Characterisation of the degradation of lignin-coated particle board under accelerated ageing conditions of temperature and humidity

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Introduction

Oriented strand board (OSB) is a type of engineered lumber, similar to particle board, formed by combining adhesives and then compressing layers of wood strands (flakes) in specific orientations. The low cost of this material is the most important factor in the choice for many manufacturers to adopt it. However, its high water absorption, leading to failure of the adhesive matrix and eventually the entire composite, coupled with its low surface quality and appearance, has led a company based in British Columbia, Canada, to invent a protective coating that can be applied to the material and significantly improve its value. In this study, a novel lignin-based polymer has been used as a protective coating and the effect of determined ambient conditions have been studied on the outcomes of hardness, mass and surface quality. In this project, two types of lignin based coatings has been employed; simple coloured Lignin coating and a lignin-alumina powder coating. Given the inherent modes of degradation of polymer-based materials, including composites [1-3], under these conditions, such an investigation was warranted for this novel material.

Test Procedure

Coated samples were provided by the company cut in square shape pieces with the approximate size of 80mm x 80mm. Each material was cut into five samples, for a total of 10 samples. These samples were sealed on the five faces that did not have the lignin-based polymer coating, with an elastomeric resin, in order to guarantee a seal on those five sides. All samples weighted using a Qualitest MDS-300 electronic densimeter, measured for hardness on the Shore D scale using a Qualitest BS 61 II tester. Furthermore, the surface profile of each sample with coloured lignin coated samples were tested for surface quality, or specifically, surface roughness, using a Bruker Contour GKT White Light Interferometer (WLI). The coloured lignin samples only required this test, due to surface quality being an outcome of importance, unlike the alumina composite samples, which are used for high-grip surfacing.

The samples were then subjected to two weeks of elevated humidity (relative humidity of 99%) and temperature (50°C), to simulate accelerated ageing conditions. A Thermotron SM-4-800 environmental chamber was used to achieve this.

All samples were tested and data analysis performed according to ASTM D2240-05 for hardness measurements and ISO 4287-1997 for surface texture profilometry. All measurements were taken five times for repeatability and statistical robustness. Data reported in the results are averages.

Results

It was found that there were statistically insignificant differences found in the samples, between the before and after exposure conditions. This was the case for the mass, density and surface roughness measurements. The results have been presented in table and graphical form below for ease of interpretation.

(a) (b) (c)

Figure 1: The samples and conditioning chamber used in this study, the (a) lignin-alumina coated samples, the (b) coloured lignin coated samples and the (c) Thermotron SM-4-800 environmental chamber for exposure.

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Table 1: Mass of colored lignin coated samples (grams)

Sample	Before exposure	After exposure	% Water absorption
1	59.936	60.111	0.2920
2	55.99	56.151	0.2876
3	53.199	53.329	0.2444
4	55.583	55.748	0.2969
5	67.724	67.963	0.3529

Table 2: Mass of alumina-lignin coated samples (grams)

Sample	Before exposure	After exposure	% Water absorption
1	37.661	37.845	0.4886
2	36.845	36.978	0.3610
3	37.868	38.011	0.3776
4	38.03	38.134	0.2734
5	39.161	39.342	0.4622

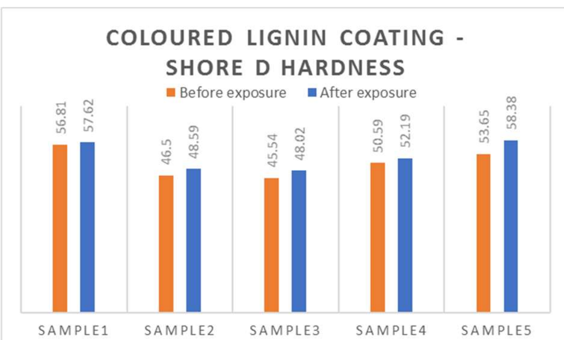

Figure 2: Shore D hardness values of coloured lignin samples before and after exposure.

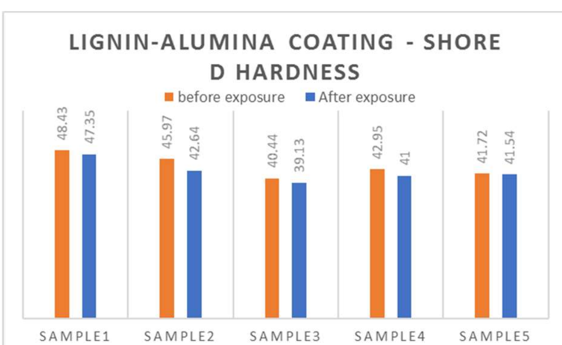

Figure 3: Shore D hardness values of alumina-lignin samples before and after exposure

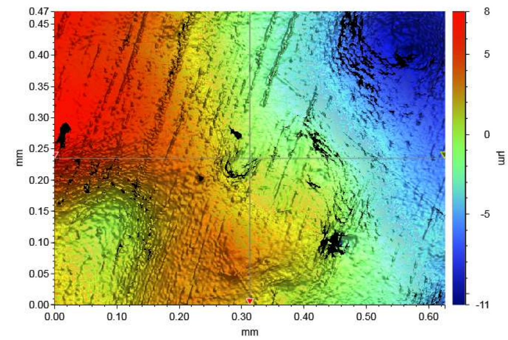

Figure 4: Surface roughness parameter R_a contour plot of coloured lignin sample 1 prior to exposure (R_a = 1.625µm).

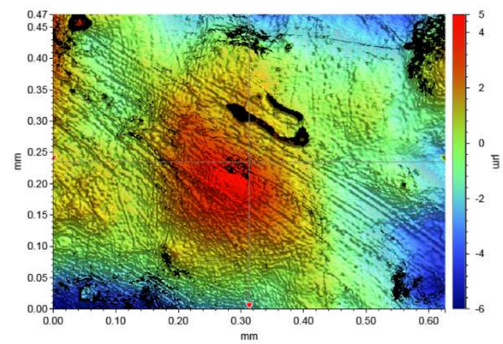

Figure 4: Surface roughness parameter R_a contour plot of coloured lignin sample 1 after to exposure (R_a = 1.717µm).

Due to the nature of the surface roughness measurements, the results were highly variable. This high variance in the results contributed to the conclusion that there was no statistical significance between the R_a values before or after exposure. Overall, the evidence collected supports the conjecture that the novel lignin-based polymer acts as an excellent protective coating for the lower quality OSB substrate material, allowing it to be used in applications where moisture is high and aesthetics are important.

References

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