CENTRAL EUROPEAN INITIATIVE

The Gas Institute of National Academy of Sciences of Ukraine

E.O. PATON ELECTRIC WELDING INSTITUTE

The Third Central European Symposium on Plasma Chemistry

August 23 – 27, 2009

Kyiv

UKRAINE

Book of Abstracts

National Taras Shevchenko University of Kyiv
Radio Physics Faculty
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INVITED LECTURES

INVESTIGATION ON DIELECTRIC BARRIER DISCHARGE SURFACE ACTIVATION EFFECTS

P. Dineff[1], D. Gospodinova[1] and I. Avramova[2]

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1. INTRODUCTION

The plasma aided flame retardation of wood, wooden products and cellulosic fibrous materials has been conceived and developed as a result of a new plasma aided process of capillary impregnation. The plasma-chemical surface pre-treatment of wood modifies the chemical activity of its surface as well as the capillary activity of wood and improves such technological characteristics of the capillary impregnation process as the penetration depth, speed of solution spreading and adsorption, and specific quantity of adsorbed solution per unit of area. This allows using the plasma aided retardation as a finishing process and applying it in situ. A system of plasma device and applicators has been created to produce cold technological plasma through barrier electrical discharge (DBD) at atmospheric pressure and room temperature [1, 2].

2. DIELECTRIC BARRIER DISCHARGE SURFACE ACTIVATION EFFECTS

2.1. XPS – a surface analysis technique used to study the surface reorganization after plasma pre-treatment

X-ray photoelectron spectroscopy (XPS) is a very powerful non-destructive surface analytical technique which provides valuable data on chemical surface composition and surface reorganization after plasma-chemical pre-treatment. XPS is a surface chemical analysis technique that can be used successful to analyze the surface chemistry of a material in its "as received" state, or after some treatment such as cold plasma pre-treatment. The binding energy is a characteristic of the atoms, which can be used for elemental identification. XPS analysis for this work was carried out using a photoelectron spectrometer VGS ESCALAB Mk II with Al K radiation (FWHM = 0.5 eV). The angle between the directions of the incident X-ray and that of the observations (fixed by analyzer entrance slit) was 50. XPS spectra are obtained by irradiating a material with a beam of X-rays while simultaneously measuring the kinetic energy and number of electrons that escape from the top 1 to 10 nm of the material being analyzed. XPS detects all elements with an atomic number (*Z*) of 3 (lithium) and above. This limitation means that it cannot detect hydrogen (*Z*=1) or helium (*Z*=2). Detection limits for most of the elements are in the parts per thousand (ppm) range.
The interpretation of the curve fit of the carbon C1s peak after *Kazayawoko* (1998) was used to interpret the changes of wood surface chemistry after plasma pre-treatment: binding energy of 285.00±0.4 eV corresponds to C-C and C-H kind of chemical bonds; 286.5±0.4 eV – to C-O, C-OH, and H-C-OH; 288.0±0.4 eV – to C=O and O-C-O; 289.5±0.4 eV – O-C=O. This study was developed as part of a large investigation on plasma-chemically activated and flame retarded wood surface.

2.2. Surface activation effects after DBD pre-treatment

Wood inactivation is a surface phenomenon affecting just a thin outer layer of wood. An inactivated wood surface does not absorb capillary well an impregnating solution containing phosphorous compound as flame retardant. Plasma-chemical surface activation (functionalization) with an effective participation of ionic surfactants and silicone spreaders eliminates the inactivation-impregnating problem creating a protective flame retardant layer on the wood surface.

Table 1: XPS-measurement results - elemental composition across the top the softwood surface.

Kind of Wood: Density, kg/m³	*Samples*			*Chemical Surface Composition,* at. %				
			Carbon Peaks	**C**	**O**	**N**	**O/C**	**N/C**
Heart Douglas Fir wood (Pseudotsuga menziesii, Canada): 678 *kg/m³*	K (Non-Treated)		Voltage	77.69	21.79	0.52	0.28	0.0067
	DBD Pre-treated	SO	10 kV (50 Hz)	68.30	31.70	0.00	0.46	0.0000
		SN	15 kV(50 Hz)	69.10	29.90	1.00	0.43	0.0145
		SHF	10 kV (10 kHz)	74.00	25.50	0.50	0.34	0.0068
Heart Pine Wood (Pinus Sylvestris, Bulgaria: 371 *kg/m³*	K (Non-Treated)		Voltage	74.80	24.40	0.70	0.32	0.0094
	DBD Pre-treated	SO	10 kV (50 Hz)	70.10	28.50	0.60	0.41	0.0086
		SN	15 kV(50 Hz)	70.40	29.00	0.60	0.41	0.0058
		SHF	10 kV (10 kHz)	73.50	26.10	0.40	0.36	0.0049

XPS-measurement results, Table 1, and carbon and oxygen peaks analysis led to the conclusion that the air plasma-chemical treatment at atmospheric pressure by DBD was a useful and effective method for surface chemical activation of inactivated wood (douglas fir, pine) by oxidation of lignin, resin and extractive materials.

2.3. Surface effects after DBD –aided capillary impregnation

XPS-measurement results and phosphor peak analysis showed the improvement of the capillary impregnation process – less phosphor in the chemical surface composition after DBD plasma pre-treatment and capillary impregnation – the surface layer (thickness less then 5 nm) holds less phosphor compound after plasma-aided impregnation – it goes in the depth of the wood.

CONCLUSION

The investigations on plasma-aided capillary impregnation carry out by XPS surface analysis technique hold out new opportunities for improvement of the impregnation flame retardency of wood and wood products.

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REFERENCES

[1] Beecher, J., Frihart, C.: X-ray Photoelectron Spectroscopy for Characterization of Wood Surfaces in Adhesion Studies. Wood Adhesives 2005: Session 1A – Analytical Techniques, pp. 83÷89.

[2] Dineff, P., Gospodinova, D., Kostova, L., Vladkova, T., and Chen, E. "Plasma aided surface technology for modification of materials referred to fire protection". Problems of Atomic Science and Technology, 2008, 6; Series Plasma Physics (14), pp. 198÷200.

[3] Dineff, P., Gospodinova, D. "*Electrode Configuration and Non-Uniform Dielectric Barrier Discharge Properties*". XVI-th International Symposium on Electrical Apparatus and Technologies "SIELA 2009", 04÷06 June 2009, Bourgas, Bulgaria; Proceedings, 2009, vol. 1, pp. 79÷88.