

Evaluation
of the habilitation dissertation entitled „Analysis of Wood Structures with Scanning
Electron Microscope” by Ing. Miroslava Mamoňova, PhD.

1. Grounds for performing the review

The formal basis for the performance of this review is the official letter of the Dean of the Faculty of Wood Sciences and Technology of the Technical University in Zvolen dated 2 April 2019 requesting the review of the enclosed dissertation. By force of the decision of the Scientific Board of the Faculty of Wood Sciences and Technology of the TU in Zvolen dated 14 March 2019, I was appointed reviewer of the habilitation dissertation of Ing. Miroslava Mamonova, PhD. in the Wood Structure and Properties research area.

2. Evaluation of the dissertation form

The dissertation consists of 18 published articles of considerable length devoted to wood microscopic anatomical analysis. The work contains the introduction to the research topic and three chapters in which the candidate presented information on her research areas. These chapters are entitled as follows:

1. Impact of external factors on the change of the wood tissue structure.
2. Evaluation of the penetration of wood structures in order to increase its biological resistance.
3. New applications and SEM imaging used for wood structure.

The final section of the work contains summary and conclusions, as well as appendices with specification of own participation in the article.

3. Evaluation of the contents

In the chapter devoted to external factors altering wood structure, the candidate has demonstrated that veneer pressing causes irreversible morphological changes in wood tissue. Under the influence of pressing, tracheids and fibres undergo considerable deformations and condensed formations of lignin and degraded hemicellulose products occur on the surface of the cellular wall. In her works, the candidate has documented the collapse of cell lumen [intracellular space] and increased occurrence of irregularities in the form of cracks in cell walls caused by temperature and pressure. When pressing was done with high temperatures at low pressure, considerable fragility and thermal erosion of the cell wall of the conductive tissue were noticed.

Anatomical microscopic examinations of common alder (*Alnus glutinosa* L.) revealed that surface quality of pressed veneers (coarseness, hardness) was improved after STTM treatment. Those studies widened our knowledge of changes in the cell wall structure and anatomical deformations of alder wood elements under the influence of thermomechanical pressing. On the basis of the analysis of microscopic images it was concluded that STTM treatment caused thermomechanical collapse of cells, axial cracks, cell wall folding and increased brittleness of wood structures (intracellular cracks); the tendency for the emergence of horizontal cracks increases and thermal erosion of the secondary cell wall occurs. The analysis results allowed the candidate to establish a correlation between the degree of pressing and tracheid size. The results were published in several works published in specialist journals.

On the basis of microscopic analysis, Ing. Miroslava Mamoňová, PhD. documented surface condition before and after STTM treatment of alder, beech, birch and pine veneers. She demonstrated that pores and microcracks that had originated during veneer cutting and drying closed, and thus STTM considerably improved veneer surface quality. Microscopic examinations have revealed that the morphology of pressed veneer depends on the degree of pressing. Increase in the applied pressure increased the plastic deformation of tracheids up to the point of collapse. In the process of pressing cell walls get weakened by cracks. On the basis of her microscopic research, the author came to the conclusion that together with the increase of temperature and pressure, reduction of cell lumen and cracking of the walls of deformed cells also increase. A negative correlation between the degree of pressing and the size of tracheids was established.

Ing. Miroslava Mamoňová, PhD devoted a considerable part of her dissertation to studies of the beech wood microstructure following hydrothermal processing. These studies were undertaken with the aim to separate native structures undergoing physiological changes from structures post hydrothermal wood processing. The obtained results of hydroscopic analysis indicate that simple perforations of amorphous tracheids occur already at the temperature of 100°C, while at 110°C amorphous areas on the walls of early wood begin to occur. The candidate has proven that thermal and hydrothermal wood treatment causes pronounced changes in monosaccharides. During thermal processing, acetic acid is produced as a result of deacetylation of hemicelluloses, and cleavage of β -O-4 ether linkages in lignin occurs. Microscopic tests confirmed the occurrence of greater amounts of protoplasm in beech late wood. During beech wood steaming, the biggest changes occur in the cell wall of the tracheids, where lignin is dislocated. The results of microscopic observations confirm the penetration of degraded wood components of the secondary cell wall onto the S3 surface of early tracheids, where amorphous areas occur. During hydrothermal treatment of wood, those areas are formed of lignin and degraded hemicellulose products. These findings are valuable from the scientific point of view, as this is the explanation of chemical and mechanical taking place in wood during its hydrothermal treatment.

In the section devoted to the evaluation of the penetration of wood by wood-modifying substances in order to improve its biological resistance, the candidate has proven that scanning electron microscopy makes it possible to obtain information on the residues of modifying substances, particularly mineral ones, in the wood tissue structure. She was observing crystals or groups of crystals and their distribution in wood tissues. This is

significant for the process of wood modification and for examinations of historic wood deposits in peat conditions.

With the use of the SEM analysis, Ing. Miroslava Mamoňová PhD. demonstrated that during secondary wood modification with silico-organic compounds, silanes penetrate the secondary cell wall, which manifested itself in scaling of the S3 layer and the occurrence of cracks in the penetration area. The consequence is increased brittleness of modified wood. In co-operation with international research centres, the candidate published the results and their analysis in major scientific journals.

Ing. Miroslava Mamoňová, PhD. has proven that the application of a unique research tool, the Cryo-SEM, enables studying of secondary cell walls of wood after thermal and hydrolytic treatment and wood degraded with other biotic factors, e.g. archaeological wood.

For the preparation of samples for microscopic analyses, the author used the modern method of FIB-SEM dual beam, which enabled her to observe the cell wall in its native unaltered condition and document the results in the 3D format.

Recapitulation

Electronic microscopy is sometimes the only method to present wood spatial structure. The set of studies submitted for review presents unique images of wood structure for wood samples prepared with state-of-the-art techniques.

Analysing the submitted works, one can notice that Ing. Miroslava Mamoňová, PhD. is capable of working in co-operation with domestic research centres and international teams, and the effects of that co-operation are numerous valuable publications in journals with impact factors. The fact worth emphasizing is the candidate's use of modern applications for nano-structural examination of materials that enable observation and documenting the image in-situ.

The SEM analysis offers not only scientific but also practical applications. It is helpful in the selection of parameters for technological processes in the manner that ensures obtaining the intended product without too much destruction of wood cells.

On the basis of the dissertation presented to me for evaluation I am able to confirm that Ing. Miroslava Mamoňová, PhD. has become an expert in microscopic analyses, particularly in the interpretation of test results, which results in numerous publications included in the Web of Science database (43 publications), and the number of citations from works written with her participation exceeds 100. According to that database, the Hirsch index is 7.

Conclusions

On the basis of the performed evaluation as described above, I conclude that the habilitation dissertation of Ing. Miroslava Mamoňová, PhD. entitled „Analysis of Wood Structures with Scanning Electron Microscope”, containing a coherent set of publications, testifies to the candidate's professional expertise and qualifications and fulfils the requirements foreseen for the habilitation procedure. Minor inaccuracies noticed in the work do not have any impact on the overall very positive evaluation.

Taking the above into consideration, I propose that the dissertation be accepted for defence and - following a positive outcome of the defence, in line with the Decree No. 6/2005 Coll. of the Slovak Republic Ministry of Education on the Procedure in Attaining Research-teaching Degrees or Artistic-teaching Degrees of Associate Professor and Professor - that Ing. Miroslava Mamoňová, PhD. be awarded the title of associate professor in the Wood Structure and Properties research area.

Accordingly, I do not hesitate to recommend Ing. Miroslava Mamoňová, PhD. for further procedure related to the award of the degree of docent at the Technical University in Zvolen.