СИБИРСКОЕ ОТДЕЛЕНИЕ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

ФЕДЕРАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ЦЕНТР
КРАСНОЯРСКИЙ НАУЧНЫЙ ЦЕНТР
ИНСТИТУТ ЛЕСА ИМ. В.Н. СУКАЧЕВА

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ
РОССИЙСКОЙ ФЕДЕРАЦИИ

МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ
ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ ИМ. Н.Э. БАУМАНА
МЫТИЩИНСКИЙ ФИЛИАЛ

РЕГИОНАЛЬНЫЙ КООРДИНАЦИОННЫЙ СОВЕТ
ПО СОВРЕМЕННЫМ ПРОБЛЕМАМ ДРЕВЕСИНОВЕДЕНИЯ

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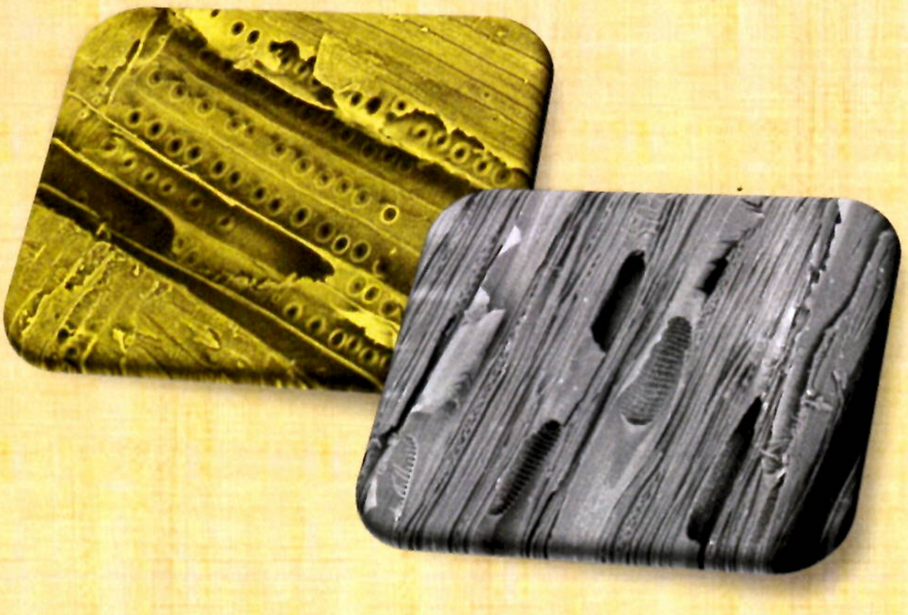

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Материалы

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посвященного 50-летию Регионального Координационного совета
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10–16 сентября 2018 г., Красноярск

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WOOD STRUCTURE, PROPERTIES AND QUALITY – 2018: in honor of B.N. Ugolev. Proceedings of The 6-th RCCWS International Symposium dedicated to the 50th anniversary of the Regional Coordinating Council of Wood Science. Krasnoyarsk, September 10–16, 2018. Novosibirsk: FUE «Publishing House SB RAS» – 237 p.

В докладах участников Симпозиума представлены результаты исследований по основным направлениям древесиноведения – биологическому и техническому. По первому направлению представлен ряд докладов о влиянии условий произрастания деревьев – ботанико-географической приуроченности, условий плантационного лесовыращивания, густоты насаждения, гидротермического режима почвы, техногенного воздействия и т.п. – на базисную плотность, структуру годичного прироста, физико-механические, теплофизические, акустические и др. свойства древесины. Рассмотрены некоторые физиолого-биохимические вопросы ксилогенеза и адаптации древесных растений к неблагоприятным условиям среды; биоиндикационной способности сосны обыкновенной при оценке загрязненности территорий промышленными газопылевыми выбросами. Второе направление представлено докладами, посвященными развитию идей Б.Н. Уголева об эффекте памяти формы, усовершенствованию, метода расчета напряженного состояния с учетом изменения влажности древесины и величины прикладываемой нагрузки. Обсуждаются современные тенденции в области термического модифицирования древесины, стандарты модифицирования; обсуждаются различные методы «активационной» обработки древесины, физико-химические свойства «активированного» древесного сырья и дальнейшее его использование в производстве новых материалов. В теоретических исследования рассматриваются вопросы использования лесных машин, сушки древесины, уточненные модели прессования древесины. В докладах участников Симпозиума предлагаются технологии эффективной утилизации биомассы деревьев при «быстрооборотном» плантационном выращивании; дается анализ возможностей (с оценкой экономической эффективности) создания нового процесса переработки древесины в продукты малотоннажной химической технологии. Ряд сообщений посвящен морфолого-анатомическому строению, химическому составу и способам утилизации древесной коры. Представлены доклады по проблеме биоповреждений древесины, деревянных строений и конструкций и способам их защиты.

В докладе д.т.н., профессора, академика ИАВС В.Г. Санаева – Председателя РКСД (Мытищинский филиал Московского государственного технического университета им. Н.Э. Баумана) – освещаются основные события в истории развития отечественного древесиноведения и функционирование Координационного совета. Выделяются два периода его деятельности: красноярский (1968–1989) и московский, начиная с 1990 года.

Сборник представляет интерес для научных работников, специализирующихся в области биологического и технического древесиноведения, химии древесины, дендроэкологии и лесоведения, а также для инженеров, аспирантов и студентов соответствующих специальностей.

Ключевые слова: экологические, морфолого-анатомические, физиологические и биохимические аспекты ксилогенеза; дендроэкология, химические, физические, технологические и эксплуатационные свойства древесины; физические и физико-химические методы в исследованиях древесины; древесные материалы, изделия; биоповреждения, защита древесины, биотехнология; качество древесины, изделий и конструкций; стандартизация и сертификация.

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WOOD MODIFICATION RELATED RESEARCH AT THE UNIVERSITY OF SOPRON

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INTRODUCTION

Wood is recognised as the most important of the renewable base materials with the added advantage of being recyclable and CO_2-neutral. But wood is a biodegradable material. Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials. The aim is to get better performance from the wood, resulting in improvements in dimensional stability, decay resistance, weathering resistance, etc. Wood modification in different ways dates back decades at the University of Sopron (Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts, Institute of Wood Science). Wood modification processes indicate continuously new challenges. During the last years, special attention was given to heat treatment processes in different media, acetylation, densification or compression perpendicular and parallel to the grain and some impregnation processes. The application possibility of nanoscale materials in wood industry was also investigated.

HEAT TREATMENT IN GASEOUS ATMOSPHERES

The institute possesses a programmable heat treatment chamber in which it is possible to treat a maximum 60 cm long samples. In this electric heated equipment, which is supplied with ventilators and control panels, heat treatment is executable in normal atmospheric air. Due to the elaborated schedules and experience, the good quality of heat-treated wood is secured. In 2010, a combined heat treatment-steaming equipment of 0,5 m^3 capacity was purchased. This autoclave is suitable for heat treatments up to 250°C temperature in vacuum, inert gases and steam. Investigated wood species so far: oak, turkey oak, black locust, poplar, hornbeam, beech, maple, pine and spruce. As a result of the treatments, durability was improved remarkably and swelling decreased as well. By means of heat treatments, exotic and homogeneous colour can be achieved in whole cross-section of the wood. This property was very useful in case of the production of flooring elements from the heat-treated material (fig. 1). Besides the favourable properties, the bending, tensile (20–40 %) and impact bending strength (30–70 %) decreased considerably. However, hardness and compression strength increased slightly.

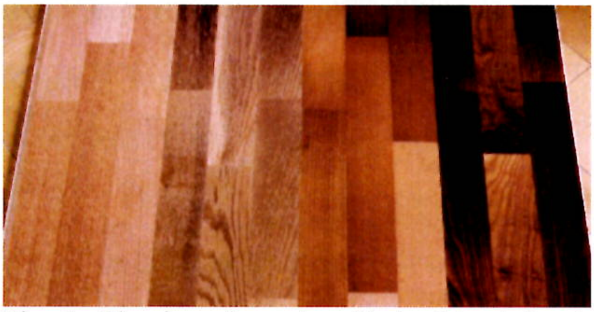

Fig. 1. Flooring elements with heat-treated oak, turkey oak, beech and ash top-layer (left to right)

HEAT TREATMENT IN DIFFERENT FLUIDS

Efficiency of heat treatment processes depends on the rate and regularity of the heat growth in the wood, and on the reduction of oxidative processes in order to avoid unreasonable decomposition. Heat treatment in vegetable oils can be a solution for these problems. Wood was heat treated in rapeseed-, linseed- and sunflower oil at 160–200 °C (fig. 2). Swelling properties decreased by 20–60 % and strength decreased less than in case of heat treatment in a gaseous atmosphere. Colour changes were similar to heat treatments in a gaseous atmosphere. Further advantage of a heat treatment in vegetable oils is the short treatment time (up to 6 hours including drying in case of a 25 mm thick poplar board). However it has to be noted, that for example in case of black locust, which has a practically impermeable structure, longer treatment times are needed to avoid cracks and deformations [1]. With applying paraffin as heat treatment medium instead of vegetable oils, similar results can be achieved as well as moisture uptake decreased further because of the thin paraffin layer on the surface [2].

Fig. 2. Colour change of poplar wood due to different heat treatment schedules in linseed oil

THERMO-HIGRO-MECHANICAL (THM) TREATMENT OF WOOD

In terms of each product, often only one property is important to be suitable for the requirements. In case of poplar wood, indoor use surface hardness is the property which limits the utilization. The goal in this case was to produce a material with low density and high surface hardness. With Thermo-Hygro-Mechanical treatment (fig. 3) – using heat, steam and compression on wood – hardness of poplar wood can be increased from very low 10 N/mm^2 to 22 N/mm^2. With 30 % compression of poplar wood, hardness increases by 120 % and reaches hardness of maple wood, which is a popular wood species of flooring production. Besides the improved surface hardness, wood colour became brown in 2–3 mm depth [3].

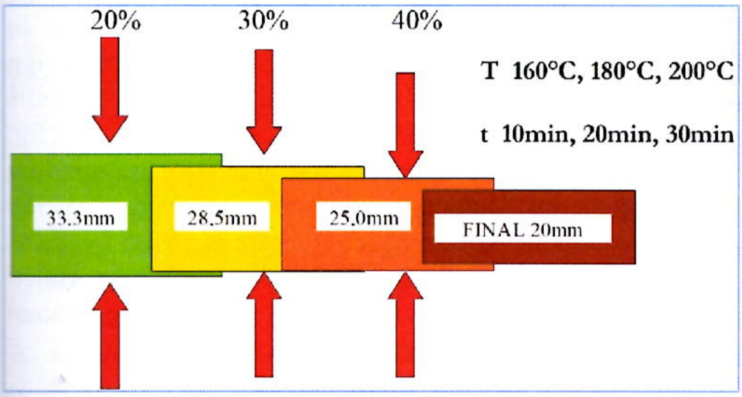

Fig. 3. Parameters of different THM process schedules

ACETYLATION OF WOOD

One of the most common chemical modification processes is acetylation, which changes –OH groups in wood to acetyl-groups. Our first investigations were focussing on black locust (*Robinia pseudoacacia* L.) and poplar (*Populus* × *euramericana* cv. Pannonia). The swelling of poplar wood decreased by 70 %, besides that the mechanical properties remained unchanged. Black locust cannot be effectively treated due to the small penetration depth caused by its tyloses. However, as veneer or flake, good result can be achieved (e.g. production of weather resistant panels). Treated material typically loses colour but with appropriate surface finishing it can be deepened. Acetylated wood has pungent smell for a long time (evaporation of acetic acid), furthermore when applying hinges increased corrosion rate has to be taken into account.

As a next step, hornbeam (*Carpinus betulus* L.) wood was acetylated in cooperation with Accsys Technologies (the Netherlands) [4]. The results are promising, as the equilibrium moisture content and fibre saturation point decreased by 58 % and 33 % respectively, beside a slight increase in the density (4–15 %, depending on the moisture content state). As a result of that, shrinkage decreased remarkably as well. The decrease was ~80 % in radial and tangential directions, and ~60 % in longitudinal direction. Weight loss by decaying fungi decreased by 95–98 % as a result of acetylation, this means that the weight loss by three types of fungal decay was below 1 %.

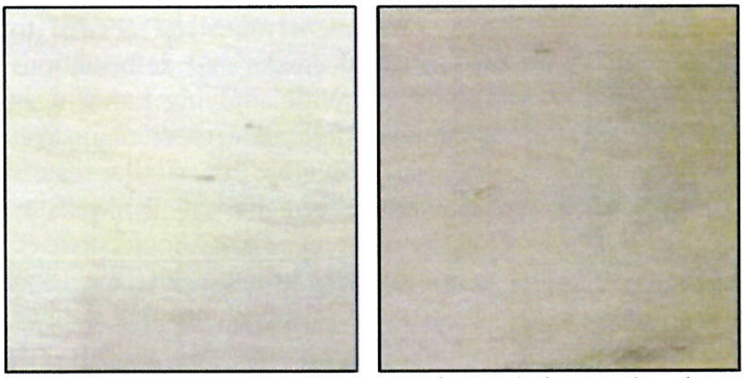

Fig. 4. Colour change as a result of acetylation on hornbeam wood (left: untreated; right: acetylated)

Usually acetylation has a slight effect on wood colour as well, which can be darkening or brightening. It depends usually on the initial colour and the WPG, that means light coloured woods become slightly darker, while dark coloured woods become slightly lighter. Similar results were found for acetylated hornbeam as well, as a slight darkening was observed as a result of acetylation (fig. 4).

COMPRESSION PARALLEL TO THE GRAIN

Longitudinally compressed wood can be bent easier and in smaller radius compared to steamed wood. The method can be used mostly for high-density hardwoods. Another advantage is that longitudinally compressed wood can be kept cold for longer time in bendable state, therefore it is storable. This material can be used primarily in interior design and in the furniture industry. During the modification process, the normally smooth cell walls deform, buckle and finally seem like a half-closed concertina on the microscope images (fig. 5). Therefore this method can be called «pleating» [5]. The pleating and also the bending process needs high-quality hardwood raw material. Before the compression procedure, the wood has to be plasticized, practically with steaming. The compression rate is 15–25 % of the original length. The sample can be held compressed for a while, this period is called relaxation. Relaxation also increases the bendability of the wood. After longitudinal compression and relaxation, the shortening of the samples increases.

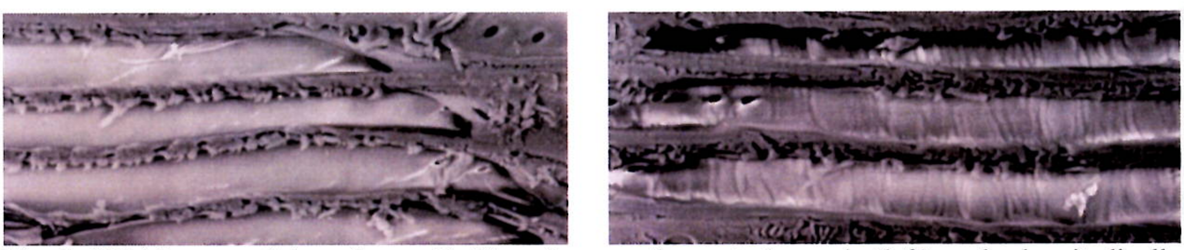

Fig. 5. SEM images of the oak wood's fibres in case of a control sample (left), and a longitudinally compressed sample (right). Magnification: 1000×

OTHER WOOD MODIFICATION PROCESSES

In addition to the modification processes above, some other processes were investigated too. First of all, impregnation processes with beeswax or nanoparticles can be highlighted. Both treatments have the goal to improve fungal resistance and dimensional stability of wood. Zinc-nanoparticles improved durability very effectively as very low concentrations resulted already in significant resistance against decay. Better results could be achieved by using zinc-borate compared to zinc-oxide [6]. Impregnation with beeswax has a positive result that the process decreases moisture uptake of wood significantly (10-40 %) and it increases the durability in short term applications, thus it can be a natural based preservative for wood without any chemicals (fig. 6.) [7].

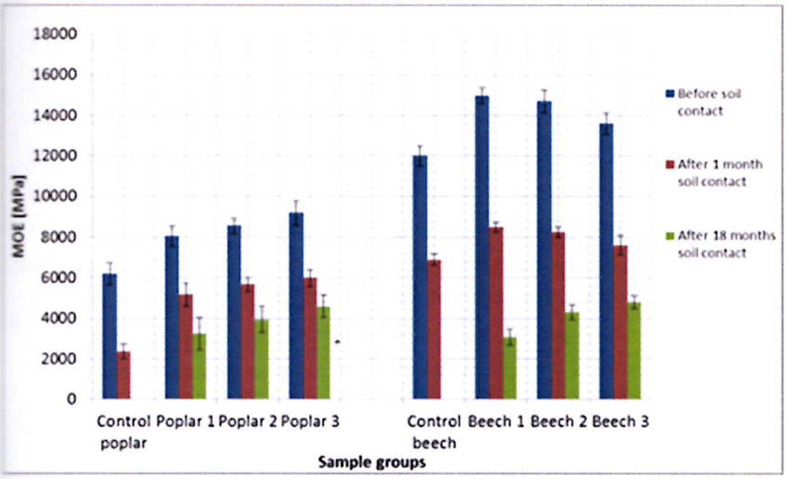

Fig. 6. MOE of poplar and beech samples (control and with 3 different DPS) in the investigation periods

CONCLUSIONS

At the University of Sopron (Institute of Wood Science) important research activity was executed during the last 30 years in terms of wood modification. In course of that, effects of numerous modification processes were investigated on wood. The main topic was the investigation of different heat treatments (heat treatment in different gaseous atmospheres or liquids and with compressing), but in terms of acetylation and in development of environmentally friendly wood preservatives (beeswax, nano-zinc particles) too.

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REFERENCES

1. *Bak M., Németh R.* Changes in swelling properties and moisture uptake rate of oil-heat-treated poplar (*Populus × euramericana* cv. Pannónia) wood // Bioresources. 2012. 7(7): 5128-5137.
2. *Németh R., Bak M., Csordós D.* Thermische Modifizierung von Buche und Pappel mittels Paraffin // Holztechnologie. 2012. 53: 5-10.
3. *Ábrahám J., Németh R., Molnár S.* Thermo-mechanical densification of Pannonia Poplar. In: Proceedings of the final conference of COST Action E53: 'Quality control for wood & wood products', 2010. Pp. 282-292.
4. *Fodor F., Lankveld C., Németh R.* Testing common hornbeam (*Carpinus betulus* L.) acetylated with the Accoya method under industrial conditions // Iforest-Biogeosciences and Forestry. 2017. 10: 948-954.
5. *Báder M., Németh R.* The effect of the relaxation time on the mechanical properties of the longitudinally compressed wood // Wood Research. 2018. 63(3): (under press).
6. *Németh R., Tsalagkas D., Bak M., Lykidis C., Bak M., Mantanis G., Németh R.* Biological resistance of pine wood treated with nano-sized zinc oxide and zinc borate against brown-rot fungi // European Journal of Wood and Wood Products. 2015. 74(6): 909-911.
7. *Németh R., Tsalagkas D., Bak M.* Effect of soil contact on the modulus of elasticity of beeswax-impregnated wood // Bioresources. 2015. 10(1): 1574-1586.