Thermal modification of wood and a complex study of its properties by magnetic resonance

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Heat treatment has proved to be an effective method of improving some of the useful properties of wood. Recent technological developments have achieved increased hydrophobic properties, better elasticity, and improved dimensional stability, among other things.

The corresponding chemical modifications depend on the heating regimes and the heating atmosphere and involve degradation of hemicellulose, changes of lignin and cellulose structures and chemical wood composition due to wood extractives loss. Researchers from Institute of Physics of Kazan Federal University and their partners conducted an investigation of various thermally treated wood species from the Central European region of Russia using magnetic resonance methods. The tests revealed important changes in wood structure that were not available for observation by other methods.

Magnetic resonance methods are very well known as non-invasive techniques that can obtain information on structure and processes inside samples. The selection of sapwood samples included Scots pine (Pinus sylvestris), birch (Betula pendula), Russian larch (Larix sibirica), Norway spruce (Picea abies) and small-leaved lime (Tilia cordata). Samples were vacuum-treated by heat at 220 C with various durations up to eight hours.

Electron paramagnetic resonance experiments revealed changes in the amount of free radicals in samples with the thermal treatment duration. They proved that the EPR signal amplitude of free radicals strongly

depends on the moisture content of the wood samples and decreases as the latter value grows. Additional EPR experiments with absorbed ethanol indicate a possible connection of this effect with the electric dipole properties of H2O molecules.

Observed changes in pore size distributions by microscopy methods indicate cell wall shrinkage and deformation. This process is indirectly related to the mass loss and formation of stable free radicals detected by the EPR method. Since the correlation between the EPR signal amplitude and wood hardness was found for larch, lime and spruce, it is possible to use this technique to assess the wood hardness.

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