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DEPOSITON OF SILVER ON PLASMA ACTIVATED POLYPROPYLENE SURFACE BY DIELECTRIC BARRIER DISCHARGE

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Abstract. The aim of this work is plasma activation and functionalisation by silver ions of nonwoven polypropylene. For analyzing prepared samples we used ICP-OES, SEM and AFM. In this paper we presented some preliminary results.

1. INTRODUCTION

Production of the technical textiles is one of the fast growing sectors of the global textile industries. Textile materials used in the medical, health care and hygiene sectors are an important and expanding part of the industry, and they are usually referred as biomedical textiles. This group of products demonstrates a great range of applications, from simple bandages to biocompatible implants and tissues; antibacterial wound treatment material, prosthetics and so called intelligent textiles.

The application of nonwoven fabrics varied in the wide range from hygienic products to medical fabrics and industrial applications. By appropriate surface treatments nonwoven PP can be advanced in the biocompatible fabric and can acquire antimicrobial properties.

Silver is a well known antimicrobial agent due to its inherent properties such as high thermal stability, a long-term activity, and because it posses antimicrobial and antifungal properties (Radheshkumar et al. 2006, Ladnsdown 2006).

In this work our focus is mainly on the silver attachment on the surface of polypropylene and the influence of plasma treatment on silver absorption. In this study we continue our previous work with plasma modification of other textile materials and functionalisation by silver absorption to the surface (Kostic et al. 2009).

We studied how silver ions are incorporated by chemisorption into polypropylene (PP) fabric previously treated in dielectric barrier discharge (DBD). ICP-OES, SEM and AFM analyses were used to assess the surface changes on the PP fabric.

2. EXPERIMENT

In this work, for nonwoven polypropylene surface plasma activation we used dielectric barrier discharge (DBD) with plane-parallel electrodes for operation at atmospheric pressure.

Discharge configuration consisted of two aluminum electrodes (80x80 mm^2) both covered by a 0.65 mm^2 tick alumina layer (105x105 mm^2). The distance between the covered electrodes was fixed by glass space holders to ensure a fixed discharge gap of 3 mm. To avoid problems with humidity and to maintain homogeneous discharge we used zeolite. Spherical zeolite granules (diameters 2.0 - 2.4 mm) covered, in one layer, the bottom electrode of the DBD (Fig. 1). For simultaneous treatment of several samples, three identical parallel connected DBDs were used.

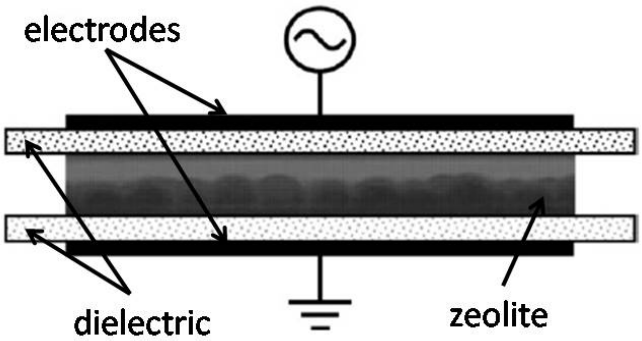

Figure 1: DBD discharge in air with zeolite.

The tested material was spun-bonded polypropylene (PP) fabric produced by Pegas Nonwovens, s.r.o. The fabric weight of the used nonwoven PP was 50 g/m^2 and 272 ± 22 μm. The fabric sample strips (15x80 mm^2) were treated for 15, 30, 60 and 120 s in the DBD. Samples of untreated and samples of plasma treated PP were immersed in a 0.01 $mmol/dm^3$ solution of $AgNO_3$ for 4 hours and dried for 24h in air.

A fast analysis methodology using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and microwave digestion sample preparation was utilized to determine the amount of absorbed silver on PP fabrics. The method used for preparation of samples for ICP-OES was Digestion Application Note DG-PL-11, in order to extract the silver from prepared PP samples.

The surface morphology of prepared samples was investigated by Scanning Electron Microscopy (SEM) using JEOL JSM 6460LV instrument and by Atomic Force Microscopy (AFM) using tapping mode AFM Dimension V produced by Veeco

3. PRELIMINARY RESULTS

We present preliminary results for absorption of silver ions on the plasma activated polypropylene surface. Silver ions were incorporated on all samples: both plasma treated and untreated polypropylene.

In Fig. 2 are presented the effects of the plasma exposure time on the absorption of silver ions by the plasma activated PP fabrics. During the plasma treatment due to the oxidation processes we create on the fiber surface new functional groups (-OH,-CHO, -COOH, etc. Dorai et al. 2003, Gheorgin et al. 1997) that silver will more easily bond to. Results indicate that a significant amount of absorbed silver is not chemically bonded to the PP surface, thus the poor sorption after rinsing, easily observable in the figure below.

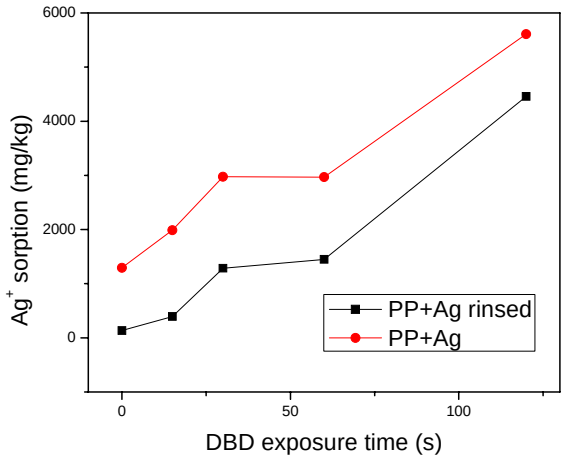

Figure 2: The effects of plasma exposure time and aging on the silver ions uptake by plasma activated PP fabrics.

We have also performed SEM and AFM imaging of PP surface. The results are presented in Figs. 3 and 4. The SEM micrographs show that the unmodified PP fiber surface is not smooth. After the plasma treatment we could not observe any changes in roughness or morphology of PP.

RBS analysis confirmed the presence of silver on the samples that were immersed in the silver solution. The creation of particles on the surface is observable also from the AFM images on the surface of PP after plasma treatment.

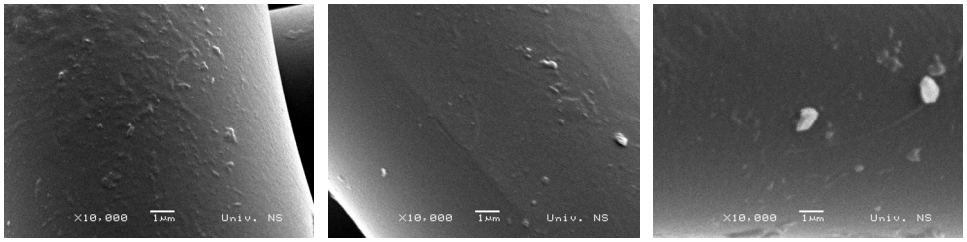

Figure 3: SEM images of polypropylene, polypropylene after immersion in silver solution and plasma treated polypropylene after immersion in silver solution (panels from left to right).

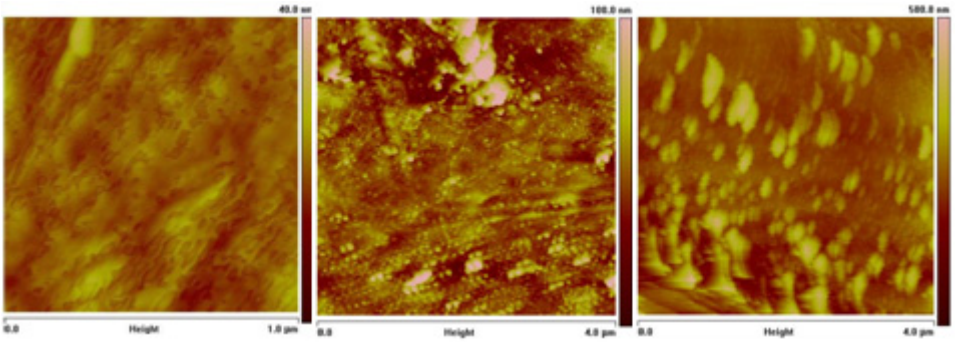

Figure 4: 2D AFM images of polypropylene, polypropylene after immersion in silver solution and plasma treated polypropylene after immersion in silver solution (panels from left to right).

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