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STSM SCIENTIFIC REPORT

Action: COST FP1006
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COST STSM Reference Number: COST-STSM-ECOST-STSM-FP1006-130114-039143
STSM Research Theme: "Effect of Thermo-Mechanical Treatment on the Gloss of Various Wood Species"
STSM Applicant: Dr. Pavlo Bekhta, National University of Forestry & Wood Technology of Ukraine, Department of Wood-Based Composites
Host: Dr. Tomasz Krystofiak, Poznan University of Life Sciences, Department of Gluing and Finishing of Wood

STSM Scientific Report Contents:

1. Purpose of the STSM

In recent years, there has been a rapid increase in the application of different methods of modification to wooden materials in order to improve their physical, mechanical, biological, and fire properties. Heat or thermo-mechanical treatment is an alternative method for improving these properties with no use of chemical additives. Besides, wood has been popularly and favourably used as a decorative material owing to its aesthetic appearance and characteristics properties. Heat or thermo-mechanical treatment would

provide an inexpensive alternative method to darken wood to imitate more expensive exotic species. Many researches have focused on the colour of heated wood, while research on the effects of thermo-mechanical treatment on gloss of wood is rather limited.
The purpose of this STSM in Poznan University of Life Sciences was to study the effect of thermo-mechanical densification process parameters (pressure, temperature, duration) on the gloss values of different wood species.

2. Description of the work carried out during the STSM

2.1. Materials

Commercial rotary cut veneer sheets were obtained from alder (*Alnus glutinosa Gaertn.*), beech (*Fagus sylvatica* L.), birch (*Betula verrucosa Ehrh*.) and pine (*Pinus sylvestris* L.) logs at Sklejka-Multi S.A. plywood company in Bydgoszcz, Poland. Defect-free veneer sheets of 300 x 300 x 1.5 mm dimensions and with 5% moisture were then transported to the laboratory. Tangential sheets of veneer were cut into 140 x 100 mm rectangular pieces for the thermo-mechanical densification process and subsequent measurements. Before thermo-mechanical densification all test samples were equilibrated at relative humidity of 65% and temperature of 20^{o}C.

2.2. Thermo-mechanical densification technique

Thermo-mechanical densification was performed using a temperature-controlled laboratory press. Three different temperatures (100, 150, and 200^{o}C) and three densification pressures (4, 8, and 12 MPa) were applied to wood samples. Each wood sample was thermo-mechanically densified between smooth and thoroughly cleaned heated plates of the press at applied temperatures and pressures during 4 min.

2.3. Gloss measurement

Changes in densified surface veneer properties were evaluated by gloss measurements. Gloss was determined according to DIN 67530, ISO 2813 using photoelectric apparatus PICO GLOSS 503 (Fig.1). Surface gloss of the non-densified and densified veneer surface was measured at 20^{o}, 60^{o} and 85^{o} angles of incident light. Two measurements were taken from the surface of each sample, one along and one across the grain orientation. Complete specular light reflection, which is perfect gloss, would be 100%, and complete diffuse light reflection mat would be 0%.

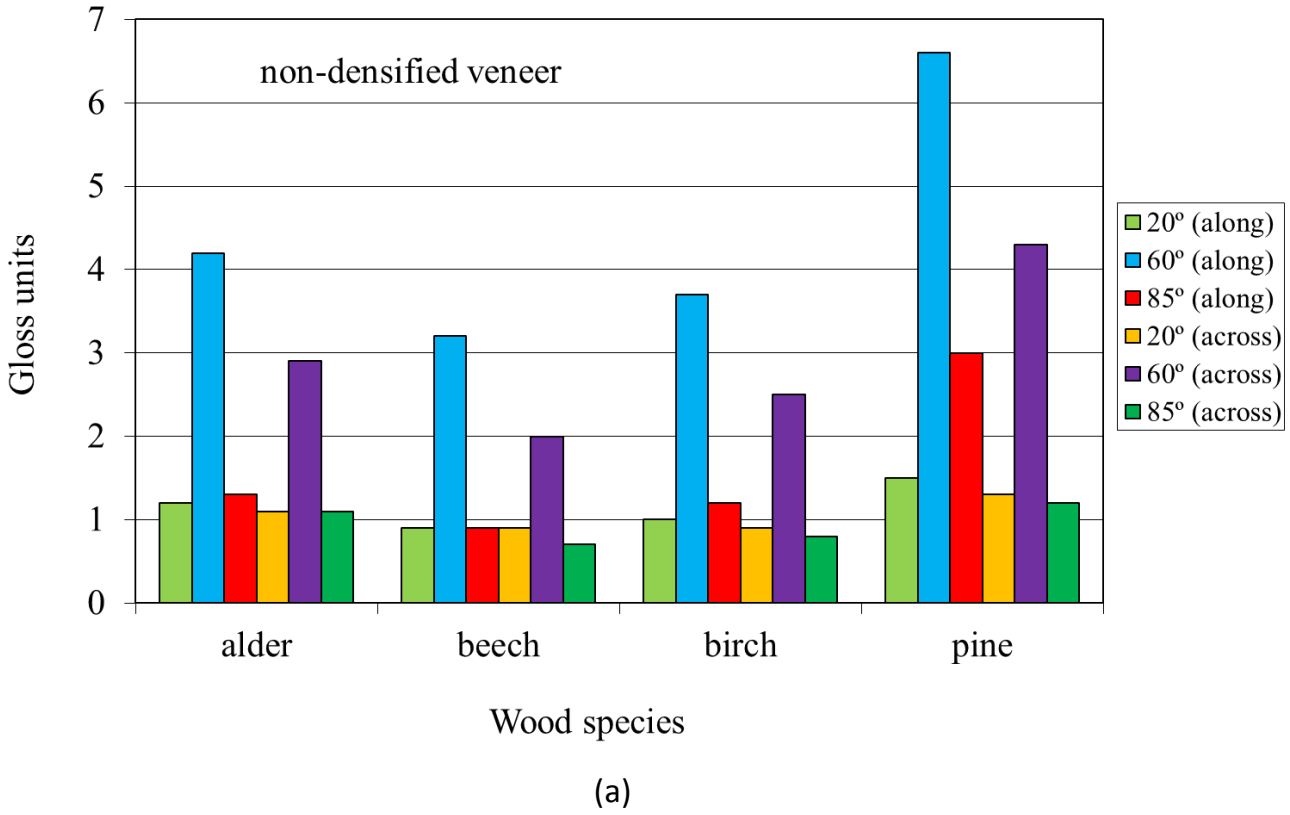
Fig.1. PICO GLOSS 503

2.4. Statistical analysis

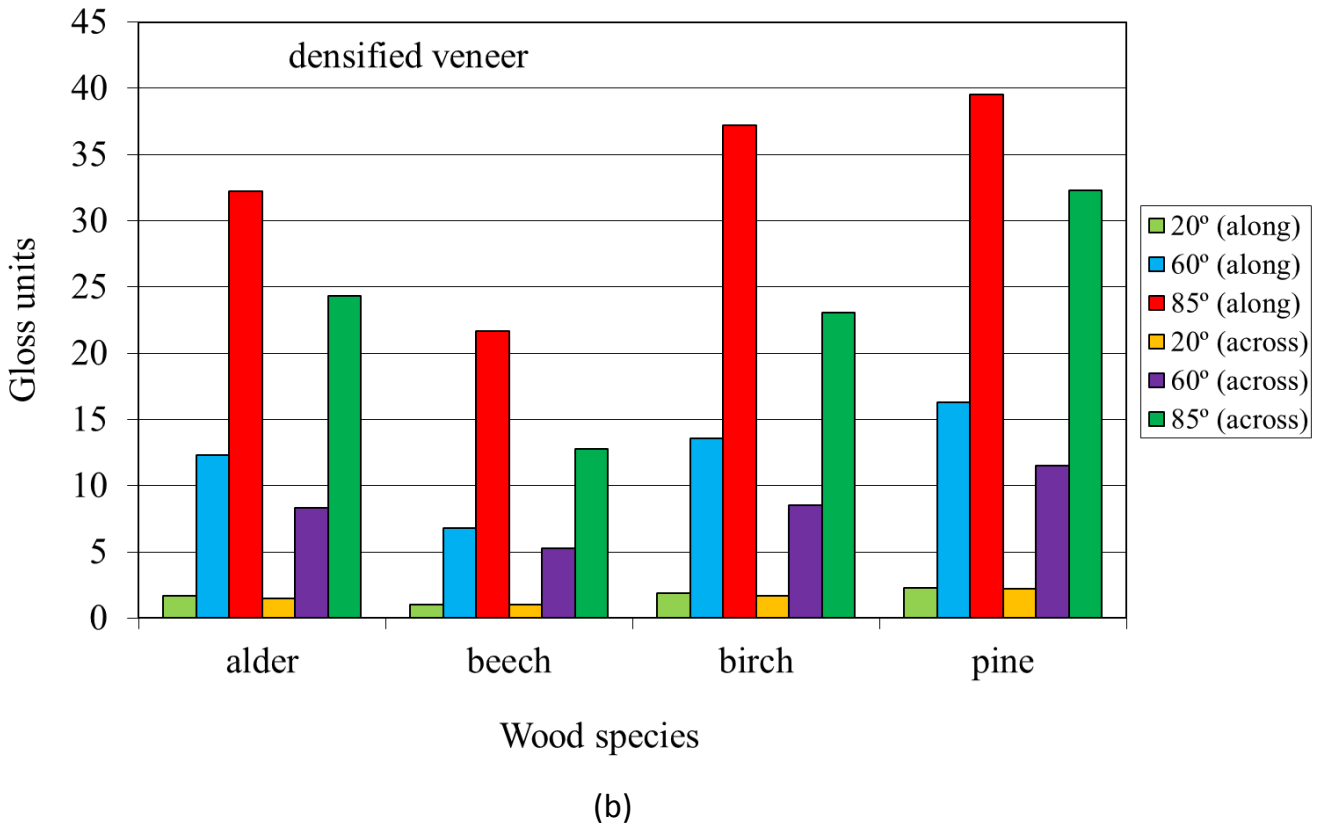
Four different species of wood (alder, beech, birch, and pine) veneers, three different densification temperatures (100, 150, and 200^{o}C), three different densification pressures (4, 8, and 12 MPa), three different angles (20^{o}, 60^{o}, and 85^{o}), two directions of measurement (along and across the grain orientation), and twelve replications for each cell were prepared (4 x 3 x 3 x 3 x 2 x 12 = 2592 samples). A full factorial variance analysis was made in order to determine the effects of each dependent variable. In cases where the differences among the groups were statistically significant, a comparison was made with Duncan's multiple range test at the α = 0.05 confidence level.

3. Description of the main results obtained

Gloss measurements showed the enhancement of aesthetic properties of densified wood. Findings of this study indicated that both densification temperature and pressure affect the wood gloss significantly. The gloss values of densified wood increased with increasing densification temperature and pressure for all investigated species. Compared to non-densified wood, the gloss (85^{o}) values (across - along the grain) for alder, beech, birch and pine increased after treatment on 2109.1 - 2376.9%, 1728.6 - 2311.1%, 2787.5 - 3000%, and 2591.7 - 1216.7%, respectively. The greatest gloss values were obtained at temperature of 200^{o}C and pressure of 12 MPa for all tested angles of incident light and for all densified wood samples (Fig.2). The gloss changes for birch were the highest but the glossiest surface was observed for pine among all investigated species after wood densification.



(a)



(b)

Fig. 2. Average gloss values of wood species at different angles of incidence light: (a) in non-densified wood veneer; (b) in wood veneer densified temperature 200^{o}C and pressure 12 MPa

4. Future collaboration with host institution (if applicable)

The STSM allowed me to exchange literature, knowledge, and research experiences. Directions for future collaboration were discussed during the visit and as the final result, some activities were decided on: (a) collaboration through publications: in international journals or through joint participations in international workshops; (b) collaboration through research projects in the framework of HORIZON 2020 and Erasmus Plus; (c) collaboration through specific STSM actions to be investigated further.

5. Foreseen publications/articles to result from the STSM (if applicable)

One joint article entitled "The Gloss of Thermally Densified Alder, Beech, Birch and Pine Wood Veneers" (authors: Bekhta P., Proszyk S., Lis B., Krystofiak T.) is being prepared according to the results of this STSM. This article will be submitted to one of the refereed journals. The results obtained during this mission will also be presented in the future meetings within COST Action FP1006. The results of this mission are stimulating new investigations in the application of the densification process for enhancing surface characteristics of veneer and overlaying properties of medium density fibreboard (MDF) panels.

6. Confirmation by the host institution of the successful execution of the STSM

The confirmation is in a separate file.

7. Other comments (if any)

I would like to thank the COST network for funding this visit. I would also like to thank my hosts, Prof. Stanislaw Proszyk and Dr. Tomasz Krystofiak, for inviting me to the Poznan University of Life Sciences and for creating such a welcoming and warm family atmosphere for me, as well as for very interesting excursions. I am looking forward to continuing our collaboration very much.

February 09, 2014, Lviv, Ukraine

Prof. Ing. Pavlo Bekhta, DrSc.