

Envelope treatment of wood based materials with concentrated organosilicons

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Received: 12 October 2009 / Published online: 8 June 2010
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Abstract Counteracting moisture ingress in wood and wood based products is crucial for service life prolongation. The use of solvent- as well as water-based organosilicons as envelope treatments on such materials is investigated. Therefore, organosilicons were applied onto four different substrates like OSB and MDF as well as solid wood and plywood. Both treated as well as untreated materials were subjected to a series of floating and imbibition protocols in combination with artificial weathering in order to quantify their hydrophobing action. Envelope treatments of organosilicons show potential in improving water repellent characteristics of solid wood and plywood but have a reduced effectiveness after artificial weathering. The wood based panels OSB and MDF behave opposite. Further research is needed to validate hypotheses on this.

Oberflächenbehandlung von Holzwerkstoffen mit konzentrierten Organosiloxanen

Zusammenfassung Um die Nutzungsdauer von Holz und Holzwerkstoffen zu verlängern, ist es wichtig, der Aufnahme von Feuchtigkeit entgegenzuwirken. Untersucht wird die Verwendung von lösemittel- sowie wasserbasierten Organosiloxanen zur Oberflächenbehandlung dieser Materialien. Dazu wurden Organosiloxane auf vier verschiedene Werkstoffe, nämlich OSB und MDF sowie Massivholz und Sperrholz, aufgetragen. Sowohl behandelte als auch unbehandelte Proben wurden einer Reihe von Wasserlagerungs- und Tauchversuchen und künstlicher Bewitterung unterzogen, um die hydrophobierende Wirkung zu bestimmen. Die

Oberflächenbehandlung mit Organosiloxanen zeigte Potential, die wasserabstoßenden Eigenschaften von Massivholz und Sperrholz zu verbessern, allerdings mit reduzierter Wirkung nach künstlicher Bewitterung. OSB und MDF verhalten sich entgegengesetzt. Zur Bestätigung dieser Hypothesen sind weitere Untersuchungen erforderlich.

1 Introduction

Wood and wood products are susceptible to physical and biological degradation when exposed outdoors. Moisture plays an important role in this degradation process. Lowering the water and water vapor uptake is one method to protect the material. This can be accomplished by modifying the material, making it less hydrophilic or by creating a protective envelope around it, inhibiting moisture ingress.

Since organosilicons are hydrophobing agents, they are supposed to interact in the wood-water relationship, leading to lower moisture uptake by the wood products. This should be beneficial for the service life of the wooden commodity. Donath et al. (2006) reported that silanes have a positive effect on water repellence and Hager (1995) found a reduction of water uptake by 70% for silicone treated spruce. Previously limited evidence was found that organosilicons applied at low concentrations lead to lower water sorption (both liquid and water vapor) of wood, especially when tested and evaluated under laboratory conditions (De Vetter 2009). Higher concentrations of organosilicons increase protection, but since De Vetter et al. (2009) have already indicated that these concentrations are no longer economically feasible for full wood matrix treatment, the application was limited to the envelope or the edges of the material.

Although moisture related properties of wood based products and the effects of envelope treatments on them

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have been investigated before, no literature references were found concerning the influence of organosilicons as envelope treatments on these building materials. It was considered valuable to investigate whether organosilicons, when applied at high concentrations, could induce a change in the wood-water relationship. Therefore, all treated and untreated specimens were subjected to a series of floating and imbibition tests in combination with artificial weathering. Solid wood is often applied under use class 3 conditions, whereas swelling of the edges of wood based panels may occur when applied as e.g. wood flooring.

2 Materials and methods

2.1 Wood materials and organosilicon products

In addition to solid Scots pine sapwood (*Pinus sylvestris* L.), four kinds of plywood and some wood based materials like medium density fiberboard (MDF) and oriented strand board (OSB) were included. While the MDF-HLS was glued with melamine urea formaldehyde resin (MUF), the OSB/3 was glued with polymeric diphenylmethane isocyanate (pMDI) (EN 13986 2002). The plywoods were made of poplar (11 plies, 15 mm thick), spruce (5 plies, 15 mm thick), birch (11 plies, 15 mm thick) and maritime pine (7 plies, 17 mm thick). All plywoods were glued with phenol formaldehyde glue (PF), except for poplar plywood which was glued with MUF.

A broad range of water- and solvent-based organosilicons was applied. An overview of their components and active ingredient concentration is given in Table 1. Micro-emulsion W4 was purchased from Wacker-Chemie GmbH (Germany) and all other organosilicons were obtained from Dow Corning Corporation (Seneffe, Belgium).

To obtain highly concentrated envelope treatments, the organosilicons were brush applied twice onto the wood substrates as supplied (without dilution). Weighing the specimens prior to and after brushing yields the product retention (Eq. 1).

$$\text{product}_{\text{ret}}(\text{g}/\text{m}^2) = \frac{m_{\text{after application}}(\text{g}) - m_{\text{before application}}(\text{g})}{\text{area}(\text{cm}^2)} \quad (1)$$

2.2 Floating test—envelope experiment (focus on Scots pine sapwood)

The organosilicons W1, W2, W3, W4, W5, S1, and S2 were brushed twice onto Scots pine sapwood specimens measuring $40 \times 15 \times 320 \text{ mm}^3$ ($R \times T \times L$). OSB specimens (18 mm thick) were treated with W2 or W4, while the plywood specimens were only treated with organosilicon W2.

Table 1 Overview of the products used with their main components and active ingredient concentrations

Tab. 1 Überblick über die verwendeten Produkte und deren Hauptbestandteile und Wirkstoffkonzentrationen

Product code	Main components	Concentration active ingredient (%)
Water-based organosilicons		
W1	n-OTES	40
W2	DMS/n-OTES	40
W3	PDMS	60
W4	PDMS/TES	100
W5	PDMS	60
Solvent-based organosilicons		
S1	n-OTES	100
S2	MTM/n-OTES	100

All boards and half of the Scots pine sapwood specimens were conditioned at 20°C and 65% RH, while the other half of the Scots pine sapwood specimens was conditioned until fiber saturation point (FSP) prior to treatment. Since Mukhopadhyaya et al. (2002) proved that the liquid moisture coefficient of wood (eastern white pine) is temperature dependent all handling was performed in a conditioned room (20°C, 65% RH). Next, the specimens, sealed at all edges, were floated onto demineralized water. At fixed intervals up to four hours the increase in mass was recorded after blotting of the specimens on drying tissue. Finally, the specimens were removed from the water and put with their longest coated face onto a rack, allowing desorption to occur at 20°C and 65% RH.

After one night of desorption, the mass of the specimens was determined again. Subsequently, the specimens were weathered in a UV cabinet with spray option (ATLAS UVCON). The first weathering cycle was a so-called wet cycle A. During this cycle the specimens were illuminated ($\lambda = 340 \text{ nm}$) for 23 hours in combination with 1 hour without illumination; this 24-hour cycle was then repeated. The spray nozzles were turned on and off according to the diagram shown in Fig. 1. After 144 hours the specimens were subjected to a second floating test, followed by a dry artificial weathering cycle B and consecutively a third floating test. During the weathering cycle B the specimens were illuminated constantly while the spray nozzles followed the spraying regime as depicted in Fig. 1. The floating test consisted of a 4 hour sorption period, followed by 20 hours of desorption under conditioned circumstances (20°C, 65% RH). The specimens were weighed after 5 s, 5, 10 min, 1, 2, 4, 5, and 24 hours. This process of alternating floating and weathering was performed several times. At the end of the experiment, the specimens were oven dried (103°C), allow-

rial absorbs water. When in direct contact with liquid water, this water absorption coefficient determines, together with the moisture-liquid diffusivity D_w (m^2/s), the moisture transport and the redistribution of the moisture into the wood (Mukhopadhyaya et al. 2002). When assuming constant diffusivity and taking the shape of the advancing moisture front into consideration these two parameters can be linked to each other as given in Eq. 6 (Kumaran 1999; Mukhopadhyaya et al. 2002; Candanedo and Derome 2005). Although liquid diffusivity D_w is assumed to be constant, Mukhopadhyaya et al. (2002) proved that D_w of untreated eastern white pine increased with increasing temperature. That is why this test set-up was performed under constant climatic conditions (20°C and 65% RH). Since A_w might be influenced by the superficial treatment with organosilicons it was calculated according to Eq. 7 (Kumaran 1999; Candanedo and Derome 2005).

$$D_w(m/s^2) = \frac{\pi}{4} \left[\frac{A_w(kg/(m^2 s^{1/2}))}{w_c(kg/m^3)} \right]^2 \tag{6}$$

$$A_w(kg/(m^2 s^{1/2})) = \frac{m_{time}(kg) - m_{initial}(kg)}{contact\ area \times \sqrt{time}(m^2 s^{1/2})} \tag{7}$$

3 Results

3.1 Floating test—envelope experiment with Scots pine sapwood

The product retentions of the envelope treatment of Scots pine sapwood are given in Table 2. The specimens were floated onto demineralized water prior to and after weathering for one week (144 h) in an ATLAS UVCON. Figure 3 shows that prior to weathering all organosilicons were able to lower the MC significantly, while this was only valid for some of the treatments after weathering.

Table 2 Product retention (g/m^2) of Scots pine sapwood pre-conditioned under different circumstances and brushed twice with seven undiluted organosilicons

Tab. 2 Produktaufnahme (g/m^2) von unterschiedlich klimatisiertem Kiefernspinhholz, das zweimal mit sieben unverdünnten Organosiloxanen bestrichen wurde

Organosilicons	20°C, 65% RH	Fiber saturated
W1	–	145 ± 21
W2	148 ± 33	164 ± 51
W3	215 ± 54	131 ± 38
W4	136 ± 43	115 ± 41
W5	167 ± 17	155 ± 16
S1	179 ± 16	147 ± 32
S2	158 ± 4	141 ± 34

In the next experiment pure products were applied onto fiber saturated wood. Figure 4 shows the resulting MC over five floating tests alternated with artificial weathering. Water has accumulated in the wood during this process of artificial weathering and floating. Just like in the first floating test prior to weathering all products show their ability to lower the MC of the wood by up to 60%. Afterwards half of the products are losing their effectiveness and the MC is gradually approaching that of untreated Scots pine sapwood. The other products continue to lower the MC by 30 to 70% even after more than 696 hours of alternating floating and weath-

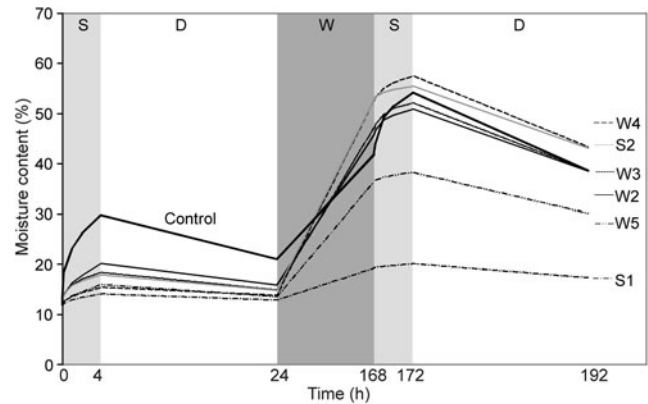


Fig. 3 Moisture content during sorption (S) and desorption (D) prior to and after artificial weathering (W) of organosilicon treated Scots pine sapwood pre-conditioned at 20°C and 65% RH

Abb. 3 Holzfeuchteverlauf während der Sorption (S) und Desorption (D) vor und nach künstlicher Bewitterung (W) von mit Organosiloxan behandeltem Kiefernspinhholz, das zuvor bei 20°C und 65% rel. Lf. klimatisiert worden war

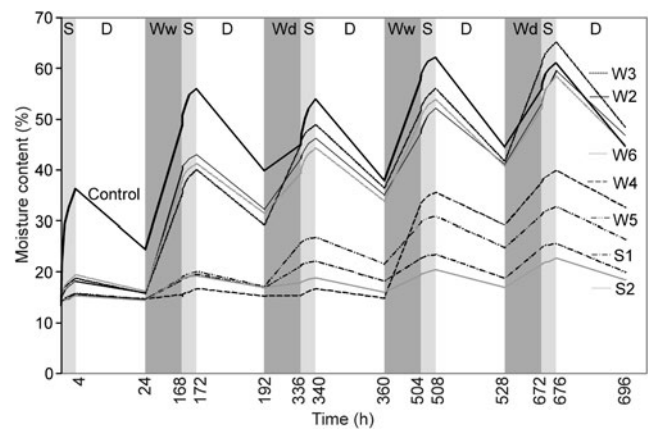


Fig. 4 Moisture content during sorption (S), desorption (D) and artificial weathering (W) of organosilicon treated Scots pine sapwood pre-conditioned at fiber saturation point. Weathering consisted of alternating a wetter (Ww) and dryer cycle (Wd)

Abb. 4 Holzfeuchteverlauf während der Sorption (S) und Desorption (D) und künstlicher Bewitterung (W) von mit Organosiloxan behandeltem Kiefernspinhholz, das zuvor bis Fasersättigung klimatisiert wurde. Die Bewitterung wechselte zwischen einem feuchteren (Ww) und einem trockeneren (Wd) Zyklus

ering. The solvent-based products S1 and S2 perform best, followed by the emulsions W4 and W5.

Due to the promising results obtained for protecting solid wood, some organosilicons were applied onto the envelope of plywood and OSB. In Figs. 5 and 6 the MC during float-

ing prior to and after one cycle of artificial weathering of untreated and organosilicon treated plywood and OSB is illustrated. The plywood specimens were brushed twice with product W2, while OSB was treated with either W2 or W4. Figure 5 shows that for OSB only slight improvements (15–30%) can be observed, while for plywood (Fig. 6) even lower impacts must be noted (<20%). However, it must be stressed that for Scots pine sapwood better results were obtained with other organosilicons, indicating that better performance might also be achieved on plywood and OSB when those other organosilicons would have been applied.

3.2 Imbibition test—concentrated edge experiment (focus on wood based panels)

Following the superficial application of organosilicons at high concentrations onto solid wood and wood based panels, a concentrated edge experiment was set up. Table 3 gives the obtained product retentions and shows that for Scots pine sapwood this retention does not differ greatly among the organosilicons, while it does for poplar and birch plywood. These differences are however small compared to the large organosilicon dependent product retentions noted for the wood based materials OSB and especially MDF.

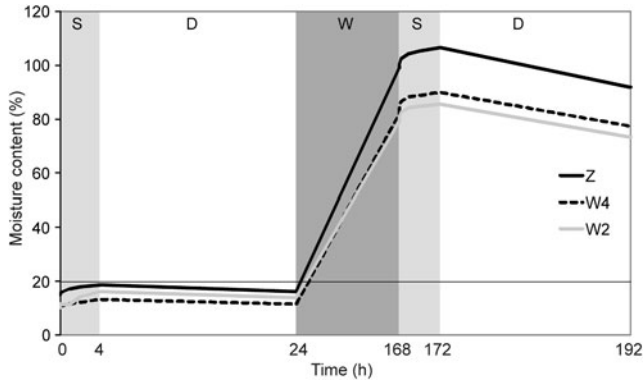


Fig. 5 Moisture content of untreated and with organosilicon W2 or W4 treated OSB during 4 hours sorption (S) and 19 hours desorption (D) prior to and after 144 h artificial weathering (W)
Abb. 5 Holzfeuchteverlauf von unbehandeltem und mit Organosiloxan W2 oder W4 behandeltem OSB bei 4-stündiger Sorption (S) und 19-stündiger Desorption (D) vor und nach 144-stündiger künstlicher Bewitterung (W)

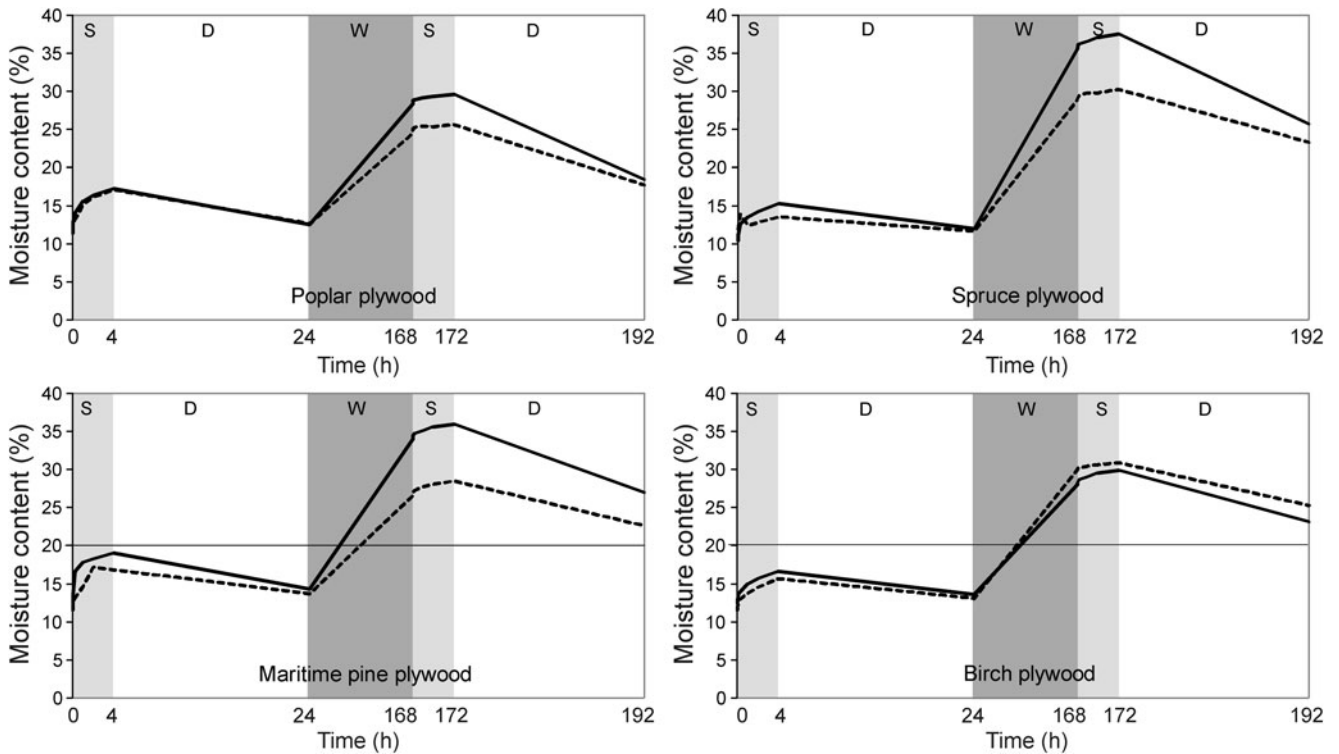


Fig. 6 Moisture content of untreated (*continuous line*) and with organosilicon W2 treated plywood (*dashed line*) during 4 h sorption (S) and 19 h desorption (D) prior to and after 144 h artificial weathering (W)
Abb. 6 Holzfeuchteverlauf von unbehandeltem (*durchgezogene Linie*) und mit Organosiloxan W2 behandeltem Sperrholz (*gestrichelte Linie*) bei 4-stündiger Sorption (S) und 19-stündiger Desorption (D) vor und nach 144-stündiger künstlicher Bewitterung (W)

Fig. 7 (a) Moisture content and (b) edge swelling during sorption (S) and desorption (D) of MDF (M), OSB (O) and Scots pine sapwood (SP), either left untreated or brushed with organosilicons W2, W3 or W5

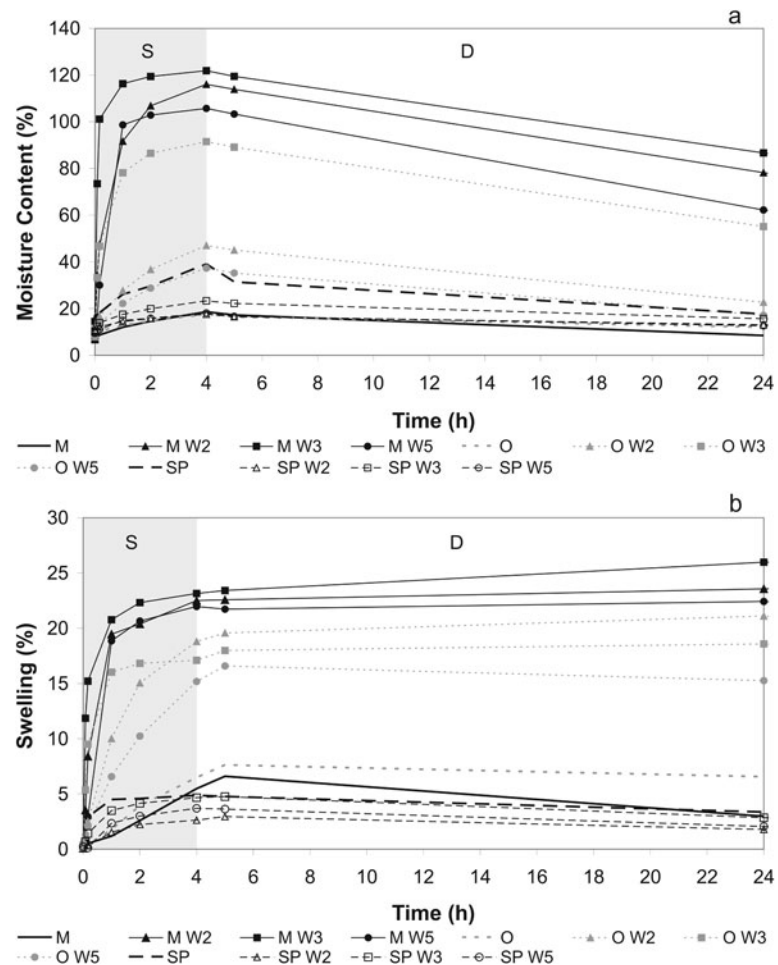


Table 3 Product retention (g/m^2) of wood based materials brushed twice with the undiluted organosilicons W2, W3 or W5

Tab. 3 Produktaufnahme (g/m^2) von Holzwerkstoffen, die zweimal mit unverdünntem Organosiloxan W2, W3 und W5 bestrichen wurden

Wood based material	W2	W3	W5
Scots pine sapwood	175 ± 23	184 ± 31	134 ± 15
Poplar plywood	295 ± 40	549 ± 60	289 ± 111
Spruce plywood	298 ± 25	705 ± 52	1368 ± 149
Maritime pine plywood	352 ± 67	630 ± 62	547 ± 90
Birch plywood	315 ± 53	345 ± 63	296 ± 92
OSB	209 ± 23	238 ± 45	213 ± 24
MDF	229 ± 54	401 ± 51	329 ± 35

Figures 7a and 7b show the moisture contents and swelling of (un)treated Scots pine sapwood, OSB and MDF. These figures indicate a reduction of moisture content and swelling during sorption and desorption for organosilicon treated Scots pine sapwood, while increased moisture content and swelling is seen for organosilicon treated OSB and MDF compared to their untreated counterparts. Although a fast reduction in moisture content is noted once the spec-

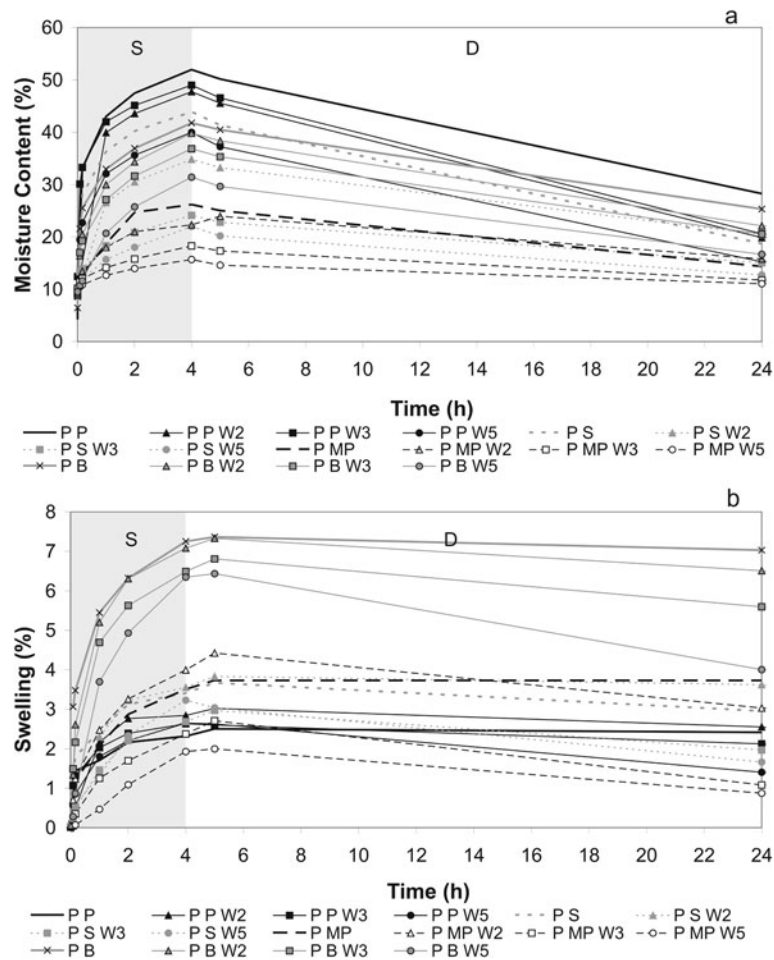
imens were removed from the water, the swelling of most specimens continued for at least another hour.

For plywood the graphs are not univocal (Figs. 8a and 8b). While the MC is lowered when organosilicons were applied, the swelling is only reduced for the products W3 or W5. Application of W2 leads to swelling which is at least as high as the one of untreated plywood. As expected the WRE values for MDF and OSB are negative, while WRE values of 50 to 65% are observed for Scots pine sapwood after 4 hours sorption. For plywood WRE-values range from 10 to 70%, depending both on the organosilicon applied and on the kind of plywood (data not presented).

Table 4 lists the resulting water absorption coefficients (A_w) for untreated and organosilicon treated Scots pine sapwood, plywood, OSB, and MDF. As expected the saturated capillary moisture content (w_c) of Scots pine sapwood was not reached within 4 hours of sorption. This means that the sorption was still in the first phase and all data points of cumulative inflow versus square root of time were used in the linear regression as the basis for the determination of the water absorption capacity. This was also valid for untreated OSB and MDF. On the other hand, the untreated plywoods reached the saturated capillary moisture content (w_c)

Fig. 8 (a) Moisture content and (b) edge swelling during sorption (S) and desorption (D) of poplar plywood (P P), spruce plywood (P S), Maritime pine plywood (P MP) and birch plywood (P B). The specimens were either left untreated or treated with organosilicons W2, W3 or W5

Abb. 8 (a) Holzfeuchteverlauf und (b) Kantenquellung während der Sorption (S) und Desorption (D) von Pappelsperholz (PP), Fichtensperholz (PS), Strandkiefernsperrholz (PMP) und Birkensperholz (PB). Die Prüfkörper waren entweder unbehandelt oder mit Organosiloxan W2, W3 oder W5 behandelt



already after circa 10 to 115 min, depending on the type of plywood. Therefore, a distinction had to be made between the first and second phase of sorption based on visual inspection. Only those points belonging to the first phase were used in the regression analysis for calculation of the water absorption coefficient.

Table 4 shows that all organosilicons lower A_w considerably for solid Scots pine sapwood. This is to a lesser extent the case for all plywoods, except for poplar plywood treated with W3. For the three other types of plywood best performance was achieved with product W5, followed by W3 and W2. The reduction of the water absorption coefficient for poplar, spruce and maritime pine plywood treated with W5 and these last two types of plywood with W3 was such that w_c was not reached within 4 hours of sorption.

In contrast, the wood based materials OSB and MDF behaved opposite. While their A_w values were the lowest of all untreated specimens, these values increased after application of organosilicons. This increase was so dramatic for OSB treated with W3 and for MDF treated with all organosilicons that they reached the saturated capillary moisture content already after 10 to 70 min.

Table 4 Water absorption coefficient A_w [10^{-4} kg/(m² s^{1/2})] for different wood materials either untreated or brush-treated with organosilicon W2, W3 or W5. Values given in *italics* did not reach the saturated capillary moisture content w_c during the experiment

Tab. 4 Wasseraufnahmekoeffizient A_w [10^{-4} kg/(m² s^{1/2})] von Kiefernspinnholz und verschiedenen Holzwerkstoffen, entweder unbehandelt oder mit den Organosiloxanen W2, W3 oder W5 bestrichen. Die Werte in *Kursivschrift* haben während des Versuchs den gesättigten Kapillarfeuchtegehalt w_c nicht erreicht

Wood based material	Control	W2	W3	W5
Scots pine sapwood	210.5	73.0	<i>115.8</i>	<i>83.1</i>
Poplar plywood	533.4	344.9	619.4	<i>385.9</i>
Spruce plywood	436.6	307.4	82.8	<i>71.7</i>
Maritime pine plywood	142.1	130.0	<i>50.5</i>	<i>36.7</i>
Birch plywood	750.4	505.9	380.2	189.9
OSB	58.6	266.6	1202.2	<i>189.3</i>
MDF	<i>91.2</i>	1524.2	3582.9	1636.1

4 Discussion

The results of the envelope treatment confirm the statements for solid wood (De Vetter 2009): (1) organosilicons are able

to lower the moisture uptake of treated wood, (2) but the effectiveness of most organosilicons is reduced significantly by weathering. Extrapolation towards wood based materials is however not straightforward. Nofal and Kumaran (1999) examined the behavior of OSB in a cyclic wetting and drying experiment. They found that sealing the edges of panels reduced the MC by 5% and slowed down the board thickness increase. This is important since thickness increase affects the volume of air cavity when the boards are used in e.g. a wall assembly and may subsequently affect its functionality.

For the floating test with edge sealed specimens a reduction in MC of up to 15% was recorded when the boards were brushed with an organosilicon. However, comparing Fig. 5 with Figs. 3 and 4 shows that OSB boards in direct contact with water during the floating test have a moisture uptake which is several times higher than for solid Scots pine sapwood. In contrast this is not the case when the edges of untreated OSB and MDF are considered and compared to the transverse surface of untreated Scots pine sapwood (Fig. 7). Although it is already known that the thickness swell of OSB is higher than the swelling of solid wood due to release of compaction stress created during pressing, this should be seen in its proper context. At the beginning of the edge swelling test, Scots pine sapwood swells fast, but also reaches its maximum soon (Fig. 8). OSB and MDF in contrast have a continuous increase in swelling during the whole sorption period and continue to swell at the beginning of the desorption stage. Initially OSB and MDF are less swollen than Scots pine sapwood, but after approximately 2 and 3.5 hours of sorption, respectively, this is reversed. Taking the higher moisture uptake and ultimate increased swelling into consideration, it is not surprising that negative WRE values were recorded for OSB and MDF (data not presented).

It has been proven before that the moisture content of wood based panels exposed to direct wetting is influenced by wetting time and by panel characteristics that affect capillarity such as wood species and wax additives of OSB. Figure 6 shows that the organosilicon W2 (40% DMS/n-OTES) succeeds in a slight reduction (<20%) of the MC of each type of plywood except for birch plywood. Focusing on the edges of the boards, reductions of MC between 5 and 50% can be achieved, depending on the plywood type and organosilicon applied (Fig. 8). The order of magnitude of MC and swelling of plywood during the envelope and edge swelling tests are comparable to that of Scots pine sapwood. In contrast to OSB not all organosilicons succeed in reducing the swelling of plywood. Between the different plywood types differences in MC and swelling are seen, which cannot directly be linked to panel characteristics like wood species, thickness and number of plies, glue type, etc.

As stated above the water absorption coefficient A_w governs the liquid moisture movement into a material. For wood used in use class 3 conditions, e.g. cladding as part of a

building envelope, it is of utmost importance to determine this water absorption coefficient as it is one of the most important hygrothermal properties necessary to deal with the overall moisture management of a building envelope (Mukhopadhyaya et al. 2002). Up to now A_w was determined for coatings as such or coatings applied on wood (Hora 1994; Ahola et al. 1999; de Meijer and Militz 2000) and for untreated softwood (Mukhopadhyaya et al. 2002; Candanedo and Derome 2005; Miniotaite 2005) but not yet for wood treated with organosilicons.

The second sorption stage was not reached for Scots pine sapwood in this edge imbibition test. This means that the moisture content was still below the capillary saturated moisture content. Mukhopadhyaya et al. (2002) found a water absorption coefficient at a water bath temperature of 21°C of on average $112.0 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$. Miniotaite (2005) and Kumaran (1999) both reported an A_w value for spruce equal to $96.0 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$. The water bath temperature was 22°C in the first report. Candanedo and Derome (2005) found A_w values between 96.6×10^{-4} and $156 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$ for undefined longitudinally sawn softwood. Logically they found lower values for radially [$19.4 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$] or tangentially [26.5×10^{-4} – $28.6 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$] sawn specimens.

The average A_w value found in this research [$210.5 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ s}^{1/2})$] for radial/tangential Scots pine sapwood was in the same order of magnitude, but higher than the previously mentioned values. Application of organosilicons lowers this water absorption coefficient three to six times, but still remains higher than literature values reported for transverse sections of softwood. Ahola et al. (1999) determined water absorption coefficients for coatings on spruce and pine and reported values between circa 50×10^{-4} and $40 \times 10^{-4} \text{ kg}/(\text{m}^2 \text{ h}^{1/2})$, much lower than the obtained values in this research for organosilicon treated wood. This means that coatings are better in reducing the water absorption coefficient of Scots pine than organosilicons. It is suggested that moisture movement through a coating is controlled by diffusion and not by capillarity (Ahola et al. 1999) while capillary liquid flow is important in uncoated wood after longer exposure times (de Meijer and Militz 2000).

The mode of action of the organosilicons may be similar when applied onto earth substrates. As such the silicone can adsorb on the substrate capillaries to form a thin hydrophobic polysiloxane film which can significantly increase the contact angle of water with the substrate capillary wall and reduce the water absorption of the substrate through capillary depression (Noll 1968; Ren and Kagi 1995). Since positive correlations between contact angles of water on coated wood and water absorption rates have been found before, this seems a plausible explanation (Hora 1994; de Meijer and Militz 2000). It was stated before that water repellents, meant to lower the velocity of water uptake

and not the maximum water uptake, can cause a reduction of the capillary tension of wood and even a capillary depression (Lukowsky and Peek 1997). De Vetter et al. (2006) found a discontinuous micro-porous network on the cell walls and in the lumens of tracheids and wood rays of Scots pine sapwood after dipping in a low concentrated organosilicon. It can therefore be assumed that highly concentrated organosilicon at the surface could lead to a thin film on the surface, leading to increased contact angle and lower water absorption coefficient. Since the formation of a polysiloxane film could be crucial in explaining the behavior of the treated material, further investigation should be performed. This can be done by doping the organosilicon prior to application and then combining image analysis (SEM or μ -CT) with elementary compositional analysis (EDX) as described in De Vetter et al. (2006). While also wavelength-dispersive spectrometry (Niu et al. 2009) might be used as compositional analysis modality, imaging techniques like confocal microscopy (Van den Bulcke et al. 2003; Singh and Dawson 2004) or X-ray imaging (Van den Bulcke et al. 2010) could be used as well. While the results for plywood follow the same trend as for solid Scots pine, other factors seem to play a role for the wood based panels MDF and OSB. After superficial application of organosilicons they absorb more water than their untreated counterparts. Since the matrices of OSB and MDF are significantly different from those of solid wood, and knowing that their sorption behavior is different, organosilicons probably act differently on those materials than on solid wood. The altered moisture dynamics of wood based panels after superficial treatment with organosilicons is clearly of interest for future research.

5 Conclusion

Superficial treatments at high concentrations show potential in improving water repellent characteristics of solid wood and plywood. Drawback is the reduced effectiveness after artificial weathering. Considering the wood based materials OSB and MDF, organosilicons behaved opposite as expected. They increased the moisture uptake of the edges and consequently the swelling. The mode of action of this process is not yet revealed and forms a challenge for future research.

Acknowledgements Since the European Commission supported the research project HYDROPHOB (QLK5-CT-2002-01439), which was the framework for this study, the authors would like to thank the Commission for the financial support. The authors also wish to thank the Fund for Scientific Research-Flanders (FWO, Belgium) for the post-doctoral funding granted to the second author.

The authors declare that they have no conflict of interest.

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