# EFFECT OF THE SANDING TIME AND ABRASIVE GRIT SIZE ON SURFACE ROUGHNESS OF WOOD

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## ABSTRACT

This paper presents the research results, showing how the surface roughness of black alder (*Alnus glutinosa* L.) and larch (*Larix sibirica* L.) wood is changing with increase of sanding time and abrasive grit size. The samples were sanded in the sanding stand using abrasive grit of three different sizes (P80, P120 and P180). The parameter of surface roughness of processed samples $R_z$ was measured by contact profilometer in three sectors. The roughness in each sector was measured along and across the wood grain. Before statistical processing and modelling the received measurement results were processed using special digital filter. The results showed that the surface roughness is best explained and ranked by the sanding time, size of abrasive grit and wood grain direction.

**Keywords:** wood surface roughness, wood sanding, alder wood, larch wood

## INTRODUCTION

Wood is anisotropic material, which physical and mechanical characteristics depend on the biological sort, humidity, environmental conditions and other factors (Varasquim et al. 2012).

Sanding is an important process of mechanical processing that affects the quality of sanded surfaces. The wood sanding process is affected by the wood's biological sort, density, humidity, structure of sanding material, abrasive grit size, sanding direction, speed, and other factors (Hendarto et al. 2006, De Moura et al. 2006, Kiliç 2006).

The sanding pressure and removal of dust also play an important role. The removal of sanding dust improves the quality of sanded surfaces and extends the usage time of sanding material (Saloni 2007).

Sanding is a complex cutting process because numerous small abrasive grits, the geometry of cutting edges of which is difficult, are used. Each abrasive grit performs the micro-cutting of certain depth. Therefore the regularities of ordinary cutting cannot be applied to sanding (Koch 1964, Pahlitzsch 1970, Lubchenko 1986, Baltrušaitis 2011). The efficiency and productivity of sanding material depends on the structure of sanding

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materials, materials and technologies used to make it, sanding regimes, and operation conditions (Koch 1964, Lubchenko 1986, Baltrušaitis 2011).
The micro ledges of abrasive grits are the independent cutting elements, which cut the shave thinner by 10–100 times than the usual cutters (Koch 1964, Lubchenko 1986, Baltrušaitis 2011). The abrasive grits are of irregular form and are set along the tool's surface unevenly, thus sanding is an unstable cutting process (Pahlitzsch 1970). The abrasive grits got worn and blunt during the sanding process. The abrasive grit that protrudes the most, especially if it has obtuse cutting angles, makes the strongest shave. The blunt grit will be torn out of the binding material under the impact of force resisting to cutting (Lubchenko 1986, Baltrušaitis 2011). When the amount of abrasive grits in the sanding area decreases, the sanding force grows and the quality of sanded surface decreases (Ohtani et al. 2004, Gurau et al. 2005, Hendarto et al. 2006, De Moura et al. 2006, Kiliç 2006). The decrease of sharpness leads to the deformation of material's surface. When the force and deformation are increasing, the bigger wear between the abrasive grit and sanded surface appears, which results in increased temperature during the process (Pahlitzsch 1970, De Moura et al. 2006, Hiziroglu et al. 2006).
L. Javorek has determined that sanding pressure has significant impact on the consumption of electric energy and cutting power of sanding process. The author has noticed the pressure's influence on the cutting direction and cutting speed, cutting power and energy consumption (Javorek et al. 2006). B. Porankiewicz has proved that the durability of sanding material depends on the pressure. The abrasive grit size also affects the servicing time of sanding material (Porankiewicz et al. 2010).
The purpose of this research is to determine the effect of the sanding time, grit size of sanding material, and biological sort of the wood on the quality of sanded surfaces.

## MATERIAL AND METHODS

The testing samples were cut from black alder (*Alnus glutinosa* L.) and larch (*Larix sibirica* L.) wood. The wood's physical characteristics are presented in the Table 1. 30 units of samples of black alder and larch wood each were prepared for tests. The length of samples was 150 mm, width – 90 mm, and thickness – 50 mm. The average temperature in the testing room was $t = 18 \pm 2$°C, and relative air humidity was $\psi = 60 \pm 5$ %.

**Table 1.** Physical characteristics of wood

| Wood species | Moisture content $\omega$, % | Number of annual rings per 1 cm | Average width of annual ring, mm | Average density, kg/m$^3$ |
|---|---|---|---|---|
| Black alder (BA) | 5…7 | 5.70 | 1.75 | 485 |
| Larch (L) | 8…10 | 7.40 | 1.35 | 629 |

The samples were sanded by AO–F sanding belts (Sait Abrasivi S.p.A.). The grits of different sizes P80, P120 and P180 (according to FEPA) were made from aluminium oxide ($Al_2O_3$) and attached to antistatic paper (type F). The length of sanding belts was 1500 mm, and their width was 120 mm.

The tests were carried out in the wood sanding stand (Fig. 1) made in the base of belt sanding machines. In order to press the sample to the sanding belt, the 2000 ± 10 g weight was used. Thus the constant sanding speed of $q = 238$ Pa was created. The manual pressing force was not applied. The specimens were sanded according to the technological scheme of the belt-sanding. The sanding speed was 11 m/s.

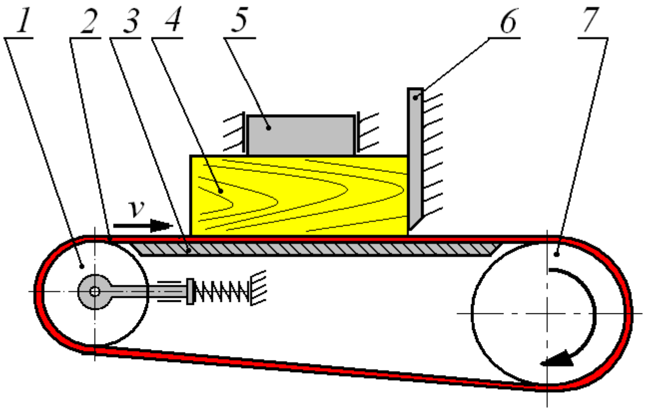



**Figure 1.** Principal scheme of sanding stand: 1 – tension roller; 2 – sanding belt; 3 – table; 4 – sample; 5 – weight; 6 – support; 7 – driving roller

The surface roughness parameter $R_z$ was measured by contact stylus tip profilometer (Mahr Marsurf PS1). The radius of stylus tip was 2 µm, the measurement angle was 90°, and the measurement length was 17.5 mm. The surface unevenness was measured after the sanding time of 5, 10, 15, 20, 25 and 30 min. Three sectors were selected in one sample (17.5×17.5 mm) and their roughness was measured along and across the grain. Three tests were conducted in order to measure one sanding material's grit size. Therefore the number of measurements of surface roughness according to one set sanding regime was 18 units. The received measurement results were processed buy Gaussian digital filter. The measurement bias of unevenness did not exceed ± 10 %.

## RESULTS AND DISCUSSION

The conducted tests helped to determine the effect of the sanding time and grit size of sanding material on surface roughness. Besides, it was determined that the numeric values of surface roughness measured along and across the grain had different values. It was noticed when the surfaces of different wood sorts were measured.

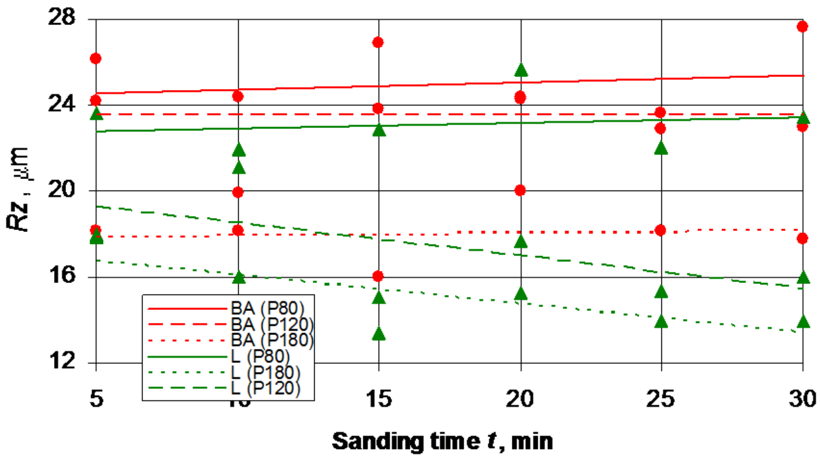
The testing results (Fig. 2) revealed that the grit size of sanding material affected the surface roughness of wood the most. The sanding time and sort of wood also remain important factors.

The analysis of numeric values of roughness parameter $R_z$ revealed that they are decreasing with decrease of grit size of sanding material.

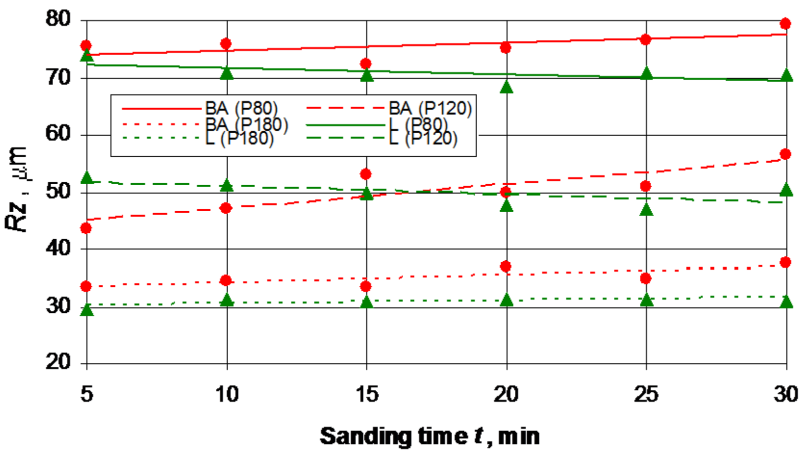
The biggest numeric values of roughness parameter $R_z$ were determined when the sanding material of P80 grit size was used; the average results were at P120, and the smallest values were received with P180 sanding material.

The changes of results were noticed during the analysis of effect of sanding time on surface roughness. The resting results manifest that when the sanding time increases, the numeric values of roughness parameter $R_z$ decrease. The surface roughness changes the most intensively, i.e. the $R_z$ numeric values are decreasing the most intensively during the first 15 minutes. The $R_z$ change is very insignificant during the period from 15 to 30 minutes.

When the average numeric values of roughness parameter $R_z$ of black alder and larch wood were compared, it was noticed that the values of sanded black alder wood exceeded the larch's values by 16 %. The results were affected by the wood's density, anatomical and anisotropic factors.




a




b

**Figure 2.** Surface roughness parameter $R_z$: a – along the grain; b – across the grain

## CONCLUSIONS

When the wood samples were sanded, the surface quality was changing the most intensively during the first 15 minutes. The quality change was very insignificant during the period from 15 to 30 minutes.

The grit size of sanding material affects the roughness of the sanded surface. When the sanding materials of smaller grit size are used, the surface unevenness gets smaller. The surface becomes smooth and the quality improves. The biggest numeric values of roughness parameter $R_z$ were determined when the P80 sanding material was used. The average values were received while sanding with P120 material, and P180 sanding material resulted in the smallest values.

The analysis of the grain's direction helped to determine that the numeric values of roughness parameter $R_z$ along the grain were smaller than the values measured across the grain.

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