

Study on Evaluation Method of Surface Roughness of Wood Processing

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Abstract. Surface roughness is one of the important indexes for evaluating the surface properties of materials. However, the present surface roughness evaluation of porous materials is not a uniform standard and equipment. In this paper, a laser three-dimensional microscope system is used to test and analyze the surface roughness of different parts of wood with different processing methods. A fast method is proposed for the evaluation of surface roughness of wood processing. The first step is to comprehensively consider the evaluation site of the selected specimen; Second step is to select two steps to meet the accuracy grade and the appropriate test mode to finish the measurement and evaluation.

1. Introduction

The surface of wood products is one of the main evaluation indexes of contact with human body and appearance performance, it affects the function and use of wood products. The surface roughness value is mainly used in the evaluation of superficial quality, and there are many factors affecting surface roughness. Wood properties, processing machinery precision, processing parameters, tool materials and tool parameters [1, 2], and other factors alone or superimposed, the shape is very complex. The different surface roughness evaluation parameters are different, the surface roughness formation mechanism is different, and the pipe and other timber structure caused by the pits. As a result, the surface roughness of wood processing is composed of two parts [1, 3] resulting from the surface roughness formed by the processing itself and the roughness caused by the wood cell structure. The wood structure affecting surface roughness mainly includes duct (Guincon), wood fiber, axial thin-walled tissue, wood ray and ring, and the influence degree of tree species and processing surface and wood structure is different [1, 3, 4, 5]. The surface shape and roughness of wood affect the consumption, non-flammable and decoration quality of adhesives and coatings, and the requirements of surface roughness should be taken into account when determining processing technology and machining allowances. Therefore, many researches have been done on the surface roughness of wood at home and abroad, and the research on the determination of surface roughness of wood has sprouted in the 30's [6], the real beginning was the 50's [3]. The main wood surface roughness parameters of the study [7, 8, 9], study on the mechanism of surface forming and the influence of tree species and wood structure [3, 10, 11], study on the influence of cutting mode and cutting parameters and roughness [12, 13], study on machined surface and suitable filtration treatment value [14]. Research on laser online test and application [15, 16, 17], research on the relationship

between surface roughness, tactile sensation and roughness [10, 14], the effect of wood treatment conditions on surface roughness [18], Application of image processing method in surface roughness measurement [19, 20, 21], Effect of surface roughness on finishing treatment [22, 23], the influence of material on surface roughness [24, 25, 26], the study of the influence of cutting tool and tool material on surface roughness [27, 28], basically covers various factors that affect the surface roughness of wood processing. With the continuous improvement of people's living standard and the rapid development of wood industry, building decoration industry and furniture industry, the surface quality requirements and importance of wood parts are more and more high. The surface roughness not only affects the appearance quality of wood parts, but also affects the processing technology and production cost. However, at present, there is no special measuring equipment and the ideal evaluation method. The measuring parameters and standard methods of surface roughness of wood parts are developed on the basis of the standardized measurement theory of the contact needle homogeneous materials [29, 30, 31]. The method of surface roughness measurement can be divided into two types: contact measurement and non-contact measurement. Contact measurement mainly refers to the stylus type measurement, this method can reproduce the surface condition of workpiece, but it is easy to damage the surface of the workpiece, at the same time the size of probe needle directly affects the precision of measurement, low measurement precision, and can not directly identify the structure of wood, it is difficult to meet the requirements of modern measurement technology. Non-contact measurement has the advantages of fast, non-contact, non-destructive and high precision, which is paid attention to by people. The Non-contact method, represented by the laser method with high measurement accuracy and relative measuring speed, is more suitable for the determination of wood surface roughness. In this study, a shape measuring laser microscope system was used to determine the surface roughness of wood with different parts, different processing modes, different magnification and different test modes, so as to propose a method for evaluating the surface roughness of wood processing.

2. Materials and methods

2.1. Test materials

The Elm (*Ulmus rubra*) and Poplar (*Populus beijingensis*) used in this experiment were taken from the woodland of Yuquan District Dalai Zhuang village, Hohhot. The age of Elm is 45-48 years. The sapwood is consisted of 6 rings; Heartwood is consisted of 41 rings. The ring width distribution of 0.35-7.90mm and the average diameter of ring is about 303mm.

Poplar is of 34-37 years. The sapwood is consisted of 13 rings, while heartwood of 23. The ring width distribution is of 0.57-9.68mm and the average diameter is of 315mm.

Pinus sylvestris was obtained from the Forest in the Ude (Ulam) region of Russia, with the age of 79-83 years. The Sapwood has about 44 rings, the heartwood is consisted about 38. The ring width is from 0.21 to 3.65mm and the average diameter is about 310mm.

2.2. Sample processing

Each log selected two sections after the cross-section saw into a disk-wood section, the disk of wood at intervals 90° intercept 50mmx50mmx70mm hardness test block, with 80 mesh abrasive belt grinder sanding into a specimen. Sawing machine with rotational speed of 3600rpm rotary sawing machines. Log cross-section saw the processing of 40mm wide rotary cutting wood section, with the modified lathe to spin cut out the chip samples, cutting edge arc radius 0.3μm [32], cutting thickness of 0.32mm.

2.3. Determination of roughness

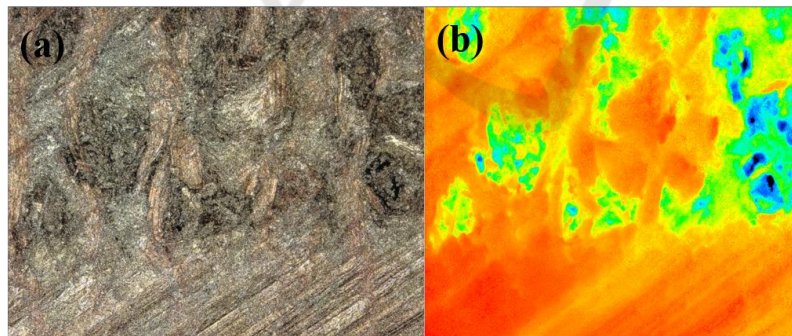
2.3.1. Test Equipment. The laser microscopy system, which is produced by Keyence (KEYENCE), is used in vk-x150 shape measurement to meet the requirements of iso4287:1997 roughness measurement and test standards. The main characteristics of the sample is not required for the initial processing of steam, and do not need to cut, disassembly and other processing, can directly carry out 3D measurement analysis. Compared with the traditional contact surface roughness instrument and optical microscope, it has many advantages such as high resolution, good definition, large-area panorama analysis, good image coherence, three-dimensional appearance and rapid acquisition of three-dimensional shape information of sample surface. such as 10 times times the objective 200 times magnification, the field range is 1350um×1012um, Z axis measurement height range 7mm.

2.3.2. Test method. The surface roughness of the specimens of *Elm*, *Poplar* and *Pinus sylvestris* was measured by the laser microscope system with VK-X150 shape, and the ring junction was selected. The influence of wood microstructure, tree species, cutting process, magnification and test mode on surface roughness of specimen was analyzed.

3. Results and discuss

3.1. Analysis of surface roughness

3.1.1. Determination of surface roughness. The process of measuring surface roughness of Elm cross section sanding is an example to illustrate the method of roughness determination and evaluation. The main image, color height image and three-dimensional image of the laser scan generated in the following Figure 1 are measured by the shape measurement laser microscope system. Clearly see the diameter and distribution of the Elm's pipe hole and the blockage of the abrasive powder into the pipe hole. Choose different test locations to get different roughness values. In this experiment, the average roughness value (Ra) was used to evaluate the roughness of machined surface under various test conditions.



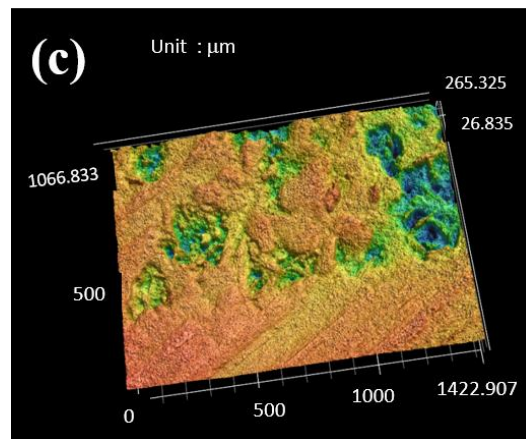


Figure 1. The three kinds of test charts for the transverse section of elm Sanding. (a): main image (laser + color); (b): height image; (c) 3D image.

The surface roughness values of the large parts of the wood structures, which are affected by the structure of the pipe and other timber structures, are measured by the line roughness measurement function, as shown in Figure 2 below. According to the laser scanning, color height and three-dimensional topography, the structure of the wood structure is clearly separated, and the suitable evaluation site can be selected. Select the stylus mode to obtain the measuring value of the stylus surface roughness.

3.1.2. Comparison of surface roughness of different parts. Wood is a naturally growing biomass material, which is mainly embodied in its three facets. Therefore, in the case of elm, the surface roughness values of the three sections and different test conditions of elm sanding are shown in Figure 3. The location of the selected rings of the determination site takes into account both the early and late materials. It is shown from the figure that the roughness of the three-cut section of Elm Wood is the cross section of the diameter section and the chord plane. This is the diameter of the duct and wood rays and other tectonic effects more prominent as a result, the chord section of the tube and wood rays on the shallow, cross section of the main pipe hole pits, to some extent by the abrasive powder blocking. The roughness of the duct, which does not contain (less) on each section, is obviously less than that of the surface roughness of the large part of the structure, and the roughness of the three sections is close to the cross section. The diameter and cross section of the structure impact of the wood fiber is more dense homogeneous, while the string on the surface of the reverse and the consequent sanding of the impact of roughness. The pits of the pipe holes are clearly seen in Figure 1 and 2.

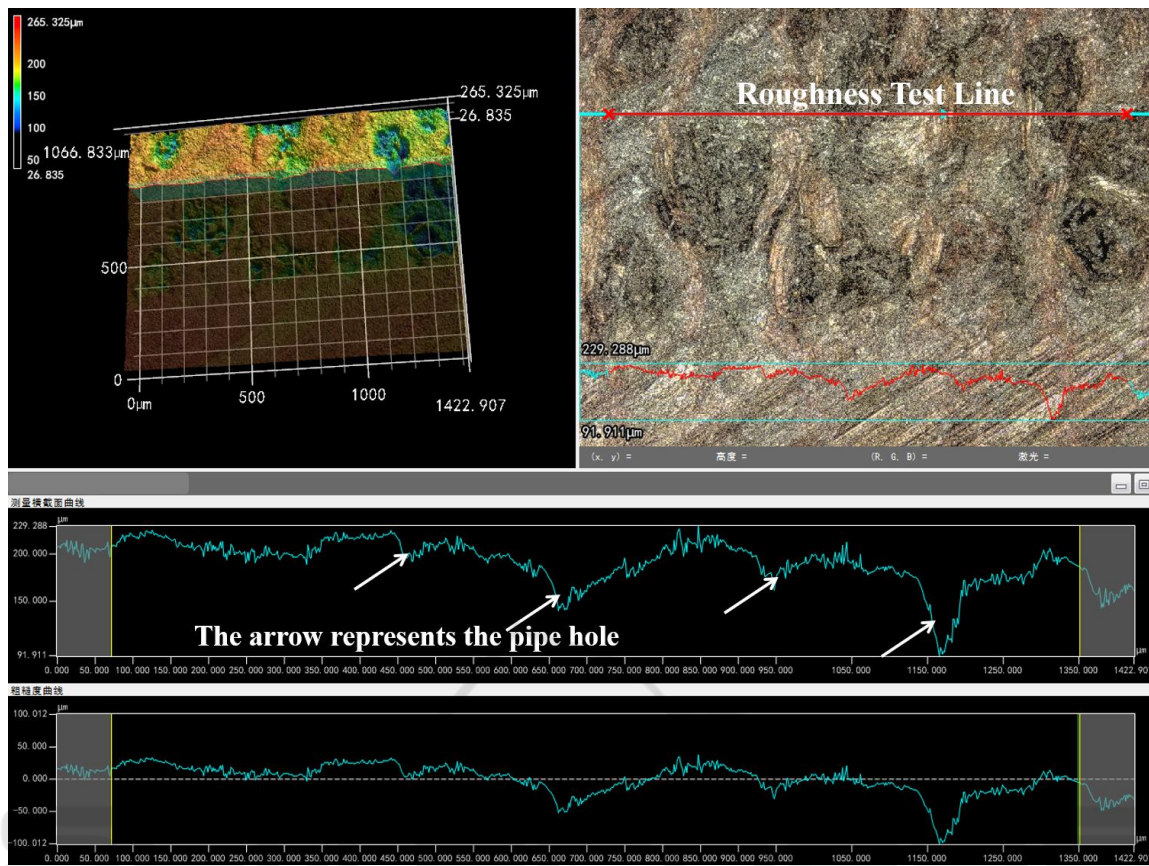


Figure 2. Sketch map of transverse test position and roughness curve of Elm wood in sanding process.

3.1.3. Influence of different measuring modes on surface roughness. The stylus mode of the selected shape measurement laser microscope system is measured to obtain the surface roughness value under the contact needle mode of the Elm three-section. Compared with the corresponding laser measurement, it is shown that in Figure 3, the roughness measured in the stylus mode is less than the surface roughness value of the laser test, which is the result of the laser scanning to the more microscopic part. Increase or decrease rate within 4%.

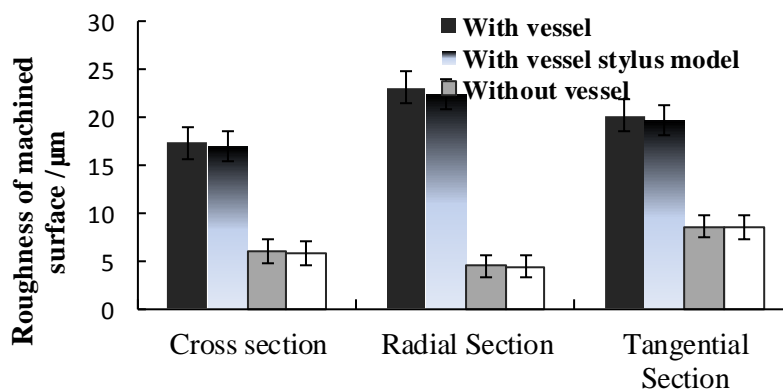


Figure 3. Surface roughness comparison of three sections and different test conditions of Elm sanding.

3.2. Comparison of surface roughness of specimens of different species

The laser scanning and three-dimensional images of three kinds of wood specimens are shown in Figure 4 as follows, as far as possible to select the ring junction area. The different and concave-convex uneven structure of the surface structure are clearly seen in the two graphs.

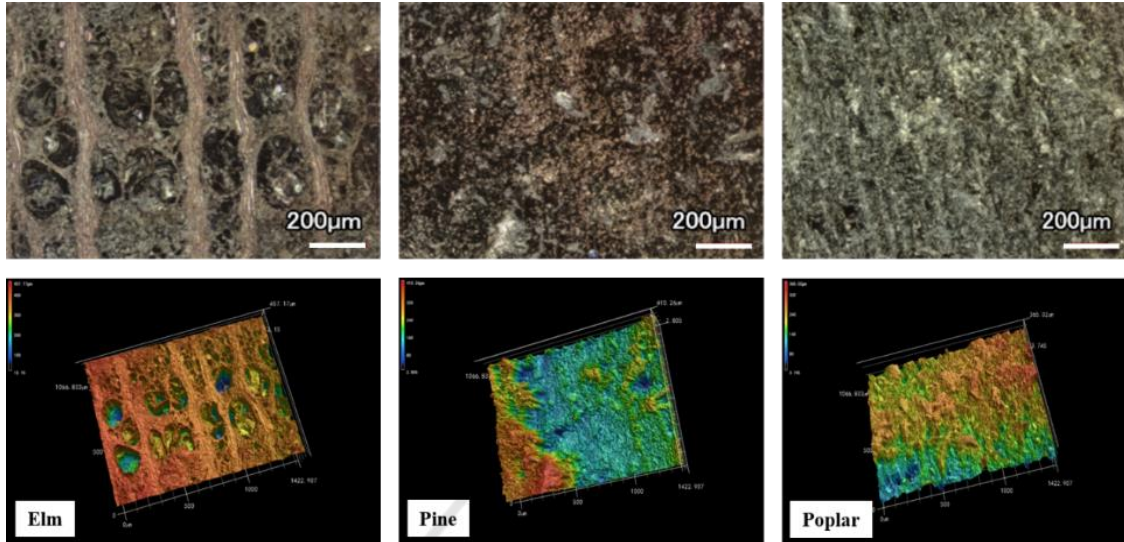


Figure 4. Comparison of laser scanning and three-dimensional structure of three kinds of timber in cross section sawing (200 times amplification).

Further testing of the surface roughness of the small part of the wood structure and the influence of the roughness of the structure on the large parts show that in Figure 5, the roughness of the microstructure of the wood cell tissue was significantly greater than that of the small part, and the roughness value was obviously different. The roughness value is elm, pine and Poplar, but the roughness value tends to be close to the effect of small structure, and the effect of tree species is not significant.

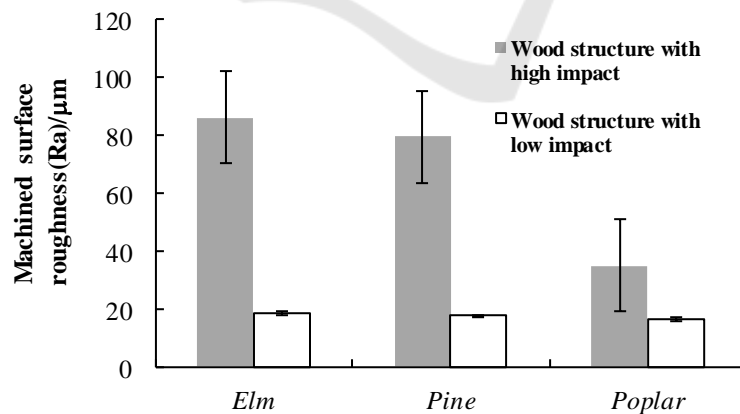


Figure 5. Comparison of roughness of three kinds of wood sawn cross-section.

3.3. Analysis of different machining methods and surface roughness

The cutting, sanding and turning plane of the poplar specimen 200 times times magnified laser scanning picture and three-dimensional image picture as shown in Figure 6, the two kinds of pictures are not difficult to see the surface of the sawing wood burr, observed that the sanding surface

structure is not clear. The surface structure and uneven distribution are clearly seen on the sawing and rotating plane.

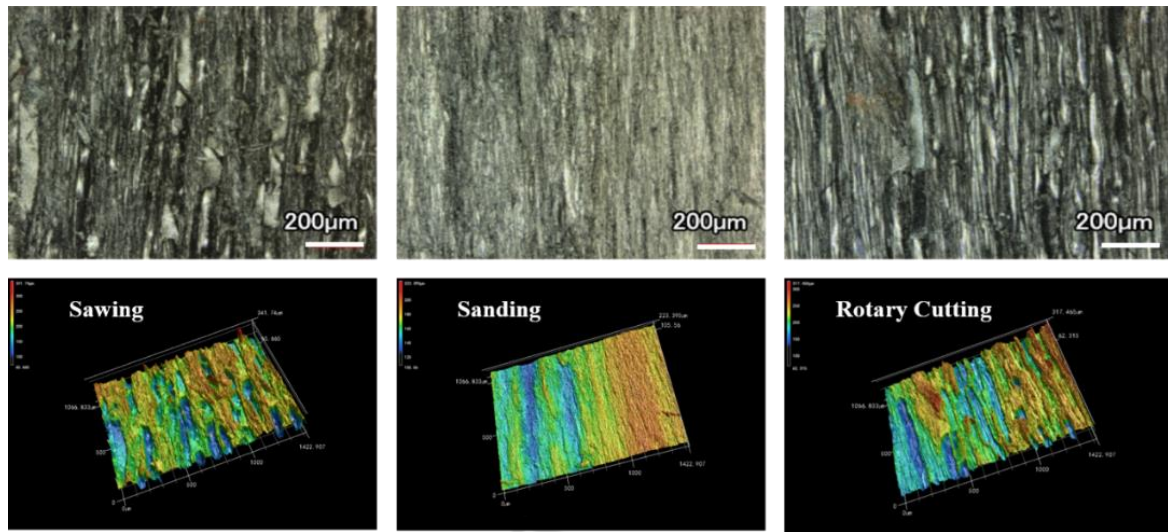


Figure 6. Comparison diagram of 200 times of different cutting process of poplar specimen.

Further testing the surface roughness of the parts with large influence on the wood structure and the roughness values of the parts with little influence on the wood structure show that in Figure 7, the surface roughness of the slice are close, and the surface roughness of the sanding process is obviously small.

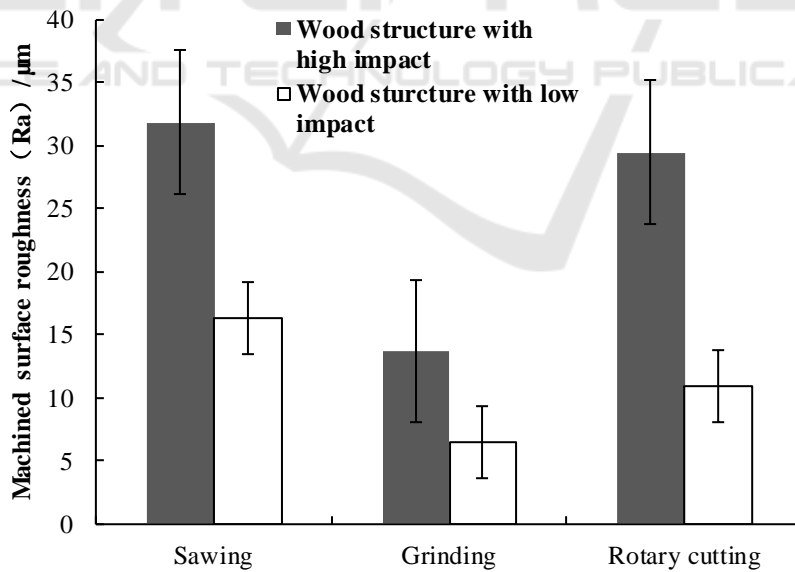


Figure 7. The change of machining mode and surface roughness of *Poplar*.

3.4. Magnification and surface roughness

Selecting the Poplar and elm specimens for example, the laser scanning microscopic structure of the different magnification ratios of the tangential cutting of the chord plane is shown in Figure 8 below. It is difficult to evaluate the roughness of the machined surface, especially when the elm duct and the

wood rays take up the whole surface of the microscopic structure such as the specimen tube, the wood ray and the grain hole.

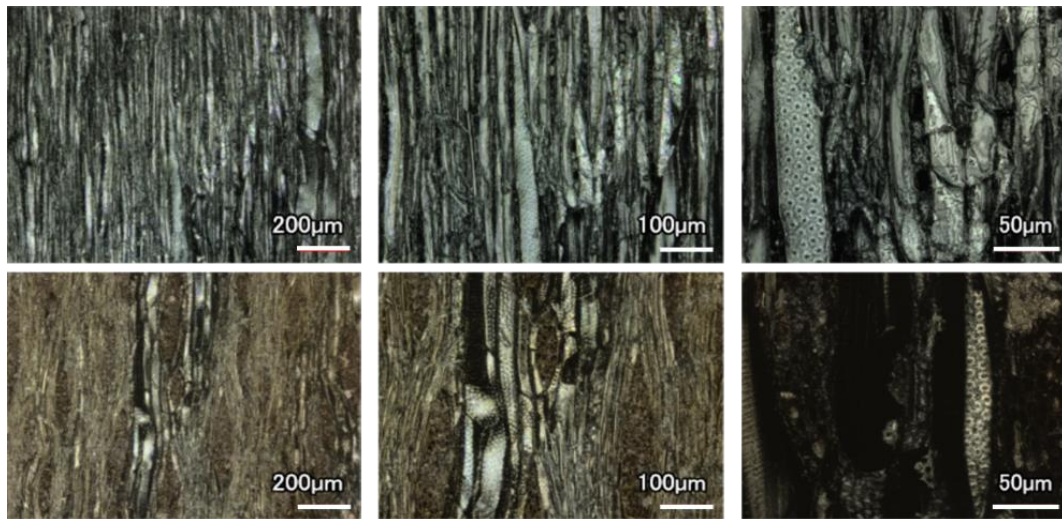


Figure 8. Comparison of microstructure of Poplar and elm specimens with different magnification.

It is shown that the roughness value of the parts with large influence on the surface roughness of the wood structures and the roughness of the wood structure is less than that in Figure 9. The variation tendency and size of the roughness value of the small part of wood structure are very close to that of tree species. It is not difficult to see that the structure of wood has a great influence on the roughness, and the influence of wood structure must be taken into account in the determination and evaluation. The influence of wood structure on the roughness of large parts is very different, the bigger the surface roughness of poplar wood is, the more the positive and decreasing relationship is. However, the roughness of elm wood structure affects large parts with the increase of magnification and then tends to a certain value, it is difficult to evaluate the processing surface roughness when the magnification is large. The appropriate magnification must be selected, and the test results show that the magnification ratio of elm wood is 200 and that of poplar wood magnification 400 is advisable.

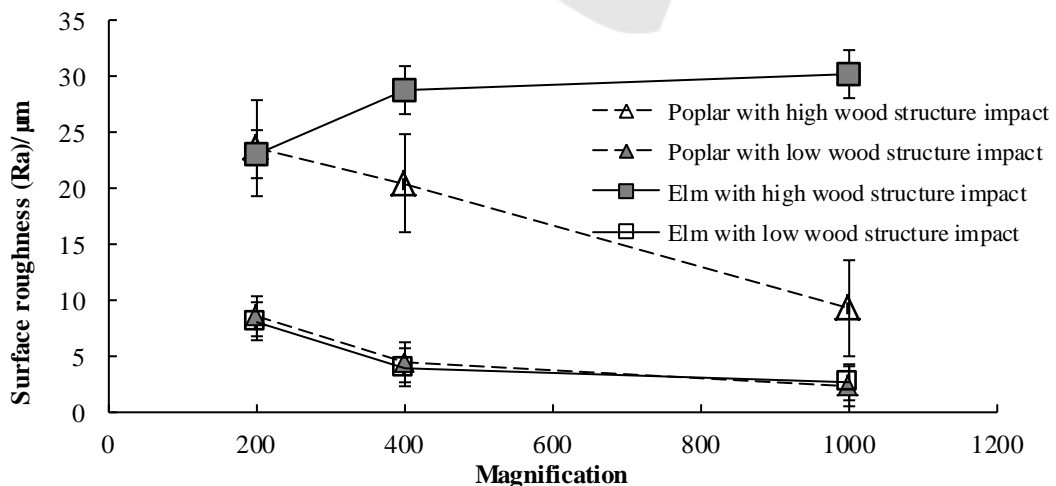


Figure 9. Magnification and surface roughness variation.

4. Conclusions

To Elm, Poplar wood for testing materials, different parts, different magnification, different cutting methods and different test mode to determine the surface roughness and impact of wood processing, the following conclusions are drawn:

1. Surface roughness value due to different processing methods, with the improvement of processing accuracy and reduce. In the test range, the influence of wood structure on the roughness values of different sections of Elm is the cross section and the cross section of the chord plane, and the cross section of the wood structure affects the hourly chord plane. The effect of wood structure on roughness is particularly obvious, and the influence of different parts and wood structure must be considered when evaluating surface roughness.

2. The same tree species, the same section, sanding surface roughness is significantly lower than sawing and cutting surface roughness, sawing and cutting surface roughness value is close. Magnification has obvious effect on tree species and cut, but the influence of wood structure on the hours is not significant.

3. The factors affecting the surface roughness of wood processing are considered, and the two-step method for measuring the surface roughness of wood is proposed. The first choice of the selected wood products such as tree species, different sections, wood structure and processing methods to determine the evaluation site, and then consider the test mode method and equipment accuracy, selected to meet the determination of the requirements of the method to complete the wood processing surface roughness measurement and analysis.

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