How contact angle measurement can help to quantify outdoor weathering effects on wood paints

Wood is still one of the most important materials in our life due to its abundancy and favourable material properties. However, unprotected wood easily undergoes shrinkage or swelling and even biological or chemical degradation during outdoor utilizations. A huge variety of paint formulations have been developed to protect wood surfaces by improving hydrophobicity and dimensional stability. One of the main components in wood paints are binders which have an important effect on the performance of paints. A very common and widely used naturally derived paint binders is linseed oil. Linseed oil belongs to the class of drying oils with a high drying power, which can form a solid and cohesive film via autoxidation and crosslinking polymerization. Paints based on linseed oils binders are furthermore attractive coming from renewable sources. Nevertheless, the prolonged drying time of linseed oil still impedes its application. Recently, Sansonetti *et al*. studied the properties of linseed oil based paints and their utilization in wood surfaces protection.

In this work, based on linseed oil as binder, a black paint (BP), a grey paint (GP), and a water-based dispersion (WD) were employed as test coatings respectively. To have a better understanding of these three paints, the viscosity and glass transition temperature (T_g) of the paints' films were studied (**Table 1**). Especially, T_g is a vital parameter for wood coatings, because it has significant influence on their outdoor application. Usually, a lower T_g of the coating film is good for outdoor use since bellow T_g the paint gets more brittle and less flexible making it more vulnerable to mechanical damage. The reason might be a higher degree of crosslinking in the films of WD compared to GB and BP. This might also be the reason for the higher viscosity of WD.

Table 1. properties of the linseed oil based paints.

Paint	Type	Density (g/cm^3)	Viscosity $t_{30°C}$ [s]	T_g (°)
GP	Oil paint	1.22	38.8	−23.7 ± 0.8
BP	Oil paint	1.24	29.3	−26.1 ± 0.5
WD	Dispersion	0.98	217.2	42.8 ± 0.4

Furthermore, the wettability of the coloured wood surface is a vital parameter to indicate the anti-weathering and water repellence. If the coated wood surface is more hydrophobic, the dimensional stability and anti-weathering resistance are higher. To evaluate the wettability of the coated wood surfaces during outdoor weathering (OW), water contact angle (CA) measurements were conducted. As **Table 2** shows, all initial CA values and CA values after 90 days of OW are near or above 90°, indicating that the treated wood surface displayed and kept a good hydrophobicity. Besides, the CA of GP coated surface increased after three months, which may be caused by the higher degree of continued polymerization during OW. In addition, a small decrease of CA on BP coated surface was explained by small checks on the painted surface.

Table 2. CA measurements of coated surface before and after 90 days of OW.

Paint-n. layers	GP-2	GP-3	BP-1	BP-2	WD-3	WD-4
Initial CA (°)	87.7±1.3	88.0±0.8	93.7±1.0	89.4±1.4	94.3±1.7	93.4±4.1
91 days CA (°)	92.5±1.8	95.7±4.1	90.6±1.3	86.5±3.7	93.9±3.3	92.0±3.4

Overall, Linseed oil based paints are environmental friendly, however, they need a long time to form a cohesive and solid film which improves their properties. The CA measurements showed that all three paints can fabricate a good hydrophobic film on wood surfaces, and the further polymerization of linseed oil and cross-linking reactions of the film are still happening during OW. This work nicely displays how CA measurements can be used to quantify weathering effects on paints.

An optical contour analysis system OCA (DataPhysics Instruments GmbH, Germany) was used in this research.

For more information, please refer to the following article:

Changes in Ecological Linseed Oil Paints During Outdoor Weathering of Wood Panels; Errj Sansonetti, Dace Cīrule, Bruno Andersons, Ingeborga Andersone, Edgars Kuka; *Key Engineering Materials,* **2020**, 316-321*;* DOI: 10.4028/www.scientific.net/KEM.850.316.