

ABSTRACT

“Study of durability of the CH₄-O₂ low-pressure plasma on polypropylene films and non wovens. Improvement of polypropylene nonwovens absorption properties for filtration applications”

In this work, a research on the durability of the hydrophilic behavior of films and nonwovens of polypropylene, PP (of different weights) using low-pressure discharge luminescence plasma technology with a mixture of gases CH₄-O₂ 80:20, as well as on the improvement of technological properties (absorption) in such nonwovens for applications in the field of filtration has been carried out.

Firstly, the effects of plasma on PP films with different treatment times have been studied in detail, optimizing previously the treatment power. The hydrophilic behavior variation (wettability) has been evaluated by studying the contact angles and surface energy with different measuring liquids. The variation of the chemical structure/composition (functionalization) of the surface has been studied for different times of treatment by attenuated total reflection Fourier transform infrared spectroscopy (FTIR-ATR) and the x-rays photoelectron spectroscopy (XPS). The evaluation of changes in the topography (morphology and surface roughness) has been done by scanning electron microscopy (SEM) and atomic force microscopy (AFM). As a complement, weight variation has been studied for obtaining information about deposition or etching of material on the film surface. Once the treatment time has been optimized, a study on the durability of the hydrophilic properties obtained has been carried out through the monitoring of changes in the contact angles, surface energy and the chemical composition/functionalization of film surface for different ageing times and in different conditions. Finally, the improvement of wettability on PP nonwoven substrates of different weights and its durability have been evaluated for different treatment times. At technological level, the improvement of the absorption and filtration properties of these substrates has been studied by measuring the absorption capacity and absorption time of the liquid as well as its propagation velocity.

For the PP film, the increase of wettability depends on the power and treatment time with plasma CH₄-O₂ 80:20, being 150 W and 60 seconds of treatment the optimal values. The main mechanism of this plasma is the surface functionalization by inclusion of active species (containing oxygen) by deposition of a thin layer of functionalized polymer (plasmapolymerisation) and slight modification of the topography (predominance of deposition against etching). In general, the hydrophobic recovery process (ageing) with CH₄-O₂ occurs to a lesser extent than in other gases (O₂, N₂, Ar, etc.) due to the presence of an organic component promotes the plasmapolymerisation and oxygen allows the formation of oxygen species. Improvement of treatment remains acceptable after three weeks of ageing at environmental conditions. Furthermore, ageing is more pronounced in more aggressive conditions (especially temperature), by promoting diffusion or movement of low molecular weight organic species as well as the reorganization of different polar groups towards the core of the material.

In general, the mentioned plasma treatment causes a significant improvement in the wetting properties of different PP nonwoven substrates, regardless of the weight, and this is reflected through the improvement of various properties related to the absorption phenomena: absorption capacity and absorption velocity of the liquid and its wetting time. In this way,

increases its absorption capacity and possibilities for using in filtration applications. Degradation marks or significant changes in surface morphology are not appreciated and the effects of the treatment are still at acceptable levels after three weeks of treatment.