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Efficient surface treatment of polymers by means of atmospheric pressure high current diffuse dielectric barrier dischargeSergey Starostin¹, Hindrik W. de Vries², Bernadette van der Velden-Schuermans¹, Jan B. Bouwstra¹¹FUJIFILM Manufacturing Europe B.V., Tilburg, Netherlands ²Dutch Institute For Fundamental Energy Research (DIFFER), Eindhoven, Netherlands

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Surface functionalization of polymers for better wettability and adhesion is the process continuously demanded by industries. For in-line web-rolled production the common approach is the application of the filamentary dielectric barrier discharge (DBD), often referred as "corona". Yet the corona treatment is sometimes not sufficient to provide efficiency and uniformity for critical applications. This contribution adopts a high power density, uniform type of DBD, operating in diffuse glow-like mode and benchmarks the treatment results against the standard techniques.

The diffuse DBD was sustained between rotary drum electrodes in the N₂ and N₂/O₂ based gas mixtures. The most common industrially used polymer foils: polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET) and polycarbonate (PC) were roll-to-roll plasma-treated at various web speeds and specific discharge power. The effect of ultrathin Si_xO_yH_zC_w layers (< 5 nm) deposited in discharge plasma on surface properties was also investigated. The surface energy and aging behaviour was studied by means of contact angle analysis. Surface morphology and chemical composition was assessed by AFM and XPS respectively.

The results indicate that the direct treatment by the diffuse high current DBD is significantly more efficient when compared to standard corona in terms of energy costs and exposure time. The aging (hydrophobic recovery) was found to be only moderate. For the nitrogen plasma treatment, even after one month aging in ambient environment up to 10% concentration of grafted nitrogen atoms was found on PET surface by XPS. It is discussed that the enhanced treatment effect can be related to the high rates of radicals production in the cathode sheath of the glow-like discharge, as well as to the uniform and relatively high incident flux of ions and electrons to the surface.

Keywords

polymer

treatment

roll to roll

dielectric barrier discharge

atmospheric pressure