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Editorial

Performance and Modification of Wood and Wood-Based Materials

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Wood remains one of the most attractive building materials. However, its applications are limited because it undergoes biological degradation, is combustible, and changes its properties under the influence of weathering conditions. Many of these disadvantages of solid wood are to some extent eliminated in wood-based materials such as plywood, particleboard, fiberboard, OSB, etc. However, in addition to the fact that it is not possible to eliminate the shortcomings of solid wood, these materials bring new shortcomings, such as toxicity. Therefore, the problem of improving the properties of wood and wood-based materials still needs a solution. One of the effective ways to improve the properties of wood and wood-based materials is to modify them with conventional processes (thermal, chemical, etc.) or latest ones (plasma treatment). Concerning wood-based materials, it is possible to treat their components (particles, fibers, glue, etc.) and use them in wood-based materials or to use the post-treatment of ready-made materials to improve their certain properties.

This Special Issue, entitled "*Performance and Modification of Wood and Wood-Based Materials*" comprises 12 high-quality original research papers by 74 authors from 17 countries on three continents: Asia (China, Indonesia, Malaysia, and Russia), Europe (Bulgaria, Czech Republic, Germany, Portugal, Romania, Slovakia, Slovenia, Sweden, Ukraine, and United Kingdom), and North America (USA). They provide examples concerning the conventional and novel modification processes of wood and wood-based materials, their improved/modified properties, and their relevant applications.

Usually, the calculation of moisture content (MC) is used to estimate the water absorption of wood. However, the traditional method of determining MC by oven drying does not allow us to accurately obtain the amounts of free and bound water separately. In their work, Gao et al. [1] the absorption of water by heat-treated Chinese fir wood was studied using gravimetric analysis and time-domain nuclear magnetic resonance (TD-NMR). The wood samples were treated in a chamber with steam at several temperature levels, 160, 180, 200, and 220 °C, for 2 h. The results showed that when the temperature of heat treatment increased, the amount of free and bound water decreased. Moreover, the water absorption in the radial direction was faster than that in the tangential direction. Such a trend also existed when the heat treatment process was completed. The authors also stated that the pore structure of wood can seriously changes at a high (over 200 °C) heat treatment temperature causing the closing of the pits in wood cells.

It is well known that the preparation of the surface of the wood substrate is one of the important processes before finishing, and has a significant effect on the surface properties of the coating, as well as on the adhesion of the coating to the substrate. Usually, this process is performed by sanding. Another interesting work [2] confirmed and proved that the thermal compression of wood substrate prior to the varnishing process, instead of the labor-intensive sanding process, makes it possible to apply varnish on the surface of the wood substrate without having an adverse influence on the esthetic characteristics of the samples. The thermally compressed surface still has an attractive "exotic appearance of wood", which allow the use of transparent varnishes that increase the attractiveness of the final product. It was also found that thermally densified surface-varnished veneer is more resistant to color changes during artificial aging compared to sanded surface-varnished veneer. The transparent varnish systems showed better photo-stability when thermally densified wood veneer was used as substrate compared to that of sanded wood. The water-based varnish showed the greatest resistance to discoloration during UVL + IR irradiation, followed by polyurethane and UV-cured varnishes. The findings of this study indicated that replacing the sanding process with the thermal compression of the wood surface before varnishing could be considered an alternative method of producing varnished panels with satisfactory color properties on the surface.

It is a well-known fact that waste plastic material is a serious problem that has a negative impact on the environment. The findings of another study [3] demonstrated that environmentally friendly wood plastic composite (WPC) with different applications can be manufactured using a combination of waste polyethylene terephthalate (PET), silica, and rubberwood particles. The basic properties of this composite were also determined.

In another paper, to make the birch wood more water resistant and resistant to biological degradation, the wood was modified by impregnation with spent engine oil [4]. It was found that this impregnation treatment significantly increased the dimensional stability, water resistance, and biostability of birch wood against brown rot fungi.

Timber is widely used in construction, which is not true of densified timber. This can be explained by our insufficient knowledge on the long-term creep behavior of densified timber. From this point of view, reference [5] is another very interesting and important study. The authors studied the influence of the thermo-hydro-mechanical (THM) densification process on the creep properties of Scots pine sapwood. It was found that the THM densification significantly changed the physical and mechanical properties of wood. The results of this study also demonstrated that the creep of Scots pine timber under a long-term bending load in a constant climate is reduced with the combination of THM densification and impregnation by low-molecular-weight phenol-formaldehyde resin or thermal modification.

To expand our knowledge on the behavioral characteristics of cellulose properties during THM treatment, Ouyang and Wang [6] developed a water and cellulose theoretical model based on molecular dynamics. The authors also analyzed the effects of the hydrogen bond numbers, small molecule diffusion coefficients, end-to-end distances, and mechanical parameters of the water–cellulose model on the mechanical properties of wood cellulose. They found that the pressurized hydrothermal treatment of wood can significantly improve its rigidity and deformation resistance.

In another interesting study, an attempt was made to combine the use of chemical treatments by amines (tricine and bicine) and thermal modification to investigate the properties of the treated spruce and beech wood [7]. However, an improvement of the properties of wood by such combining treatment was not confirmed in these studies. The authors attributed this to the thermal instability of the bicine and tricine.

Another study [8] aimed to expand the fast-growing Acacia hybrid usage in the timber engineering field by using copper chrome arsenic (CCA) treatment. It was found that the treated samples in the tangential direction performed better than the untreated samples, while the radial direction gave a high average strength increment when treated.

Coir fiber has good mechanical properties and has been applied in various fields. Usually, coir fiber is treated with alkali to improve its properties. Ru et al. [9] proposed a different approach to improve the mechanical properties of coir fiber alkali treatment. According to this approach, the properties were optimized and analyzed to find the treatment conditions under which these properties are optimally improved simultaneously. This allowed the authors to find the optimal values of sodium hydroxide (NaOH) concentration, treatment time, and temperature at which the maximum values of mechanical properties are achieved. Such an approach of the optimized combination can be also applied to fiber products when strength and toughness are required.

Another interesting work [10] presents the effects of thermal treatment temperatures (160, 180, and 210 °C) on the color and chemical changes of black locust wood during the ThermoWood process. The authors found that color changes were mainly caused by reducing the content of extractives during thermal treatment. The degradation of wood compounds, such as hemicelluloses and cellulose, also contributes to color changes. It was also confirmed that temperature is a significant factor affecting the color of the wood surface.

It is well known that thermal compression is often used to improve the properties of solid wood. The research conducted by [11] aims to develop plywood panels with two wood species (birch and black alder) and two types of veneer treatments (non-densified and thermally densified) in order to evaluate the influences of different lay-up schemes on the properties of the plywood. The authors used different lay-up schemes to identify opportunities to improve the mechanical and physical properties of the plywood by replacing the birch veneer in the plywood structure with an alternative alder veneer. The results showed that the type of construction, wood species, and applied thermal densification of the veneer affected the examined physical and mechanical properties. The WA, MOR, MOE, and shear strength of plywood were more sensitive to the mixing of wood species in one panel than the mixing of densified and non-densified veneers. Alder veneers can be used to form the inner layers of plywood panels without reducing the shear strength. Increasing the proportion of thermally densified veneer in one panel leads to a higher density, MOR, MOE, shear strength, and TS of plywood panels. It was found that plywood panels manufactured from a mixture of species offered higher bending properties when compared to panels manufactured from alder veneers only. It was also shown that non-treated alder veneer, despite exhibiting somewhat lower strength properties than birch veneer, could be successfully used with proper lay-up schemes in the veneer-based products industry. Therefore, the mixed-species plywood panels allowed an increased use of the lower cost, low-grade, and low-density alder wood veneers as core veneers in panels to reduce production costs and increase the mechanical properties of predominately low-density alder wood plywood.

The findings of another study [12] showed that the Eucalyptus hybrid wood infected by the *Chrysoporthe deuterocubensis* canker disease demonstrates improved biological durability. This opens the possibility of using infected wood in non-structural applications. The authors observed reductions in cellulose and hemicellulose contents and increases in lignin and extractive contents in the infected samples. It was also stated that infected wood demonstrated better durability against fungi and termites than healthy wood.

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