other visual defects**	**Water uptake [g]** Avg (stdev)
Hybrid primer opaque	LG 110	none	none	41 (4)
	LG 127	none	none	33 (3)
Alkyd emulsion transparent	LG 110	none	none	39 (4)
	LG 127	none	none	39 (10)
Acrylic dispersion opaque	LG 110	none	none	42 (8)
	LG 127	none	none	32 (3)

**blistering of the coating layer has been determined according ISO 4628-2. No blistering is expressed as "0", while blistering is expressed by a number for density and size (in example 1S2; density class 1, size class 2).*

4 Conclusion

Based on the results, it can be concluded that the paintability of Accoya™ wood is good for the tested coating formulations based on alkyd emulsion (transparent) and acrylic dispersion (opaque). For the tested hybrid coating system (opaque) the wet adhesion is considered to be critical.

In general Accoya™ wood can be successfully finished with opaque and transparent alkyd emulsion and acrylic dispersion coating systems. For hybrid coating systems, wet adhesion might be critical in some joinery applications. However, since only a few coating systems were tested in this investigation, it is strongly recommended that the dry and wet adhesion of the coating layer on Accoya™ wood should be systematically determined for each "new" coating product.

References

BRL 0605 (dated 31-01-2003). National Assessment Directive for the KOMO® Product Certificate Modified Timber. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

ISO 4628-2 (1982). Paints and varnishes / Evaluation of degradation of paint coatings / Designation of intensity, quantity and size of common types of defect / Part 2: Designation of degree of blistering.

SKH Publication 97-04 (concept). Beoordelingsgrondslag Houtsoorten voor toepassing in geveltimmerwerk; eisen en bepalingsmethoden. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

SKH Publication 99-02 (2004). Basis of assessment for opaque primer systems for timber. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

SKH Publication 00-01 (2004). Basis of assessment for transparent film forming coatings on timber. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

SKH Publication 05-01 (2005). Bepaling van de hechting van verf op hout. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

Appendix 1 Sampling, codes and batch numbers

Batch LG110	Batch LG127
LG110 RP1	LG127 RP14
LG110 RP7	LG127 RP23
LG110 RP27	LG127 RP16
LG110 RP12	LG127 RP22
LG110 RP19	LG127 RP25
LG110 RP61	LG127 RP8
LG110 RP9	LG127 RP19
LG110 RP10	LG127 RP2
LG110 RP17	LG127 RP5
LG110 RP52	LG127 RP10
LG110 RP20	LG127 RP20
LG110 RP28	LG127 RP30
LG110 RP44	LG127 RP7
LG110 RP47	

Appendix 2 Detailed test results for dry and wet adhesion

Coating system	Batch	Sample Code	Dry Adhesion*	Wet Adhesion**			
Hybrid primer opaque	LG 110	H110,10 (A)	0	2			
		H110,10 (B)		0	1	0	
		H110,19	0	0			
		H110,1	0	2			
		H110,52		2	1	1	1
		H110,47		0	3	3	0
		H110,20		0	1 0	1 0	1 0
		H110,61		0	0	1	0
		H110,17		1	0	1	0
		H110,27		0	0		
	LG 127	H127,30	0	0	0		
		H127,16	0	0	1		
		H127,10	0	0	0		
		H127,14		1	0		
		H127,22		1 2	1 3	1 2	1 3
		H127,23		1			
		H127,25		1	1	1	1
		H127,5		0	0	1	1
		H127,23		1	1	0	0

** Dry adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5.*

*** Wet adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5. For most sample codes the adhesion test was repeated several times on the same side of the sample. Where two rows of adhesion results for a sample code are shown, the results in the second row were obtained from the opposite side of the panel.*

Coating system	Batch	Sample Code	Dry Adhesion*	Wet Adhesion**			
Alkyd emulsion transparent	LG 110	P110,12	0	0			
		P110,20	0	0			
		P110,28	0	0			
		P110,52		0	0	0	0
		P110,7 (A)		0	0	0	0
		P110,7 (B)		0	0	0	0
		P110,12		0	0	0	0
		P110,44		0	0	0	0
		P110,28		0	0	0	0
	LG 127	P127,7	0	0			
		P127,10	0	0			
		P127,8	0	0			
		P127,19		0	0	0	0
		P127,2 (A)		0	0	0	0
		P127,2 (B)		0	0	0	0
		P127,8		0	0	0	0
		P127,16		0	0	0	0
		P127,20		0	0	0	0

** Dry adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5.*

*** Wet adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5. For most sample codes the adhesion test was repeated several times on the same side of the sample.*

Coating system	Batch	Sample Code	Dry Adhesion*	Wet Adhesion**			
Acrylic dispersion opaque	LG 110	S110,17	0	0			
		S110,47	0	0			
		S110,27	0	0			
		S110,19		0	0	0	0
		S110,9		0	0	0	0
		S110,44		0	0	0	0
		S110,61		0	0	0	0
		S110,1		0	0	0	0
		S110,10		0	0	0	0
	LG 127	S127,30	0	0			
		S127,20	0	0			
		S127,25	0	0			
		S127,22		0	0	0	0
		S127,14		0	0	0	0
		S127,23		0	0	0	0
		S127,5		0	0	0	0
		S127,7		0	0	0	0
		S127,9		0	0	0	0

** Dry adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5.*

*** Wet adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5. For most sample codes the adhesion test was repeated several times on the same side of the sample.*

Appendix 3 Detailed test results of the discharging of volatile deposits

Coating system	Batch	Sample Code	Discharging of volatile deposits	Dry Adhesion*
Hybrid primer opaque	LG 110	H110,17	none	0
		H110,20	none	0
		H110,61	none	0
	LG 127	H127,22	none	0
		H127,23	none	0
		H127,25	none	0
Alkyd emulsion transparent	LG 110	P110,7	none	0
		P110,28	none	0
		P110,52	none	0
	LG 127	P127,2	none	0
		P127,8	none	0
		P127,16	none	0
Acrylic dispersion opaque	LG 110	S110,9	none	0
		S110,10	none	0
		S110,44	none	0
	LG 127	S127,14	none	0
		S127,22	none	0
		S127,23	none	0

** adhesion of the coating layer to the wood substrate is determined according to SKH Publication 05-01. Good adhesion is class 0 and 1, critical adhesion is class 2 and 3 and bad adhesion is class 4 and 5.*

Appendix 4 Detailed test results of the blistering test

Coating system	Batch	Sample code	Bliste-ring*	Other visual defects	Water uptake calculation		
					Weight before test [g]	Weight after test [g]	Water uptake [g]
Hybride primer opaque	LG 110	H110.10	0	none	80.79	126.2	45.41
		H110.10	0	none	70.42	109.4	38.98
		H110.19	0	none	59.89	98.63	38.74
	LG 127	H127.10	0	none	75.37	107.28	31.91
		H127.16	0	none	74.98	106.72	31.74
		H127.30	0	none	49.45	85.88	36.43
Alkyd emulsion transparent	LG 110	P110.12	0	none	76.5	119.56	43.06
		P110.20	0	none	78.77	117.86	39.09
		P110.28	0	none	69.76	104.45	34.69
	LG 127	P127.7	0	none	75.2	112.72	37.52
		P127.8	0	none	60.97	110.74	49.77
		P127.10	0	none	75.47	106.23	30.76
Acrylic dispersion opaque	LG 110	S110.17	0	none	69.34	118.79	49.45
		S110.27	0	none	69.46	102.44	32.98
		S110.47	0	none	71.58	113.79	42.21
	LG 127	S127.20	0	none	56.71	88.19	31.48
		S127.25	0	none	64.63	94.45	29.82
		S127.30	0	none	49.61	85.55	35.94

**blistering of the coating layer has been determined according ISO 4628-2. No blistering is expressed as "0", while blistering is expressed by a number for density and size (in example 1S2; density class 1, size class 2).*