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Influence of wood surface processing on roughness and wetting

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Abstract: *Influence of wood surface processing on roughness and wetting*. The paper gives the evaluation of the influence of various ways of technological processing of aspen wood surface on the roughness, and consequently on wetting of the wood surface with a liquid. The wood surface was processed by three various technologies: milling, sanding, and pressing. On these surfaces, the arithmetic mean deviation of the assessed profile was measured. Subsequently, wetting of these surfaces with redistilled water was measured – by the method of static measurement of the equilibrium contact angle of a sitting drop. The milled surface reached the greatest roughness and, at the same time, the best wetting.

Keywords: roughness, wetting, adhesion, aspen wood, surface processing

INTRODUCTION

At wood gluing or the wood surface finishing, there is necessary to deal with the adhesion of wood toward various substances in solid or liquid forms. At the technology of gluing or surface finishing, various substances, adhesives, or coatings are applied on wood in liquid state; and subsequently they pass into solid state. It is important to know all the factors that influence the adhesion of wood. If joining the wood materials with non-wood materials, it is necessary to reach the best adhesion between these two different materials.

When a drop of a liquid covers the element of the solid surface, after stabilisation of steady-state, the system "solid substance – liquid" is stabilised (Liptáková, Sedliačik, 1989). When the system is formed, adhesion may be accompanied by penetration.

Adhesion on the interphase "wood – liquid" is manifested by wetting of wood by liquid phase (Liptáková, Sedliačik, 1989). Wetting process can be defined as a macroscopic manifestation of molecular interactions between liquids and solids that are in direct contact on their interphase (Berg, 1993). One of the parameters describing wetting is the contact angle. Liptáková and Kúdela (1994) have defined steady-state between the surface and a drop. In the exactly moment, it is possible to measure the equilibrium contact angle of a sitting drop. The method of determination of wetting of wood, based on the measurement of the initial contact angle θ_w, which corresponds to the ideal homogenous wood surface without pores, was used by Liptáková and Kúdela (1994), Kúdela and Liptáková (2006), and Kúdela and Wesserle (2013).

Some different model of wetting of wood was created by Shi and Gardner (2001). They have described wetting of wood quantitatively, based on the initial contact angle θ_0, the equilibrium contact angle θ_u, and the constant of spreading and penetration K.

The purpose of this work was to understand the influence of various technological processing of aspen wood surface on the surface roughness and subsequently on wetting of wood surface with a liquid.

MATERIALS AND METHODS

In the experiment, we used aspen wood specimens (*Populus alba* L.) with dimensions 200 mm × 100 mm × 20 mm, with tangential-radial surface, with wood moisture content of 8 % ± 2 %, and the average density in absolute dry condition ρ_0 = 420 kg/m^3.

The surface of the tested specimens was processed by following technologies:

1. wood milling – with milling machine,
2. pressing – in the press with two heated pressing plates; pressing temperature 140 °C, pressing time of 5 minutes, and densification of the specimens by 1 mm from the thickness,
3. sanding – with the belt sander; sandpapers with the grit numbers 60 and then 120.

After processing, the specimens were conditioned for 24 hours in the room, at the temperature of 20 ºC ± 2 ºC, and the relative air humidity of 60 % ± 5 %. Subsequently, the surface roughness was measured in the parallel and perpendicular directions to wood grain. The arithmetic mean deviation of the evaluated profile *Ra* [µm] was measured with the contact profilometry device POCKET SURF (with a radius of sensor roughness r = 0,005 mm) on the length of L = 1 mm

Wetting of various processed surfaces of aspen wood was measured on the base of static measurements of the equilibrium contact angle of a sitting drop. In the experiment, redistilled water was used and dropped onto the wood surface in the amount of 2 µl. Behaviour of the droplet on the wood surface was recorded as a video; and subsequently, the computer measured the equilibrium contact angle of a sitting drop. Spreading of the drop onto the wood surface was monitored in the longitudinal direction to wood grains.

RESULTS AND DISCUSSION

The average values of the parameter R_a measured on aspen wood surface processed by three various technological processing are graphically illustrated in the figures: the parallel direction in Figure 1 and the transverse direction in Figure 2. Average values of the equilibrium contact angle of a sitting drop (measured on various processed surfaces in the longitudinal direction are illustrated in Figure 3.

The wood surface roughness, characterised as the mean arithmetic deviation of the profile R_a, measured in the transverse direction, was the lowest on the pressed surface.

In the longitudinal direction, R_a on the pressed and sanded surfaces was about the same. Significantly higher roughness in the longitudinal direction was measured on the milled surface. The results are comparable with results by Slabejová and Móza (2009), and Slabejová (2010).

From the relationship between the roughness and the equilibrium contact angle (Figures 1, 2, and 3) follows, that wetting of aspen wood surface with redistilled water is worse on surfaces with lower roughness.

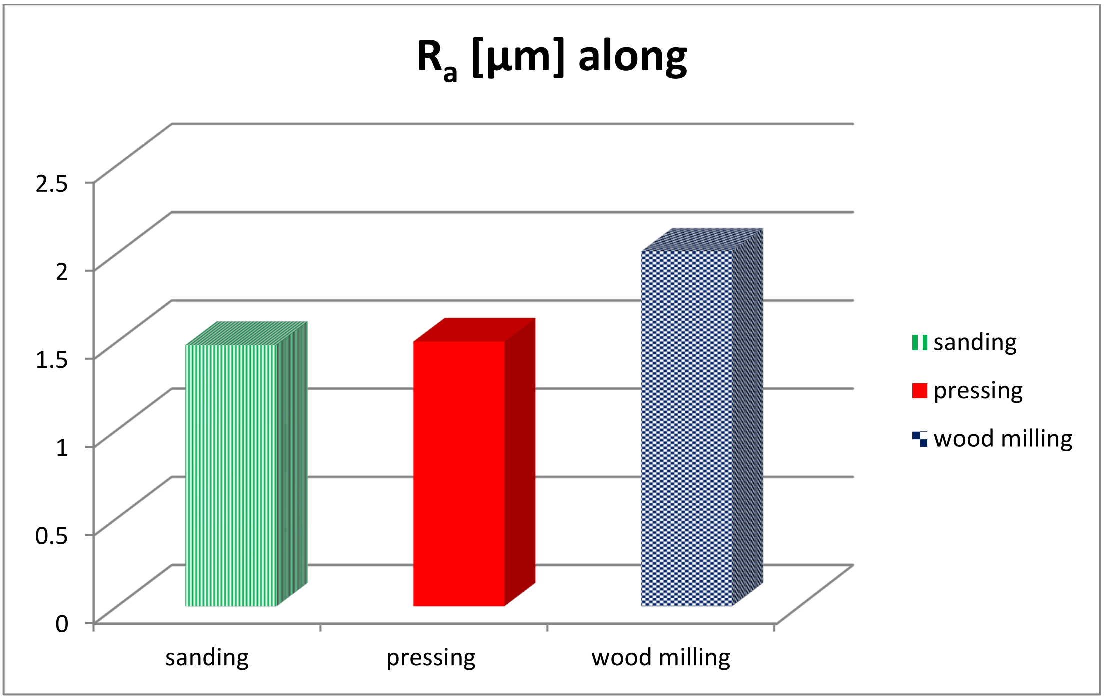

Figure 1. Roughness R_a in the direction parallel to wood grain; surfaces of aspen wood processed by various technologies

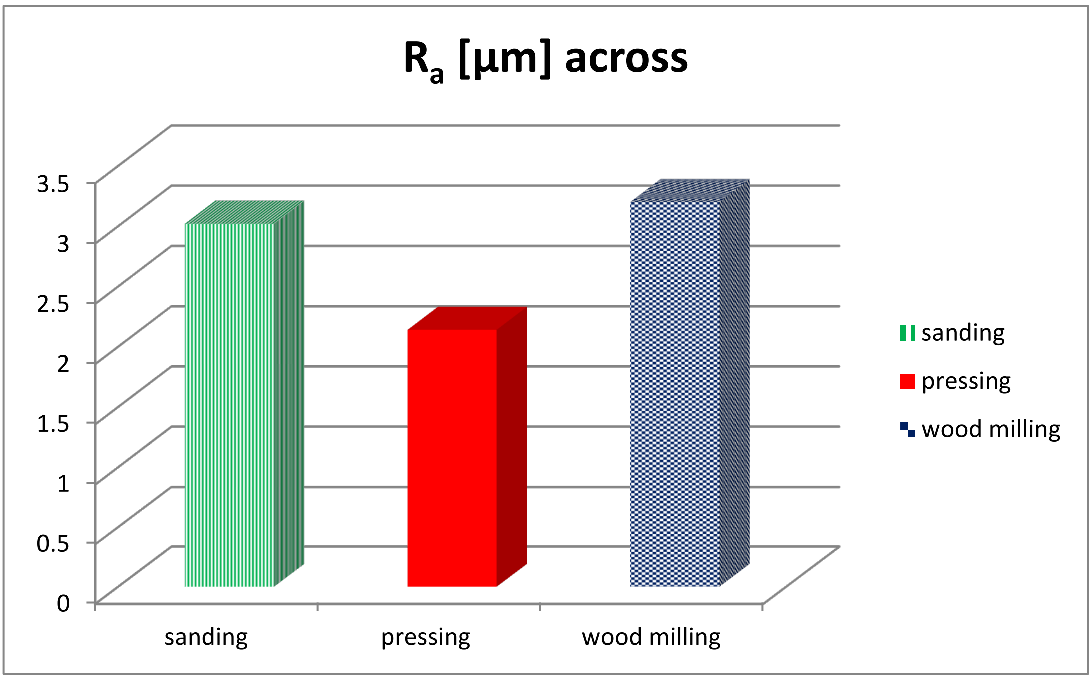

Figure 2. Roughness R_a in the direction transversal to wood grain; surfaces of aspen wood processed by various technologies

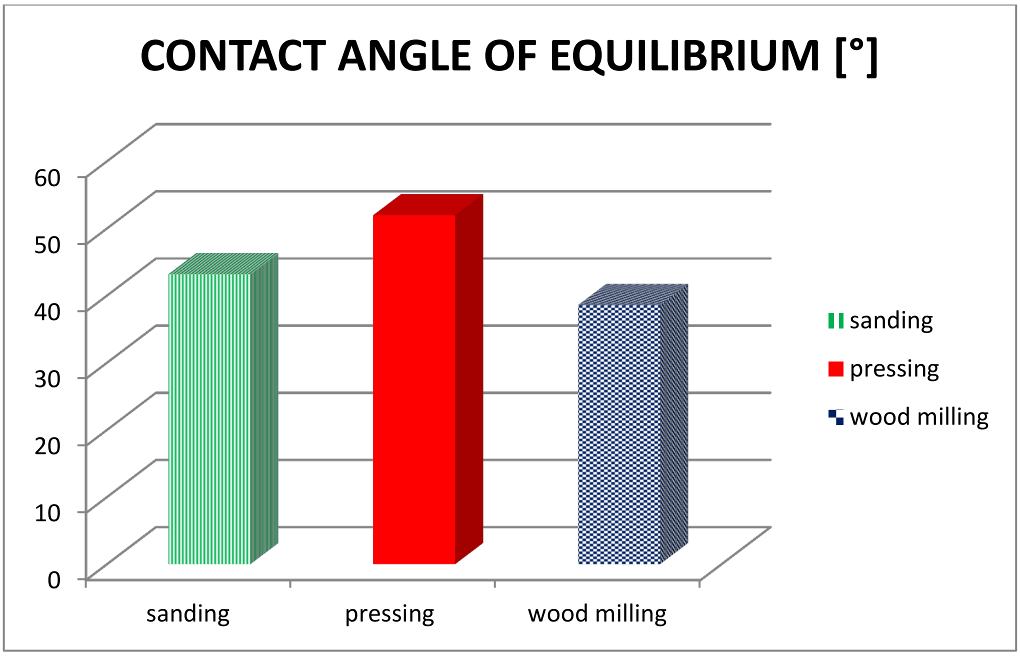

Figure 3. Equilibrium contact angle of a sitting drop;
surfaces of aspen wood processed by various technologies

The measured values of the equilibrium contact angle confirm that wetting is influenced by the technology of surface processing. All the same, wetting of wood surface is influenced by some other factors which were not monitored in this paper. Wetting of wood surface is influenced also by chemical composition of wood, as it was described by Liptáková and Kúdela (1994). Wetting of wood surface is also influenced by the wood moisture content, what was described by Kúdela and Wesserle (2013).

CONCLUSION

Based on the measured results, we can conclude that wetting of aspen wood is better on the milled surface than on the sanded or pressed materials. Good wetting of the surface is a prerequisite for good adhesion in the process of joining materials. The quality of adhesion is also influenced by mechanical anchoring; and mechanical anchoring is assured by just a sufficient surface roughness.

The technologies of sanding and pressing are more proper for surface processing before surface finishing with coatings. Wood surface roughness is reduced by sanding or pressing. That is necessary for achieving a quality smooth coating. Aspen wood roughness, parallel, and especially across the fibres, is significantly reduced by pressing. At the same time, wetting of wood surface is negatively influenced.

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Streszczenie: Wpływ obróbki drewna na chropowatość i zwilżalność. Praca opisuje wpływ różnych procesów technologicznych na chropowatość i zwilżalność drewna osiki. Powierzchnia drewna została poddana obróbce na 3 sposoby, piłowaniem, szlifowaniem oraz prasowaniem. Określono chropowatość powierzchni obrobionego drewna, oraz zwilżalność powierzchni wodą destylowaną. Piłowane powierzchnie, o najwyższej chropowatości miały też najlepszą zwilżalność.

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