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Cold Plasma as Effective Tool for Aluminum Surface Cleaning

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Aluminum (Al) is heavily used to manufacture structural parts in the aeronautic, railway, automotive or naval industries because of its lightness and its corrosion resistance [1]. One of the most popular uses of Al is in the packaging industry. Moreover, it plays a main role in the construction, such as aluminum composite panel. The surface properties (surface energy, roughness and surface chemistry) of Al are critically important in achieving good wettability, bond formation and durable adhesion [2]. The classical chemical methods of surface cleaning and degreasing such as phosphoric acid anodizing are the basis for high-strength and everlasting adhesive bonds, at e.g. bonding of Al and its alloys with adhesives. However, nowadays the use of wet methods for the surface treatment of Al doesn't comply with ecologic standards [3]. Cold plasma treatment represents an efficient, clean and economic alternative to activate and enhance both wettability and adhesive properties of Al surfaces [4]. This research was focused on the improvement of surface and adhesion properties of the Al surface using eco-friendly plasma surface treatment and understanding plasma effect on the enhancement of surface and adhesion properties. In this research, plasma system was used for the cleaning of the Al surface and the improvement of the surface and adhesive properties necessary for laminates applications. The wettability of Al samples was very low as result of the impurities originated from rolling oil. Al foils are usually produced by rolling down strip processes consisted of number of cold-rolling steps responsible for the reduction of the thickness. In the final step, two layers of foils are wounded together and rolling oil is sprayed between the two layers and the "twin foil" is rolled down. A continuous amorphous oxide layer is formed immediately after rolling process due to the reaction of oxygen and air humidity and therefore new metal surface is produced [5]. The oxide layer and rest of oil usually present in prepared Al foils result in low wettability. For the above mentioned reasons, surface free energy achieved very low values, 33 mJ/m^2. Plasma treatment of Al foils led to effective removing of weakly bounded and dirty layers resulting in the wettability increase as result of ablation processes. The most increase of wettability was observed after 7 s of corona effect, while surface free energy increased to 83 mJ/m^2. Surface free energy closely relates also with the chemical composition.

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Fourier Transform Infrared Spectroscopy (FTIR) was employed to analyze the plasma effect of the Al surface. The FTIR spectrum of untreated Al was characterized by characteristic peaks corresponding to the vibrations of Al-OH groups (Fig. 1). Moreover, asymmetric and symmetric vibrations of -CH_2- groups belonging to processing oil used during production processes of thin Al foils. Plasma treatment led to the noticeable decrease of the intensity of these groups and therefore to the increase of the Al-OH absorbance band intensity. The other techniques such as Atomic force microscopy and Scanning electron microscopy confirmed the changes in the surface roughness contributing to the surface free energy increase. The enhancement of surface properties led to the improvement of adhesive properties too, which was confirmed from peel resistance measurement of prepared Al-polyethylene laminates. Moreover, the contribution of plasma effect on the enhancement of adhesion properties of Al surface was proven using Al- polyethylene adhesive joints prepared using adhesion promoters.

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References

[1] W. Polini, L. Sorrentino, Appl. Surf. Sci. 214, 232 (2003).

[2] L. Petersson, P. Meier, X. Kornmann, H. Hillborg, J. Phys. D: Appl. Phys. 44, 03401 (2011).

[3] L. Bónová, A. Zahoranová, D. Kováčik, M. Zahoran, M. Mičušík, M. Černák. Appl. Surf. Sci. 331, 79 (2015).

[4] C. Dartevelle, E. McAlpine , G.E. Thompson, M.R. Alexander. Surf. Coat. Tech. 173, 249 (2003).

[5] N.A. Thorne, P. Thuery, A. Frichet, P. Gimenez, A. Sartre, Surf. Interface Anal. 16, 236 (1990).