WOOD RESEARCH
55 (4): 2010
51-58

# EFFECTS OF THERMAL MODIFICATION ON SURFACE CHARACTERISTICS OF OSB PANELS

Oner Unsal, Zeki Candan, Umit Buyuksari
Istanbul University, Faculty of Forestry, Department of Forest Products Engineering,
Istanbul, Turkey

Suleyman Korkut
Duzce University, Faculty of Forestry, Department of Forest Industrial Engineering,
Duzce, Turkey

Marian Babiak
Technical University in Zvolen, Faculty of Wood Science and Technology, Department of Wood Science,
Zvolen, Slovak Republic

## ABSTRACT

Thermal modification is an effective process to improve dimensional stability of wood and wood composite panels. Wettability of wood based panels is also an important issue and has been affected from heat treatment process. In this study oriented strandboard (OSB) panels were subjected thermal modification process. Wettability and surface roughness properties of the panels were evaluated. The results obtained in this study showed that the thermal modification process improved surface roughness parameters of all the treated panels compared to untreated control panels. The contact angle (CA) values of the treated panels were clearly higher than the untreated panels. The thermally treated panels had a poorer wettability property when compared to the untreated panels. The panels having smoother surface had greater CA values.

KEY WORDS: Thermal modification, surface roughness, wettability, contact angle, oriented strand board

## INTRODUCTION

Wood composites such as OSB (oriented strandboard), plywood, OSL (oriented strand lumber), and LVL (laminated veneer lumber) have been slowly replacing the use of solid wood in many structural applications.

During the construction of houses, OSB can be exposed to rain water, and this leads to thickness swelling, which can be pronounced at the edges of boards (Gu et al. 2005). Such swelling increases the surface roughness of boards and can cause misalignment of flooring panels in the Z (thickness) direction (Brochmann et al. 2004).

Plywood and oriented strandboard (OSB) panels are very similar in the conception of reducing the dimensional stability and anisotropy of the wood, but raw material, manufacturing process and mechanical properties are very different. The disadvantage of OSB compared to plywood is the higher dimensional instability. To improve this property it is necessary to reduce the water adsorption of the wood and release the stress imposed during the hot-pressing process. Some studies have evaluated a method which can do this in an one-way step: the thermal treatment applied after the consolidation of the panel.

Heat treatment is an effective process to improve dimensional stability of wood and wood composite panels. Wettability of wood based panels is also an important issue and is affected by heat treatment. There is a close relationship between surface roughness and wettability of the wood and wood composites. Several studies were done related to relationships between production parameters and wettability characteristics of wood composite panels such as plywood, OSB, and LVL (Aydin 2004, Aydin et al. 2006, Ayrilmis et al. 2009, Khan et al. 2004).

In this study, OSB panels as structural wood composites were subjected to heat treatment process. Surface roughness and contact angle (CA) in terms of wettability characteristics of the panels were evaluated.

## MATERIAL AND METHODS

In this research, oriented strandboard (OSB) panels as structural wood composite were supplied by Kastamonu Integrated Wood Industry and Trade Inc. in Kocaeli, Turkey. The panels were 100 cm in length, 100 cm in width and 1.2 cm in thickness. Then, they were cut into 40 cm by 40 cm before thermal modification process.

Thermal modification process was performed in an oven controlled with ± 1 °C sensitively under atmospheric pressure. Experimental design of the study was shown in Tab. 1. The panel parts were cut into test specimens with dimensions of 50 mm × 50 mm × 12 mm to obtain surface roughness and wettability of the panels. Treated and untreated samples were conditioned at 20 ± 2 °C and 65 ± 5 % relative humidity (RH) in a climate chamber for three weeks.

*Tab 1: Experimental design of the thermal modification process*

| Panel Type | Temperature (°C) | Time (hours) |
|---|---|---|
| Control | - | - |
| A | 150 | 1 |
| B | 150 | 3 |
| C | 170 | 1 |
| D | 170 | 3 |
| E | 190 | 1 |
| F | 190 | 3 |
| G | 210 | 1 |

Specific gravity of the specimens was determined according to EN 323 (1993) standard. Twenty samples with dimensions of 50 mm × 50 mm × 12 mm were used from each group.

Twenty samples were used from each group. The points of roughness measurements were randomly marked on the surface of test samples. A Mitutoyo SJ-301 surface roughness tester, stylus tyPpe profilometer, was employed for the surface roughness test. Two roughness parameters characterized by ISO 4287 (1997) standard, respectively, average roughness ($R_a$) and maximum roughness ($R_{max}$) were considered to evaluate the surface characteristics of the panels. Roughness values were measured with a sensitivity of 0.5 µm. Measuring speed, pin diameter and pin top angle of the tool were 5 mm.min$^{-1}$, 4 µm and 90°, respectively. The length of tracing line ($L_t$) was 12.5 mm and the cut-off was λ = 2.5 mm.

Twenty samples were used from each group. Contact angle (CA) was analyzed to obtain the wettability characteristics of the specimens. CA values were determined using with a KSV Cam-101 Scientific Instrument . Distilled water was used as liquid. The image of the liquid drop was captured by a video camera and the CA was measured by digital image analysis software. After the 5 µL droplet of distilled water was placed on the sample surface, contact angles from the images were measured at 1-s time intervals up to 60 s total and average CA was calculated.

For the surface roughness and wettability, all multiple comparisons were first subjected to an analysis of variance (ANOVA) at $p<0.05$ and significant differences between mean values of the treated and untreated groups were determined using Duncan's multiple range test.

## RESULTS AND DISCUSSION

Tab. 2 shows Ra and Rmax values as surface roughness characteristics of the thermally modified OSB panels. The results obtained in this study showed that the thermal modification process improved surface roughness parameters of all the treated panels compared to untreated control panels. The highest Ra value was determined in the untreated control panels, while the lowest Ra value was determined in the panels (Group G) treated with 210 °C for 1 hour. The Ra values of the panels decreased with increasing thermal modification temperature for both modification period of 1 and 3 hrs. The Ra value of group G was approximately 30 % lower than that of untreated panel. The results seem similar to that of Korkut and Akgul (2007), who found that the Ra value of the Oak veneer decreased as heat treatment temperature increased. Aydin and Colakoglu (2002a, b) also found similar results. Aydin and Colakoglu (2005) reported that surface roughness of beech wood improved with temperature increase. Thermal modification time did not significantly affected $R_a$ values of the panels. The findings indicated that the temperature was major parameter affecting the $R_a$ values.

*Tab. 2: Surface roughness results of the panels*

| **Panel Groups** | **Surface roughness (μm)** | |
|---|---|---|
| | $R_a$ | $R_{max}$ |
| Control | 6.07 (0.79) a | 34.42 (5.37) a |
| A | 5.45 (0.63) ab | 33.66 (3.15) ab |
| B | 5.58 (0.63) ab | 33.27 (2.24) abc |
| C | 5.25 (0.72) bc | 33.81 (2.80) ab |
| D | 5.00 (0.85) bc | 31.37 (2.77) abcd |
| E | 4.66 (0.70) cd | 30.06 (4.99) bcd |
| F | 4.68 (0.73) cd | 29.62 (4.21) cd |
| G | 4.26 (0.73) d | 27.90 (2.52) d |

Control panels had the highest $R_{max}$ values, whereas group G had the lowest $R_{max}$ values. The results indicated that the $R_{max}$ values of all the treated panels were lower than those of the control panels. With increasing the thermal modification temperature, the $R_{max}$ values of the panels decreased.

CA values of the panels are shown in Fig. 1. The statistical analysis indicated that significant differences were found between the CA values of the treated panels and the control panels. The CA values of the treated panels were higher than that of the control panels. The CA values of the panels increased with increasing thermal modification temperature. The highest CA values were reached in 190 °C for 1-h however the CA values decreased by increasing in temperature from 190 °C to 210 °C. It might be caused by increased porosity in surface of the panels. The peak point was obtained 170 °C for 3-h period. Further increases in temperature decreased the CA values of the panels. The results indicate that the wettability of the panels decreased as temperature increased. The treated panels had a poorer wettability property when compared to the untreated panels. Similar results were found by Ayrilmis et al. (2009) and Hakkou et al. (2005). They reported that contact angle values increased with increasing treatment temperature. Thermal modification time negatively affected the wettability properties of the panels. The CA values of the treated panels except the panels treated with 190°C increased with increasing treatment time.

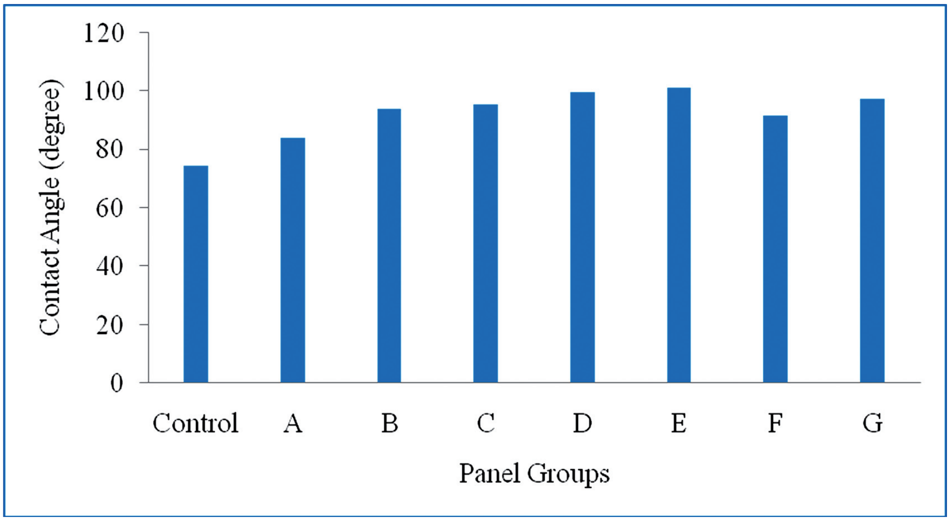


*Fig. 1: Contact angle values of the thermally treated panels*

Overall results of the study indicate that the surface roughness of the panels was improved by the thermal modification process, while the wettabilty of the panels was decreased. It could be said that higher CA values obtained in the panels having smoother surface.

## CONLUSIONS

The findings obtained in this study could be concluded as follows:

– The results obtained in this study showed that the thermal modification improved surface roughness characteristics of the OSB panels. The Ra and Rmax values of the panels decreased with increasing modification temperature for both 1-h and 3-h. The findings also indicated that the treatment temperature was major parameter affecting the Ra and Rmax values.

– The CA values of the treated panels were clearly higher than the untreated panels. The CA values of the panels increased with increasing thermal modification temperature and time. The peak point in temperatures were obtained in 190 °C for 1-h and 170 °C for 3-h. The thermally treated panels had a poorer wettability property when compared to the untreated panels.

– A clear relationship was determined between surface roughness and contact angle of the panels. The panels having smoother surface had greater CA values.

– Surface characteristics such as surface roughness and wettability of the OSB panels could become an important issue for painting, lacquering, and coating applications. Quality of the mentioned applications depends on surface quality of the panels.

## ACKNOWLEDGEMENT

The authors would like to thank Kastamonu Integrated Wood Industry and Trade Inc. located in Kocaeli, Turkey for supplying OSB panels used in this study. The authors also would like to thank Olcay Karatas, Ozan Dogus Dal, and Ugur Yilmaz who are former undergraduate students at Department of Forest Products Engineering, Istanbul University for their assistance with surface roughness and wettability testing procedure.

## REFERENCES

1. Aydin, I., Colakoglu, G., 2002a: The effects of veneer drying temperature on wettability, surface roughness and some properties of plywood. In: Proceedings of the sixth panel products symposium, 9-11 October 2002, Wales, UK: Llandudno. Pp. 60-70.
2. Aydin, I., Colakoglu, G., 2002b: The effect of steaming and veneer drying temperature on the weathering reactions. Wood-based materials, wood composites and chemistry. International Symposium, 19-22 September 2002, Vienna, Austria. Pp. 1-9.
3. Aydin, I., 2004: Activation of wood surfaces for glue bonds by mechanical pre-treatment and its effects on some properties of veneer surfaces and plywood panels. Applied Surface Science 233: 268-274.
4. Aydin, I., Colakoglu, G., 2005: Effects of surface inactivation, high temperature drying and preservative treatment on surface roughness and colour of alder and beech wood. Applied Surface Science 252: 430-440.
5. Aydin, I., Colakoglu, G., 2005: Effects of surface inactivation, high temperature drying and preservative treatment of plywood as a function of log temperature in peeling process. International Journal of Solids and Structures 43: 6140-6147.
6. Ayrilmis, N., Dundar, T., Candan, Z., Akbulut, T., 2009: Wettability of fire retardant treated laminated veneer lumber (LVL) manufactured from veneers dried at different temperatures. Bioresources 4(4): 1536-1544.
7. Brochmann, J., Edwardson, C., Shmulsky, R., 2004: Influence of resin type and flake thickness on properties of OSB. Forest Prod. J. 54: 51-55.
8. EN 317, 1993: Particleboards and fiberboards, determination of swelling in thickness after immersion
9. Gu, H., Wang, S., Neimsuwan, T., Wang, S., 2005: Comparison study of thickness swell performance of commercial oriented strandboard flooring products. Forest Prod. J. 55: 239-245.
10. Hakkou, M., Petrissans, M., Zoulalian, A., Gerardin, P., 2005: Investigation of wood wettability changes during heat treatment on the basis of chemical analysis. Polymer Degradation and Stability 89: 1-5.
11. ISO 4287, 1997: Geometrical product specifications surface texture profile method terms, definitions and surface texture parameters
12. Khan, S., Chui, Y. H., Schneider, M. H., Barry, A. O., 2004: Wettability of treated flakes of selected species with commercial adhesive resins Journal of the Institute of Wood Science 16 (5): 258-265.
13. Korkut, S., Akgul, M., 2007: Effect of drying temperature on surface roughness of Oak (*Quercus petraea* ssp. *iberica* (Steven ex Bieb) Krassiln) Veneer. Building and Environment 42(5): 1931-1935.

Oner Unsal
Istanbul University
Faculty of Forestry
Department of Forest Products Engineering
Bahcekoy, Sariyer
34473 Istanbul
Turkey

Zeki Candan
Istanbul University
Faculty of Forestry
Department of Forest Products Engineering
Bahcekoy, Sariyer
34473 Istanbul
Turkey

Umit Buyuksari
Istanbul University
Faculty of Forestry
Department of Forest Products Engineering
Bahcekoy, Sariyer
34473 Istanbul
Turkey

Suleyman Korkut
Duzce University, Faculty of Forestry
Department of Forest Industrial Engineering
81620 Beciyorukler Campus
Turkey
E-mail: suleymankorkut@duzce.edu.tr

Marian Babiak
Technical University in Zvolen
Faculty of Wood Science and Technology
Department of Wood Science
T. G. Masaryka 24
960 53 Zvolen
Slovak Republic