SOME EFFECTS OF PLASMA TREATMENT ON WOOD FIBERS FOR COMPOSITE PRODUCTION

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Wood fibers for composite production were treated by DC glow discharge plasmas of nitrogene and hydrogene under varying conditions regarding the position of fibers within the discharge chamber. The influence of plasma treatment upon the fiber properties such as water uptake has been investigated, and the resulting decrease in hydrophylity compared for different conditions. Some improvement in properties of wood-based composites, e.g. a decrease in swelling, might be expected on this basis.

INTRODUCTION

Adhesive bonds of different types are found to exist between wood particles and a matrix as the basic constituents of wood-based composites (Onishi et al. (1)). Quite some research has been performed into how to improve these bonds and thus produce a more reliable material (Kokta et al.(2), Maldas and Kokta (3)). Durability of wood-based composites largely depends on compatibility between these constituents of the composite, since a possible mechanism of composite failure is not only the failure of the constituents, but more critically, failure of their interfacial bond (1,2, Liu et al.(4)).

In addition to other factors influencing the bond strength, the very nature of the constituents represents a compatibility problem in the sense that wood particles are hydrophylic and a matrix generally hydrophobic. This problem is reflected in different rates of swelling of the constituents of

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the composites when the latter are exposed to humid environments or moisture in general (e.g. Schneider et al. (5)). The resulting effects of internal stresses within the constituents or at their interface can considerably decrease the ability of the composite to withstand practical application conditions. Thus, failures of these materials can frequently be ascribed to the problem quoted above (Goto et al.(6), Rowell et al.(7)).

Essentially different methods applied for purpose of increasing compatibility between wood particles and the matrix generally included some type of wood particle treatment, and recently the reports of treatments by plasma, mostly RF and ICP type, also appeared (Young et al. (8)).

In this paper the wood fibers have been exposed to the nitrogene and hydrogene DC glow discharge plasmas, and their ability to uptake water measured as an indication of the effect of plasma treatment on their properties.

EXPERIMENTAL

The experiment included plasma treatment of the chosen wood fibers, their exposure to water uptake conditions and estimates of the influence of the plasma treatment upon the latter effect.

Wood Fibers Plasma Treatment

Fibers of beech (Fagus Moesiaca) were produced by the industrial defibrator process at a hardboard factory in DP "Kopaonik" - Kursumlija. The vapour conditions were: temperature at a value of 150 ^{0}C and pressure at 0.8 MPa during 8 minutes. Thereafter the fibers were oven-dried at a temperature of 103 ± 2 ^{0}C for 18 hours. The 0.75 mm (according to DIN 1171, or mesh 8) fraction was chosen on basis of its relative abundance.

Wood fibers were exposed to DC glow discharge plasma in the appropriate chamber at ETF-IMT plasma technology centre. Both nitrogene and hydrogene plasmas were applied at a pressure values of about 1 mbar (0.1 kPa) for 10 minutes per probe, and the discharge parameters were kept at about 1 A for the discharge current and in the regions of about 600 V for the applied voltage in the case of nitrogene, and about 800 V in the case of hydrogene plasmas.

Large variations occured from the initially set values (current generally decreasing by a factor of 3 and pressure increasing for about 50%), reflecting the increase of the electrode temperatures up to about 160 ^{0}C and

requiring interventions for the quoted parameters to be kept approximately constant.

In the course of the experiments, the part of the wood fibers was placed immediately at the cathode surface, and the other lot at the surface of an isolator placed on top of the cathode.

The Results of Experiments

Both the treated and the control (untreated) samples were immersed in the distilled water at a temperature of 20 ^{0}C for 2 hours. Thereafter the fibers were drained on a coarse-porosity (B2) fritted-glass extraction crucible (or thimble) by vacuum extraction in the course of 3 minutes. Out of fibers thus treated, the necessary initial quantities were taken by the random choice method, weighed, and oven-dried at 103 ± 2 ^{0}C until constant mass was reached.

The results of water uptake measurements for the treated and the control samples are shown in Table 1.

TABLE 1- The Effect of Plasma Treatment Upon Water Uptake by the Wood Fibers

Sample treatment	Sample position in the discharge chamber	Water uptake (%)	The effect of plasma treatment (%)
None (control)	/	343.3	/
Nitrogene plasma	Cathode surface	116.9	65.95
Nitrogene plasma	Isolator	190.5	44.51
Hydrogene plasma	Cathode surface	158.7	53.77
Hydrogene plasma	Isolator	146.3	42.62

Water uptake percentage was calculated as the ratio between the mass increase from the original up to the constant-mass having reached sample, and the original mass value of the former. The effect of plasma treatment was found as the ratio between the difference of the water uptake values of the treated and the control samples and the same value of the latter.

CONCLUSIONS

The applied plasma treatments generally decrease the water uptake by the wood fibers, indicating a change in their activity, either chemical or surface type one.

The trends seem to be expressed of stronger effects of nitrogene plasma treatment and the position immediately at the cathode surface. The former should be ascribed to the difference in reactions of the plasma ions and the hydroxyl groups mostly responsible for the water absorption, and the latter to the cathode layer effect.

The results indicate a possible increase of compatibility between the former and the hydrophobic composite matrices. This compatibility increase might result in the improved properties of such wood-based composites, which however requires further research.

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