Research for the Benefit of SMEs

Title: Development of a solvent-free coating process for wooden facades

Acronym: DURAWOOD

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Deliverable 2.2	Report on wettability and waterproofing laboratory trials
Associated WP	WP2 Laboratory Validation of the plasma technology for improving wettability and waterproofing effects
Associated Task	Task 2.1: Definition of the trials at laboratory scale Task 2.2: Development of a plasma DBD reactor for trials at laboratory scale Task 2.3: Execution of trials and analysis of results
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Dissemination Level	CO

1 Publishable Executive Summary

This report outlines the work carried out as part of an EC funded project called DURAWOOD – Development of a solvent-free coating process for wooden facades. The main task of this work package was to perform laboratory trials to validate feasibility of the plasma technology for improving wettability and waterproofing effects.

Over 10,000 measurements were done in order to get reliable results. Main scope was put on measurements of surface free energy and contact angles. Laboratory trials were done for 4 wood species, 3 different treatment times, 10 different treatment gaps by using the air atmosphere. Results show that most suitable conditions for plasma treatment of selected woods were as follows: treatment time 5s; best atmospheres air, CO_2 and in some cases also Argon. Different gaps caused hydrophobization or hydrophilization effect. Small gaps up to 0.4 mm provide in most cases hydrophilization while bigger gaps provide hydrophobization.

Very important is also stability of plasma treatment. Set of spruce samples was plasma treated in atmosphere of CO_2 during 5s, samples were then aged during 1, 3, 5 and 7 days in standard laboratory conditions. Change of water droplet contact angle was measured and analyzed. Results confirmed that almost all samples of plasma treated spruce and larch had values of contact angle above the reference (except of those treated at gaps 0.1-0.2 mm) and by increasing the ageing period, the contact angle increases and the sample surface becomes more hydrophobic and plasma treatment seems to be stable.

FT-IR spectroscopy was carried out in order to determine changes in composition of the surface layer generated during the plasma treatment. FT-IR apparatus Digilab Excalibur FTS 3000MX with ATR crystal was used for determination of chemical properties of wood surface of treated and untreated samples. Two most promising atmospheres (CO_2 and Air) were chosen on the basis from the results of measurements of total surface energy, which fulfill the industrial and economical requirements. It has been found that plasma treatment has different effect on each individual wood specie, therefore it is very hard to express general conclusion from ATR FT-IR measurements. However, from the results it is obvious that using air as a treatment atmosphere leads to growth of absorbance in comparison to reference at every researched wood and for all studied absorption bands. On the other hand, it must also be said, that these changes are relatively small and they just indicate certain changes in the chemical structure of wood. Results for plasma treatment in the atmosphere of carbon dioxide show that the influence of this atmosphere on changes of the chemical structure of wood is much smaller than those caused by plasma treatment in air atmosphere.

3D topography of the surface was performed as well as AFM analysis in order to verify and to visualize structural changes on wood surface treated with atmospheric plasma. From results it is obvious, that 3D topography of the surface is not accurate enough for evaluating structural changes on the surface. AFM confirmed that diffuse coplanar surface barrier discharge causes structural changes on the surface of the wood in the nanocsale and they are visible and appear as “bubles“ newly created on plasma treated surface.

The project must fulfil requirement cost-effectiveness. Cost of plasma treatment is important for its later applicability in industry. There was performed calculation, where two most important parameters affecting the price of plasma treatment were taken into count – cost of energy and cost of technical gases used as atmosphere. Cost of energy is considerably lower than cost of gases. It means that higher energy output with no special gass (just working with air) will be preferred.