Effect of Corona Discharge Treatment on the Surface Strength and Performance Properties of Synthetic Fibre Textiles

Abstract
Corona discharge, constituting one of the forms of atmospheric plasma, is a pro-ecological alternative to many conventional processes of the wet treatment of textiles that can also assist in improving these processes. However, one has to adapt the characteristics of corona discharge to the properties of the textiles to be treated and to use this plasma under controlled conditions, optimised to the results expected. An appropriate generator was designed and built equipped with a special multi-point electrode which makes it possible to obtain the extent of surface layer modification expected without any deterioration in the original strength properties of the textiles. The treatment of synthetic fabrics with corona discharge using the generator developed under optimised process conditions, brings about physical and chemical changes in the structure of the surface layer, resulting in a considerable modification of the surface strength and performance properties of textiles. The paper discusses changes in the properties of three selected types of woven fabrics from polyester, polyamide and polypropylene fibres treated with corona discharges, including wettability, the bonding strength of laminated fabrics, as well as the water-tightness and resistance of pigment printed fabrics for multiple washing. The results obtained confirm the usefulness of the preliminary treatment of textiles with corona discharge in improving their quality.

Key words: corona discharge, synthetic fibres, textiles, strength, surface properties, performances properties.

Introduction
The increasing threats to the environment, including the general harmfulness of conventional chemical treatments of fibres, performed mainly in aqueous media and requiring large quantities of water and thermal energy consumption as well as harmful biodegradable chemicals that pollute technological effluents, force one to intensify research oriented towards the development of more environmentally friendly technologies. One of the very promising trends includes processes based on the treatment of textiles with low-temperature plasmas [1, 4 - 7, 9]. As far as textile use is concerned, due to the low thermal resistance of textiles, only low-temperature plasmas can be taken into account; they include low-pressure plasmas generated and applied under low pressure conditions, mostly 0.1 – 1.0 hPa and plasmas generated and used under atmospheric pressure, commonly called atmospheric plasmas. Despite multinational research as well as very interesting technological outcomes and considerable financial involvement, low-pressure plasma treatment has failed to gain industrial importance, with no likely turning point expected in the future. Atmospheric plasma, especially its modification through corona discharge, has been studied for more than 40 years, but the aim of those studies was mainly to modify plastic film surfaces in order to improve their printability as well as their joining and laminating capabilities [3, 4, 29]. The basic advantage of numerous atmospheric plasma varieties, including corona discharge, is primarily their generation and use under atmospheric conditions, which is of great technical and economic importance, as well as their high intensity of interacting with polymeric materials. This makes it possible to use short treatment durations and, consequently, to perform treatment by continuous methods with a considerably higher yield than in the case of batch processes, necessary for low-pressure plasma [1, 4, 14]. Corona discharges have found common use in the preliminary surface treatment of plastic films [3, 4], allowing the expected optimisation of their surface properties and, consequently, performance properties such as joinability and printability [3]. As the use of low-pressure plasma during recent years has failed to improve textile finishing, corona discharge has become the subject of research in this direction. However, the trials performed to adapt the technique of corona discharge used for plastic films directly to the purposes of textile treatment have failed to give the results expected, which was due to the principal differences in the structure of fibres and textiles made from them, e.g. woven fabrics and films of the same polymers – although a compact and homogeneous structure of film, it has a heterogeneous and porous textile structure, e.g. woven fabrics, with a coarse surface, made of fibres with circular or circular-like cross-sections. Hence, textiles have a lower sensitivity to the action of corona discharge, and consequently it is necessary to use considerably higher activation energies to obtain the modification degree expected than in the case of films [4, 7 - 9].

The aim of research carried out by numerous centres was first of all to reduce the main drawback of corona discharges: their high non-uniformity and to eliminate locally existing plasma channels with a high power: the so-called streamers, causing irreversible thermal damage to polymers, as well as to increase their modifying effectiveness. [1, 3, 8]. Finally, several different modifications of corona discharge have been developed, such as dielectric barrier discharges, diffusive coplanar barrier discharges, dielectric barrier discharges with plasma blow-in, and glow discharges occurring at radio frequencies [4, 17 - 40]. Such discharges can be generated both in air and selected gases (He, Ar, N2), as well as in the atmosphere of an air-gas mixture. In order to generate such discharges, new types of discharge electrodes have been developed, e.g. electrodes in ceramic shield or segmented electrodes placed in a ceramic block. Suitable generators have also been developed for such discharges [3, 4, 8, 31, 35, 37 - 40]. Such generators are, however, expensive, which reduces their use in the treatment of textiles in industrial conditions.

Basic aim of the research
The basic aim of our studies was to examine the effects of corona discharges
used under semi-industrial conditions on
the changes in the physical and chemical
properties of the top layer of synthetic
fiber in terms of the possible use of these
discharges for improving specific per-
formance features of textiles. In these
investigations we used an original corona
discharge generator, developed and adapt-
ed by us for the treatment of textiles [8].

Experimental

Equipment used for the treatment of
textiles with corona discharges

In the construction of our equipment,
the above presented basic problem of the
discrepancy between the necessity of
obtaining a high energy corona dis-
charge and simultaneously providing the
highest possible uniformity and elimi-
nating harmful streamers was solved by
the development of an original system of
dividing the corona discharge energy
dose required per unit of the product sur-
face activated in J/cm², whose quantified
measure is $E_j$, into several smaller doses
($n$). $E_{jn}$, whose cumulative action on fi-
bres/fabrics provides the level of plasma
modification expected ($E_j = n \times E_{jn}$).

Such „constituent” doses of discharge
energy are low enough to provide a high
level of discharge uniformity and the
elimination of streamers. To operate on
this principle, an original system for a
multi-segment electrode was designed
and made; its constructional scheme is
shown in Figure 1. More details of the
operation principle of the multi-segment
electrode, the construction of electrodes
and the corona discharge generator are
presented in paper [8].

As confirmed by the tests performed,
the system developed was effective, and
the construction of multipoint electrodes
was used in the equipment developed for
the treatment of textiles with corona dis-
charge, the scheme of which is shown in
Figure 2 [8].

Using this generator, we carried out
systematic studies on the use of corona
discharge for the modification of textile
made from synthetic fibres, such as poly-
ester (PET), polyamide (PA6) and poly-
propylene (PP) fibres. The studies per-
fomed resulted in interesting findings of
a cognitive character, which also create
real opportunities of practical utilisation.

Materials

Characteristics of the test materials, such
as PET, PA6 and PP woven fabrics are
presented in Table 1.

Fabric treatment processes

Activation of woven fabric
of synthetic fibre

The activation of fabric was carried out
by means of a corona discharge genera-
tor equipped with multipoint electrodes
(Figure 1), whose scheme is shown in
Figure 2. The technical parameters of this
apparatus are described in [8]. The
activation conditions were optimised so
as to avoid appreciable damage to the
fabric during modification as well as loss
of its strength, and at the same time to
provide expected physical and chemical
changes in the surface properties of the
fibres/fabrics [8, 10].

As a result of the systematically per-
fomed tests of the action of corona
discharges with variable values of the
following parameters: unit energy, $E_j$,
generated with variable generator power,
speeds of fabric movement through the
discharge slot, the interelectrode slot size,
amongst others, for selected fabrics made
from three types of fibres: PET, PA6 and
PP (Table 1), the optimised values of the
unit energy [8] of activation of the fabrics
tested were found with the use of the gen-
erator developed (Figures 1 & 2). It was
found that under these conditions one
can obtain considerable improvement in
the fabric surface properties, as shown in
Table 2, with simultaneous elimination
of the hazard of thermal damage to the
fabrics, such as tensile strength deteriora-
tion, shown in Table 3.

Fabric lamination

Lamination or the laminar joining of
several, at least two, flat fabrics or fab-
rics with plastic films to obtain so-called
composite fabrics with expected proper-
ties, dependant on the characteristics of
their components and the binding poly-
meric layer, can be performed by various
techniques such as laminating with ap-
propriately applied solutions in organic
solvents or aqueous dispersion of poly-

Figure 1. Constructional scheme of a mul-
tisegment electrode.

Figure 2. Block diagram of generator for the treatment of textiles with corona discharge: 1 - generator, 2 - high voltage transformer, 3 - five-segment discharge electrode, 4 - cylin-
drical electrode, 5 - nozzle of device for aerosol application, 6 - test material, 7 - rewinder, 8 - winder, 9 - drive motor of winder, 10 - frequency converter to control the rotational
speed of winder motor, 11 - sensor of linear speed of test material, 12 - auxiliary roll [8].

Table 1. Characteristic of the tested materials.

<table>
<thead>
<tr>
<th>Fibre (polymer) type</th>
<th>Warp Yarn features</th>
<th>Warp Number of threads/10 cm</th>
<th>Weft Yarn features</th>
<th>Weft Number of threads/10 cm</th>
<th>Surface weight g/m²</th>
<th>Procedure of fabric preparation for discharge treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>PET</td>
<td>150 dtex f 216 twistless</td>
<td>320</td>
<td>89</td>
<td>PET</td>
<td></td>
<td>Washing, heat-setting 20s. 190°C</td>
</tr>
<tr>
<td>PA6</td>
<td>160 dtex f 144 twistless</td>
<td>310</td>
<td>81</td>
<td>PA6</td>
<td></td>
<td>Washing, heat-setting 20s. 185°C</td>
</tr>
<tr>
<td>PP</td>
<td>84 dtex f 33 twistless</td>
<td>330</td>
<td>72</td>
<td>PP</td>
<td></td>
<td>Washing</td>
</tr>
</tbody>
</table>
meric binding agents, or techniques based on low-melting granulated polymers of the “Hot-Melt” type [5, 11 - 13, 17]. In our case, the first technique was used, and trials were carried out by means of a semitechnical line for padding, coating, laminating, drying and cross-linking, provided by Mathis (Switzerland) [5, 13].

A paste based on the aqueous dispersion of non-cross-linked, self-cross-linking acrylic-vinyl copolymer, Evo-Fin ATR from DyStar (Germany), in a quantity of about 50 g/m² (about 15 g/m² after drying), was applied on the surface of one of the fabrics joined (activated or unactivated under optimised conditions) by the method of thin-layer direct coating using a blade supported on a roll. Then, after a preliminary gelation of the coat with IR radiation, the second fabric (activated or unactivated) was overlaid, pressed with a roller, dried at 90 - 100 °C and cross-linked at a temperature of 160 °C for 60 s. Next, after conditioning for 24 h, the delaminating force of the laminated fabrics was determined. Considering the test objective (determination of the effect of preliminary activation on the laminating quality), woven fabrics of the same type were used in all the trials (with the same characteristics, activated or unactivated, respectively).

**Wetproof coating**

To obtain wetproof coats on the woven fabrics activated under optimised conditions or unactivated, coating pastes based on aqueous dispersion of non-cross-linked acrylic polymers [5, 12, 13] were applied to the fabrics by the method of direct thin-layer coating using a so-called air blade. All the three types of woven fabrics (activated and unactivated) were coated (Table 1) using the same laboratory line as in Section II (Fabric laminating). Washed and stabilised, or washed, stabilised and activated with corona discharge, the woven fabrics (Tables 1 and 2) were preliminarily padded with an aqueous bath containing 10 g/dm³ of an auxiliary agent based on fluoro-organic compounds - Oleophobol SL-AO1 from Huntsman (USA). This operation was used to avoid the coating paste penetration into the fabric structure, which would bring about too great a paste pick-up and considerable fabric stiffening.

<table>
<thead>
<tr>
<th>Fabric type</th>
<th>Unit energy of activation, J/cm²</th>
<th>Selected surface properties of woven fabrics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before activation</td>
<td>after activation</td>
</tr>
<tr>
<td>PET</td>
<td>75.6</td>
<td>38.45 – 54.16</td>
</tr>
<tr>
<td>PA6</td>
<td>18.9</td>
<td>41.79 – 45.02</td>
</tr>
<tr>
<td>PP</td>
<td>22.7</td>
<td>43.45 – 73.50</td>
</tr>
</tbody>
</table>

The coated fabrics, after acclimatisation, were padded with a bath of the following composition:

- 40 g/dm³ Oleophobol SL-AO1
- 10 g/dm³ isopropyl alcohol
- acetic acid to pH 4

Paddling bath conditions:
- bath temperature 20 °C;
- pick-up 50%.

The padded fabrics were then dried at 100 - 120 °C and polymerised at 140 °C for 3 min.

After the acclimatisation of the treated fabrics for 24 h, their water-tightness and changes were tested after standardised washing.

**Pigment printing**

Thanks to the colour qualities and generally good fastness of printed clothes, as well as the great simplicity and production reliability of pigment printing, its universality concerning practically all types of fibers and fabrics, the great progress in pigment and binding agent quality as well as relatively low production costs and favourable ecological aspects, this method of printing has gained primary importance over the past 15 years [2].

In respect of the quality of printed fabrics, due to the technical characteristics of pigment printing, the critical parameters for the assessment of performance qualities include abrasion fastness, especially wet abrasion fastness tested under considerably severer conditions. This fastness depends first of all on the quality of the printed ink and the technical characteristics of the fabric. The wet abrasion fastness of the woven fabrics printed with the pigment investigated was determined in a laboratory test with a special apparatus and a standardised load, as in the case of dry abrasion fastness, but with a water contact of 20 s. The fastness was determined after a test duration of 800 cycles.

Pigment printing involves the use of toxic and polluting materials, which makes this method unpopular and questionable at present. In recent years, however, there have been significant advances in the technology of pigment printing, which has gained increased importance compared to traditional printing, with the introduction of new, more efficient and environmentally friendly binders, the creation of new types of pigments, and the introduction of new printing techniques. The most widely used binders are water-based, which is an important advantage from the ecological point of view, but they are less resistant to light, heat and wash.
The polymeric binding agent used and, consequently, on the cross-linked print film and the force of its binding with the fibre/fabric surface, but also on the pigment particles dispersed in this film. On the other hand, it is the state of the fibre/fabric surface to be printed that is of paramount importance for the quality of print and its practical fastness. In this aspect, the use of corona discharge treatment resulting in effective physical and chemical modifications of the surface layer should lead to a noticeable improvement in both the conditions of the printing paste application and the degree of binding of the cross-linked printed film with the fibre/fabric surface, and consequently the print fastness obtained, especially wet fastness. This is of particular importance in the case of textiles made from synthetic fibres with a smooth and highly hydrophobic surface.

PET, PA6 and PP woven fabrics, presented in Table 1, were used for testing, in which different procedures of their preparation for printing were used: a) only standard washing, rinsing, dehydration, drying and thermal stabilisation (only PET and PA6 fabrics) or b) the above procedures followed by an additional treatment with corona discharge under the optimised conditions given in Table 2. The printing process was performed by the technique of hand screen printing with the use of flat patterns and typical printing pastes, which was the same for all the fabric types.

The flow chart for printing was the same for all the fabrics used and included:

1. Standard preliminary treatments (washing, drying, dehydration, heat-setting (only PET and PA6 fabrics)) → activation with corona discharge → printing → drying after printing → print fixing (thermal cross-linking).

The above series of operations was also used for printing unactivated fabrics (with no corona discharge treatment).

All the types of fabrics were printed with the same printing pastes of typical compositions:

- pigment pastes, Pigmatex from Sun Chemical A/S (Denmark) or Imperon from DyStar (Hoechst) (Germany), Fineprint (SOLCHEM srl, Italy) - 22 to 33 g/kg
- binding agent in the form of aqueous dispersion based on a self-cross-linking butadiene-acrylonitrile copolymer, Synthomer 5147 from Synthomer GmbH (Germany) - 130 to 150 g/kg
- synthetic thickener based on polyacrylic acid derivatives - 15 g/kg
- dispersing agent preventing the agglomeration of pigments in the printing paste - 5 g/kg
- anti-frothing agent - 5 g/kg.

The printing pastes used were of different colours: red (I), brown (II), violet (III) and dark blue (IV), containing the following additives:

| I | Pigmatex Orange OL | - 3 g/kg |
| II | Imperon Rot KGC | - 25 g/kg |
| III | I) Pigmatex Orange OL | - 5 g/kg |
|       | II) Pigmatex Black NG | - 2.2 g/kg |
| IV | Fineprint Brown RB | - 1 g/kg |
|       | Imperon Rot KGC | - 25 g/kg |
|       | II) Pigmatex Orange OL | - 5 g/kg |
|       | III) Pigmatex Black NG | - 2.2 g/kg |
|       | IV) Fineprint Navy Blue FRN | - 30 g/kg |
|       | I) Pigmatex Orange OL | - 3 g/kg |
|       | II) Pigmatex Black NG | - 5 g/kg |
|       | III) Pigmatex Black NG | - 5 g/kg |

Printed PET and PA6 fabrics were dried at a temperature ≤ 100 °C and then heat-ed (cross-linked) in hot air at 150 °C for 5 min. In the case of PP fabrics, the cross-linking was carried out at a lower temperature adapted to the thermal properties of these fibres: 120 °C for 8 min.

**Testing methods**

**Microscopic examination of the fibre surface**

This examination was performed at a micro-scale with the use of the SEM method and at a nano-scale by means of the AFM technique, described in [8, 9].

**Testing the chemical properties of the surface layer - X-ray micro-analysis (EDX)**

For the purpose of the qualitative and quantitative chemical analysis of the surface composition, the X radiation was recorded by means of an EDX micro-analyser of the ISIS Link System from Oxford Instruments. The topography of the surfaces tested was observed by means of a Vega TS 5135 MM scanning electron microscope from Tesca. The resolution of the X-ray micro-analysis was about 0.5 μm [8, 9].

**Measuring the contact angle and free surface energy**

The contact angle of the fabrics tested was measured by the dynamic method using a Sigma 701 tensiometer (KSV Instruments Ltd., Finland). This method consists in recording the force acting on a sample of the fabric tested after having been immersed in and removed from the measuring liquid at the same rate. The free surface energy and its components were calculated as described in [7 - 9].

**Wettability - capillarity testing**

Capillary tests were carried out in accordance with Standard PN-EN ISO 12944-1:2002 [42], using a Zwick tester, model 1120 (Germany).

In addition to the tests mentioned above, the effect of corona discharge treatment on some selected performance properties of the fibre/fabrics was also assessed, assuming the following parameters:

**Testing the delamination force of laminated fabrics.**

Testing the adhesive properties of PET fabrics treated with corona discharge comprised the determination of the delamination force of laminates. In order to assess changes in the adhesive properties of fabrics treated with corona discharge, the forces of the delamination of two laminated fabrics were determined. Tests were carried out in accordance with Standard PN-P-04950:1988 [43], using a Zwick 1120 dynamometer, operating on the principle of constant elongation increment in time with recording the delamination force.

**Testing the water-tightness of coated woven fabrics and their changes during standardised multiple washing**

The testing was performed by the hydrostatic method according to Standard PN-EN 20811:1997 (Textile. Determination of water-tightness. Hydrostatic pressure method) [44], using a Penetrometer FX 3000 from TEXTEST A.G. (Switzerland).

Changes in water-tightness after multiple washing (5 washings) were assessed under standardised conditions according to Standard PN-EN ISO 6330:2002, procedure 5A (40 °C) [45], using an automatic washing machine - WASCATOR FoM 71 MP LAB from Electrolux (Sweden).
Testing the resistance of pigment printed fabrics to washing with wet brushing

In the case of pigment printed fabrics, the standardised test methods commonly used for testing the water, washing or perspiration fastness of fabrics printed with conventional dyes are of no use due to the form of pigment binding with the textile substrate and the pigment’s insolvency in water. Only the methods of abrasion fastness, especially wet abrasion tests, can be used; however, the results obtained do not allow to assess the actual performance value of fabrics. Therefore manufacturers of pigments and binding agents develop their own test methods that allow more accurate assessment of the performance resistance of pigment printed fabrics. Such a wide-spread and most severe test method, additionally corresponding to conditions existing during the genuine use of fabrics, was developed by the company BASF - the so-called washing-with-brushing test. This method allows one to test changes in the colour of a sample using an assessment procedure for assessing the effect of the corona discharge treatment of fabrics on their performance properties.

Results and discussion

Effect of corona discharge treatment on the surface properties of activated fabrics

As a result of systematically testing the physical and chemical characteristics of woven fabrics treated with corona discharge generated under optimised process conditions by the generator developed (Figure 2), it was that it is possible to obtain a modification of the textiles under investigation (Table 1) and resultant changes in the surface layer structure the same as those observed in the case of polymeric films treated with corona discharge. Optimisation of the unit energy dose, \( E_j \), provides the degree of modification expected and eliminates possible damage to the fibre-forming polymer, as confirmed by the fact that the tensile strength of the fabrics treated remains the same as that of unmodified fabrics (Table 3). The optimised doses of unit energy, \( E_j \), and the surface properties of the treated fabrics obtained are given in Table 2.

The treatment of fabrics with corona discharge under optimised conditions resulted in changes in the micro- and nano-topography of the fiber’s top layer as shown in Figure 3.

As follows from the results listed in Table 2, the changes in the surface properties of fibres/fabrics treated with corona discharge are very significant and similar to polymer-films - the characteristic globular nano-structure of surface layers [14-16].

These results confirm that the developed technique of applying corona discharges with the use of the generator developed is fully suitable for the modification of the woven fabrics under investigation.

The dynamometric measurements of the tensile strength of the fabrics performed before and after modification with corona discharge show no adverse changes, as shown in Table 3.

Changes in the surface properties of fabrics – stability of the activation effects

Changes in the surface properties of activated woven fabrics occurring during their storage were assessed by measuring the fabric wettability by the method of capillarity measurement [41]. The results of these measurements for the 28-day period of fabric storage in a conditioned room are shown in Figure 4.

As follows from the data presented, the improvement in the wettability of woven fabrics treated with corona discharge under optimised process conditions is a durable effect in time. After 22 - 28 days from activation, the wettability of PET fabrics was higher by 44% and that of PA6 fabrics by 57% in comparison with the wettability of unactivated fabrics. Slightly smaller changes were found in the case of PP fabrics.

Effect of corona discharge treatment on the wettability of fabric

The results presented in Table 2 and illustrated in Figure 5 show that the treat-
From the results above, it follows that the preliminary activation of PET and PP fabrics provides a considerable increase in the water-tightness of the coated fabric, which makes it resistant to a large extent, to multiple washing.

**Pigment printing - improvement in the fastness of pigment printed fabrics to washing and brushing**

Table 5 lists the results of testing the fastness of pigment printed fabrics previously treated with corona discharge to boil washing with sequent wet brushing.

The presented test results of fastness to washing with wet brushing indicate that activation with corona discharges resulted in different effects depending on the type of polymer. The lowest increase in this fastness is observed in PET fabrics, while a higher increase can be seen in PA6 fibres. The best results were obtained for PP fibres. This very high increase in the fastness to washing with wet brushing obtained in corona-activated PP fibres seems to be due to the characteristics of polypropylene fibres. Based on the tests performed, it is clearly seen that preliminary activation with corona discharge can be recommended for all types of woven fabrics to be printed with pigment, as confirmed by the fastness results obtained.

**Conclusions**

1. The studies performed allowed us to develop optimised technological conditions for the modification of woven fabrics of continuous synthetic fibres with corona discharges, which make it possible to obtain a high degree of physical and chemical modification of the top layers of PET, PA6 and PP fibres, with the elimination of possible damage to the fibre-forming polymers, as confirmed by the unchanged strength properties of the fabrics modified.

2. Using appropriately selected conditions of corona discharge treatment in relation to the structure of the fabrics and fibre shape, one can obtain the extent of fabric modification/activation expected and thus appropriately form the technical and performance properties of textiles. The resultant changes in the structure of the surface layer are similar to those observed in the case of the action of corona discharge on the surface of films made from the same types of polymers.

3. Although there are essential differences between the conditions and effects of the surface modification of films and textiles from the same types of polymers.

### Table 4. Results of the water-tightness of fabrics tested by the hydrostatic method.

<table>
<thead>
<tr>
<th>Fabric type</th>
<th>Dry weight of polymeric coat, g/m²</th>
<th>Water-tightness measured by the hydrostatic method, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>New fabric</td>
</tr>
<tr>
<td>Unactivated PET fabric</td>
<td>31</td>
<td>98</td>
</tr>
<tr>
<td>Activated PET fabric</td>
<td>32</td>
<td>199</td>
</tr>
<tr>
<td>Unactivated PP fabric</td>
<td>28</td>
<td>104</td>
</tr>
<tr>
<td>Activated PP fabric</td>
<td>33</td>
<td>201</td>
</tr>
</tbody>
</table>

### Table 5. Effect of corona discharge treatment of textiles on the fastness to abrasion of pigment printed fabrics.

<table>
<thead>
<tr>
<th>Fabric type and treatment</th>
<th>Fastness to washing and wet brushing of pigment printed fabric according to BAF procedure – colour change in degrees of the grey scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Colour of printed fabric</td>
</tr>
<tr>
<td></td>
<td>Dark blue</td>
</tr>
<tr>
<td>Unactivated PET (blank sample)</td>
<td>4</td>
</tr>
<tr>
<td>Preliminarily activated PET</td>
<td>5</td>
</tr>
<tr>
<td>Unactivated PA6 (blank sample)</td>
<td>3</td>
</tr>
<tr>
<td>Preliminarily activated PA6</td>
<td>5</td>
</tr>
<tr>
<td>Unactivated PP (blank sample)</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Preliminarily activated PP</td>
<td>5</td>
</tr>
</tbody>
</table>
polymers, in both cases the final effect produces the same characteristic globular nano-structure of the surface layers.

4. The beneficial changes obtained in the surface properties of PET, PA6, and PP woven fabrics due to their treatment with corona discharge under optimised conditions show good stability during fabric storage, which is of paramount importance for possible industrial uses of this innovative treatment technique.

5. The use of the preliminary corona discharge treatment of PET, PA6 and PP woven fabrics under optimised conditions makes it possible to improve considerably the technical and performance properties of modified fabrics, those modified and then laminated, as well as coated (to obtain water-tightness) or pigment printed fabrics. Taking into account the great importance of water-tight (and not only) textile-polymeric multi-layer coating materials as well as the considerably increased water-tightness parameter obtained due to preliminary corona discharge treatment, the numerous and miscellaneous uses of composite materials as well as the common use and importance of pigment printing, the aspects of the practical use of corona discharge treatment presented are of great importance and have high implementation opportunities.

6. The possibility of a considerable improvement in such an important parameter as wettability for the whole area of textile finishing, including a wide range of synthetic textiles, offered by corona discharge treatment, has a high potential of industrial implementation.

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**References**

5. Brzeziński S.: "Wybrane zagadnienia z chemicznej technologii obróbki włościn."
7. Brzeziński S.: "Perspektywy zastosowań na- notechnologii we włókiennictwie w Polsce."
8. in Expertise of 4 Dep. WNT PAN, Warszawa 2006, pp. 10-34.