EFFECT OF COMMERCIAL WATER REPELLENT AGENTS ON FUNCTIONAL PROPERTIES OF POLYESTER WOVEN FABRIC USED FOR WASHABLE MEDICAL MASKS

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ABSTRACT

Water repellent fabrics are always used for washable medical mask production to keep them from the bacterial liquid during use. Choosing the right water repellent which is efficient and suitable for fabric is important in washable medical mask production. The water-resistant treated fabric needs to keep its water repellent for many washed cycles. Moreover, their physico-mechanical properties such as air permeability and thickness must be less changed. In this study, four commercial water-resistant chemicals (Ruco–Coat BC 7068, TP – Phob FC 2904, Phobotex RHP Hydrophobic Agent, Ruco-guard AFB60) were used to treat the 100% polyester woven fabric to examine the influence of the type and concentration of the water-resistant chemicals on water repellent capability of the polyester woven fabric. The fabric thickness and the air permeability of the untreated and treated fabric were investigated. The SEM, FE-SEM analysis, and the FTIR spectra were used to find the differences between the initial and treated fabric. The results showed that the water-resistant type influenced the water repellent capability of fabrics and their duration. Among four investigated water resistance, the TP – Phob FC 2904 presented the best water resistance for treatment of the 100% polyester woven fabric, and its concentration of 50 g/l has maintained 85 % fabric water repellent capability after 25 washed cycles.

KEYWORDS

Water repellent fabric; Woven fabric; Water resistant chemicals; Air permeability.

INTRODUCTION

Medical textiles are considered personal protective clothing for healthcare in the medical sector, specifically to mitigate the risks from exposure to hazardous substances including body fluids, and to minimize the risk of cross-infections. Medical protective clothing, usually made from synthetic fabric such as polyester because of better liquid barrier properties, could be manufactured using nonwoven, weaving, or knitting technologies. Fluid repellent finishing can be used for getting water repellent fabrics [1, 2].

Water repellent textiles are often high-density woven fabric which is made of very fine yarns or common fabrics with treated hydrophobic surface to keep the fabric pores which are not filled during the treatment processes. A water repellent fabric may be quite permeable to air and water vapor so in a wet environment, it can keep the wearer dry due to their water repellent capability. Water repellent garments are designed for use that protects the human body from the water and many harmful agents and but let effective transmission of moisture vapor from the inner to the outside atmosphere. The applications may range from their well-known use in leisure clothing, and industrial and military applications to specialized medical products such as washable medical masks [1-4].

Many researchers have investigated the different kinds of water resistant agents for fabric [5-9]. Weixia Zhu et al. have fabricated the fluorine-free breathable poly(methylhydrosiloxane)/ polyurethane fibrous membranes with water resistant capability based on the hydrophobic matrix and small pore size [5]. The authors have studied the morphologies, porous structure, surface wettability also tensile strength of the fabric. Indrajit Bramhecha et al. have used the citric acid-based polyol to synthesis waterborne polyurethane for antibacterial and water-repellent cotton fabric [6]. The author has reported that waterborne polyurethane coated cotton fabric was unchanged in tensile strength and crease recovery angle but it's excellent water repellency (100+ cm of water pressure by test using Shirley hydrostatic head tester in cm of water pressure as prescribed in ASTM

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D4491) was obtained. Guangming Pan et al. have studied the stable polydimethylsiloxane (PDMS) - copper stearate (CuSA2) coating on cotton fabric by a simple in-situ growth and dip-coating method [7]. The sample has inherent mechanical durability, UV resistance, and high oil-water separation efficiency. Y Su et al. have investigated the effect on the thermal protective performance of single- and double-layer fabric systems [8]. In their work, a hot water and steam tester was used to examine the thermal protective performance of treated fabric against hot water and steam hazards. P. De et al. have used the perfluoroalkyl-type fluorocarbon-based compound and fluorocarbon resin-type compound are used as water-repellent, chemicals are applied by different concentrations [9]. It was found that fluorocarbon resin-type compound gives the best results for a water-repellent finish. The water resistant agents in these investigations were not the commercial type which was always used in textile industries for the production of washable medical masks.

Besides, the influence of fabric structure such as the density, the used yarn, roughness, and the water repellent type and their concentrations on the fabric water repellent capacity have been reported [10-14]. Dunja Šajn Gorjanc et al. have investigated the influence of elastane incorporation in the weft direction of cotton fabrics, and the structural properties such as fabric density and type of weave (plain and twill) on the water vapor resistance of the elastic and conventional cotton woven fabrics [11]. Gulay Ozcan has investigated the effects of water repellent finishes on plain woven fabrics in two blends (100% cotton and 50/50 cotton/polyester) [12]. The research has studied the influence of three kinds of commercial water repellent (Fluorocarbon-based water repellent, Chromstearylclorur-based water repellent, and 3XDRY smart water repellent) on the woven fabric properties such as breaking strength, abrasion resistance, pilling, light fastness, wetting time. The author reported that the water repellent type and their concentrations were very important parameters that effect on woven fabric properties: Fluorocarbon-based water repellent showed the most efficacy on fabric water repellent of both fabrics (100% cotton and 50/50 cotton/polyester). However, the research did not report the air permeability of the treated fabric which was always an important property for the water repellent fabric. Alain M. Jonas et al. has studied the theoretical and experimental methods to quantitatively evaluate the water repellency of woven fabrics coated by hydrophobic formulations (Wax-modified melamine resin, Silicone rubber, Perfluorobutyl-modified polyurethane) [13]. The research was based on the relationship between the woven fabric roughness and its water repellency. The authors have investigated the surface roughness of eight different woven fabrics and their water repellency after having been coated by wax-based, silicone-based, or perfluorobutyl-based commercial polymer formulations. The result showed that the fabrics with roughness lower than the critical value (which was 1.22 in the research conditions) have partially wet state with a substantial pinning of the droplets on their surface and an absence of roll-off whatever the type of hydrophobic coating. Above this critical value, the fabrics became superficially wet with contact angle controlled by the amount of air trapped in the texture which depends on the wetting hysteresis of the coating material. Beysim Garip et al. have studied the water repellency of woven fabrics prepared from polyester filament yarns [14]. Yarns containing water repellent additives (0%, 3 %, 5 %, and 8% in weight) were produced by melt spinning method using polyester chips. Eight different yarns were produced that included 4 types of polyester yarn (P0, P3, P5, P8) and 4 types of textured yarns (T0, T3, T5, T8). Plain woven fabrics were weaved from these yarns. Then, the water repellency, tensile, and air permeability tests of the fabrics were measured. The authors reported that the yarns added water-repellent additive did not show an effective water repellency performance. The reason was the low percentage of additives in the yarns. Meanwhile, when the coating repetition increased (1, 3, and 5 times water-repellent finishing), the water repellency of the fabrics improved and air permeability decreased by approximately 80% as the number of coatings increased to 5 times.

Even though research papers can be found that compare the effectiveness of commercial water-repellents, most authors do not emphasize the preservation of breathability and water vapor permeability of fabrics, as well as the resistance in the washing of the applied treatment.

That is why the scope of this paper is to investigate the water-repelled capability of polyester fabric treated by chosen commercially water-repellent chemical solutions. The effect of the type of water-repellent solution on fabric water-repellent capability, fabric thickness, and fabric air-permeability is studied. Moreover, the effect of the type of water-repellent chemical on the durability of the applied treatment was analyzed. Based on the results, the most effective chemical concerning fabric repellent capacity and fabric air permeability was chosen and different concentrations of this chosen water-repellent chemical were studied concerning fabric repellent capacity and durability of the applied treatment during washing cycles. As a substrate polyester fabric was chosen and the treatment was applied by the pad-dry-cure method, described as commercial water-resistant chemicals are often used on textile industrial scale, especially for the washable medical mask.

Table 1. Technical parameters of the investigated polyester fabric.

Fabric density mass [g/m^2]	Fabric thickness [mm]	Yarn count [tex]		Fabric density [yarns/10 cm]	
		Warp filament yarn	Weft staple yarn	Warp	Weft
235.00	0.54	16.66/2	19.68/2	321	232

MATERIAL AND METHODS

Materials

The 100% polyester woven fabric (twill weave 2/1 Z) has been used for this investigation. Their technical parameters are presented in Table 1.

The study used four water repellent chemicals: Ruco – Coat BC 7068, a non-fluorocarbon hyperbranched and linear cationic polymer from Rudolf Group (Germany) [17]; TP – Phob FC 2904, a fluorocarbon-based water repellent from Truongphat JSC (Vietnam) [18]; Ruco-guard AFB6 conc from ODG Company (Taiwan) [19], Phobotex RHP Hydrophobic Agent, a non-fluorinated water repellent from the Huntsman (Germany) [20] and the cross link Phobol extender xan, a dispersion of an oxime-blocked polyisocyanate from Huntsman (Germany) [21]. The chemicals were used as supplied without any further purification.

Methods

The pad-dry-cure method has been used in the research. The woven fabric (100% polyester) was pre-treated (desizing and washing at 80 °C for 20 minutes) and then cut into samples of 40 cm x 20 cm. The samples were then kept in the standard condition (temperature at 21 ± 2 °C (70 ± 4°F), relative humidity of 65 ± 5%) for at least 4h before testing.

Water repellent chemicals with suitable concentration, the cross link Phobol extender xan (15 g/l), and 0.15 ml of acid acetic were added to the padding solution to obtain the pH of 5 to form the padding solution. The concentration of water repellent chemicals was prepared depending on every investigation.

The padding machine model Rapid (Taiwan) was used. Every fabric sample was passed the padding solution then they were pressed with the pressure of 0.8 kg/cm^2 (80% pressure level) followed by a drying process at 150 °C for 60 seconds. After that, the fabric samples were cured at 190 °C for 60 seconds. The padding conditions were chosen based on the textile industrial scale (Textile Namdinh factory, Vietnam) where the washable medical masks were fabricated.

<u>Influence of the water-repellent type on the fabric treated water repellent capability and its duration after washed cycles</u>

To investigate the influence of water repellent chemical type on the water resistant capability and its duration of fabric treated water repellent, four water repellent chemicals were used with the same concentration of 30 g/l for every padding solution. The padding conditions were as described in the above section.

The fabrics treated with the water-repellent chemical then have been washed by the standard ISO 6330:2012 using washing machine Type C (Vertical axis, top-loading pulsator machine) with the washing procedure 4M (washing at 40 °C ± 3 °C, 40 liters of water for 6 minutes, spinning for 3 minutes; rinsing with 40 liters of water for 2 minutes, spinning for 3 minutes). The water repellent capability of the treated fabric was evaluated after 5, 10, 15, 20, and 25 washed cycles by the Spray Test AATCC 22-2017 to choose the best water resistant chemical for further research.

The SEM image, the thickness, and the air permeability of initial and treated fabrics were investigated to examine their differences. The fabric thickness was measured by ASTM D1777- 96 (2011), each sample was measured in ten positions and their mean value was taken. Fabric air permeability had been determined by the standard ASTM D 737: 2004. SDL Atlas AirPerm Air Permeability Tester was used with a 20 cm^2 test head and pressure of 100 Pa. Each sample had been measured in five positions and their mean value was taken.

The ATR-FTIR analysis of the chemicals and the fabric before and after being treated by the best water repellent was carried out using an FTIR spectrometer (Thermo Scientific Nicolet iS50, USA) by recording 64 scans in transmittance mode [%].

<u>Influence of the concentration of water repellent on the water repellent capability and duration of treated fabric after washable cycles</u>

The best water repellent chosen from the first investigation would be used with 5 different concentrations (10 g/l, 20 g/l, 30 g/l, 40 g/l, and 50 g/l) for treating the woven fabric (table 1) with the same concentration of the cross link Phobol extender xan (15 g/l) and 0.15 ml of acid acetic was added to obtain the pH of 5 for the padding solution. The padding conditions were described above.

The fabric treated by water repellent chemicals has been then washed by the standard ISO 6330:2012. The water repellent capability of the fabric was evaluated after 5, 10, 15, 20, and 25 washed cycles by the Spray Test AATCC 22-2017.

Table 2. Ratings of the water repellent by Spray Test AATCC 22-2017 standard.

Ratings	Signification
100	Not sticking or wetting of the specimen face
90	Slight random sticking or wetting of the specimen face
80	Wetting of the specimen face at the spray points
70	Partial wetting of the specimen face beyond the spray points
50	Complete wetting of the entire specimen face beyond the spray points
0	Complete wetting of the entire specimen face

Table 3. Influence of the water repellent type on the fabric water repellent capability.

Order	Water resistant chemical	Fabric water repellent capability [%]	Image
1	Before treating	0	
2	Ruco – Coat BC 7968	85	
3	TP – Phob FC 2904	100	
4	Phobotex RHP Hydrophobic Agent	70	
5	Ruco-guard AFB6 conc	95	

Table 4. Influence of the water resistant type on the fabric water repellent capability after washed cycles.

Order	Water resistant chemical	Washed cycles (time)					
		0	5	10	15	20	25
		Fabric water repellent capability					
1	Ruco – Coat BC 7068	85	80	80	75	70	65
2	TP – Phob FC 2904	100	100	90	85	80	75
3	Phobotex RHP Hydrophobic Agent	70	70	65	60	60	50
4	Ruco-guard AFB6 conc	95	85	85	80	75	70

Evaluation of the water repellent capability fabric

The water repellent capability of the fabric was evaluated by the Spray Test AATCC 22-2017 standard (Table 2).

Verification of water repellent chemicals in treated fabric

The morphology of fabric surface was analyzed by Scanning electron microscope (SEM) and by Field emission scanning electron microscopy (FE-SEM). SEM was used to examine the change of the fabric surface after treating water resistant and FE-SEM (model JSM 7600 USA) was used to determine the presentation of Flour element. Scanning electron microscope (SEM) JEOL JSM7600F, USA was used at working conditions of 5.0 kV; LM mode; WD 4.4 mm. The observation was captured at magnifications of x1000 to observe the fabric surface before and after treating water repellent then the capture at magnifications of x 50 000 was carried out for the detail examination of the fabric surface.

RESULTS AND DISCUSSION

Influence of the water repellent type

Influence of the water repellent type on fabric water repellent capability

The 100% polyester woven fabric was treated with four types of water resistant (Ruco – Coat BC 7068, TP – Phob FC 2904, Phobotex RHP Hydrophobic Agent, Ruco-guard AFB6 CONC) with the same protocol described in the methodology part where four water resistant chemicals were used with the same concentration of 30 g/l. The fabric water repellent capability was evaluated by the AATCC 22-2017 standard (Table 2).

The fabric water repellent capability before and after treatment by four water-resistant chemicals is presented in Table 3.

The results showed the effect of the water resistant type on fabric after treatment (table 3). All the water resistant treated fabrics have increased their water repellent capability from 70% to 100% in comparison to the initial fabric sample which had the fabric water repellent capability of 0 %. The water resistant TP – Phob FC 2904 demonstrated the best with its fabric water repellent capability of 100%. The fabric treated by the Ruco-guard AFB6 conc, Ruco – Coat BC 7968, and Phobotex RHP Hydrophobic Agent showed the fabric water repellent capability of 90%, 85%, and 70%, respectively.

Influence of the water resistant type on fabric water repellent capability after washed cycles

After water resistant finishing, the fabric samples were washed by standard AATCC 187 – 2013 for 5 times, 10 times, 15 times, 20 times, and 25 times to evaluate the influence of the water resistant type on fabric water repellent capability after washed cycles. The test was important for washable medical mask production, where the fabric water repellent capability needs to be kept as long as possible during use. The results were shown in Table 4.

It could be seen that the increase in the number of washed cycles caused the diminution of the fabric water repellent capability which was influenced by the type of water resistant chemical. After washing cycles 5 and 25, the fabric water repellent capability was 70% and 50%; 80% and 65%; 85% and 70%; 100% and 75% for the Phobotex RHP Hydrophobic Agent, Ruco – Coat BC 7068, Ruco-guard AFB6 conc and TP – Phob FC 2904, respectively. The water resistant TP – Phob FC 2904 showed the most efficacy in water repellent capability for 25 washed cycles.

The initial fabric and the treated fabrics were then observed by SEM to examine the change in the fabric surface after treatment (Fig. 1).

In the surface of the fabric sample treated by Ruco – Coat BC 7068 and Ruco-guard AFB6 conc water resistant, a number of small particles could be observed (Fig. 1). These particles appeared less in the fabric sample treated by Phobotex RHP Hydrophobic Agent and by TP – Phob FC 2904 water resistant.

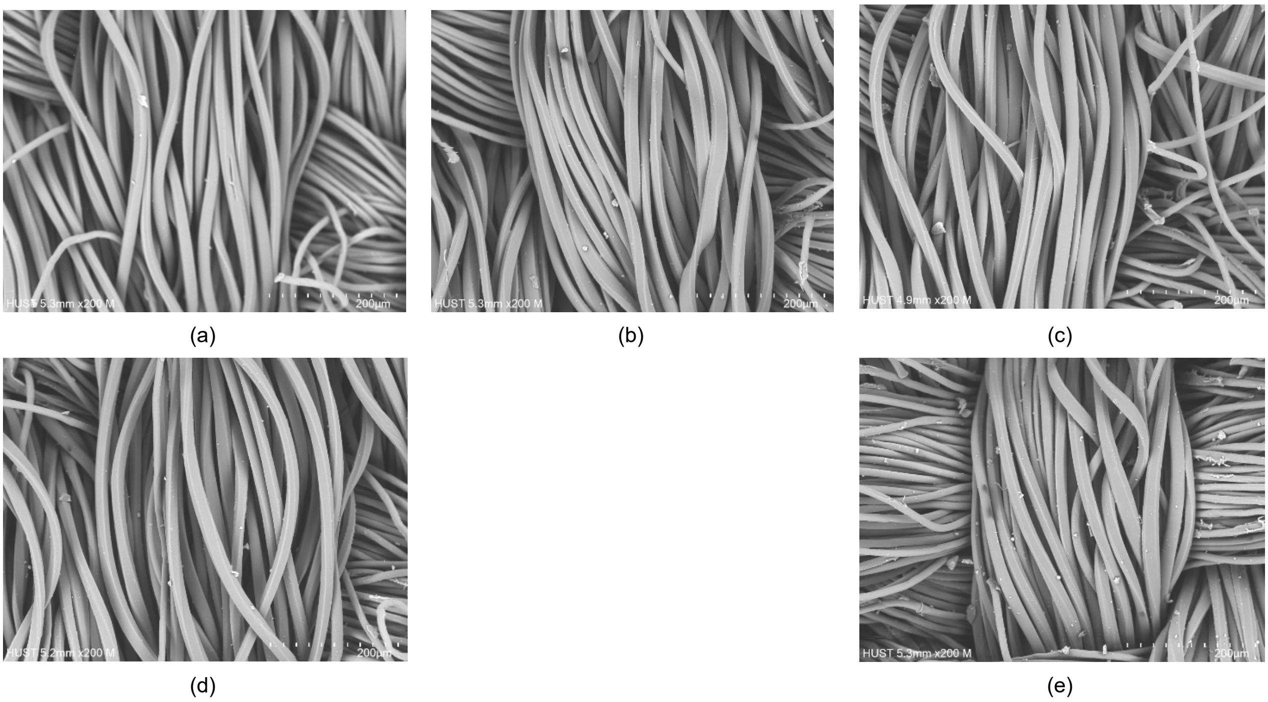

Figure 1. SEM images of fabric surface before and after treatment by the water resistant: (a) initial fabric, fabric treated by (b) TP – Phob FC 2904, (c) Phobotex RHP Hydrophobic Agent, (d) Ruco – Coat BC 7068, (e) Ruco-guard AFB6 conc.

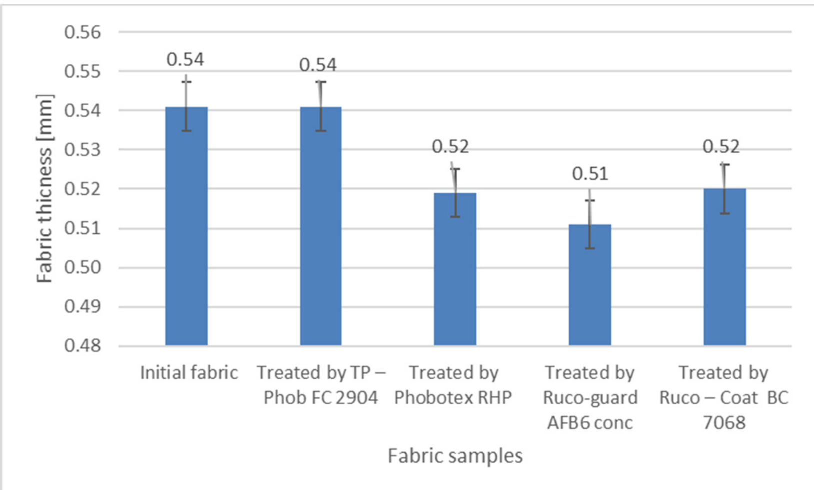

Figure 2. The fabric thickness before and after treatment by the water resistant.

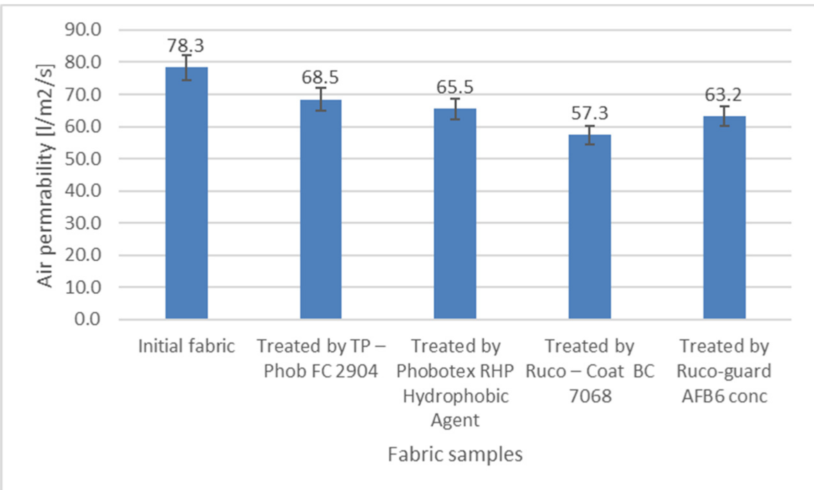

Figure 3. The fabric air permeability before and after treatment by the water resistant.

Table 5. Fabric water repellent capacity using different concentrations of TP-Phob FC 2904 chemical.

Order	Water resistant concentration [g/l]	Fabric water repellent capability [%]	Image
1	0	0	
2	10	80	
3	20	90	
4	30	100	
5	40	100	
6	50	100	

There were nearly no particles observed in the initial fabric surface. The water repellent may not be well reacted with fabric, and they rested in the fabric surface as small particles. By this hypothesis, the fabric sample treated by TP – Phob FC 2904 water resistant was considered the best, and the water-resistant chemical could become the thin membrane in the fibre surface, which improved the best fabric water resistant capability as the above results (table 3 and table 4). Further tests and explanations were carried out in the following sections to demonstrate this supposition.

The fabric thickness (Fig. 2) and the air permeability (Fig. 3) were examined to evaluate the influence of four water resistant types on the fabric properties after water repellent finishing.

The fabric thickness was diminished from an initial 0.54 mm to 0.52 mm, 0.51 mm, and 0.52 mm for the fabric treated by Phobotex RHP Hydrophobic Agent, Ruco – Coat BC 7068, and Ruco-guard AFB6 respectively (Fig. 2). Meanwhile, it rested unchanged while the treatment was carried out by the TP – Phob FC 2904 water resistant. So, the fabric may keep its soft and porosity after finishing by TP – Phob FC 2904 because its volume was almost unchanged. The test of air permeability could verify this hypothesis (Fig. 4).

The initial fabric showed a low level of air permeability with 78.3 $l/m^2/s$ which lightly decreased to 68.5 $l/m^2/s$ when treated by TP – Phob FC 2904. The values diminished strongly to 65.5 $l/m^2/s$, 57.3 $l/m^2/s$, and 63.5 $l/m^2/s$ when fabric was treated by the Phobotex RHP Hydrophobic Agent, Ruco – Coat BC 7068 and Ruco-guard AFB6, respectively. The fabric air

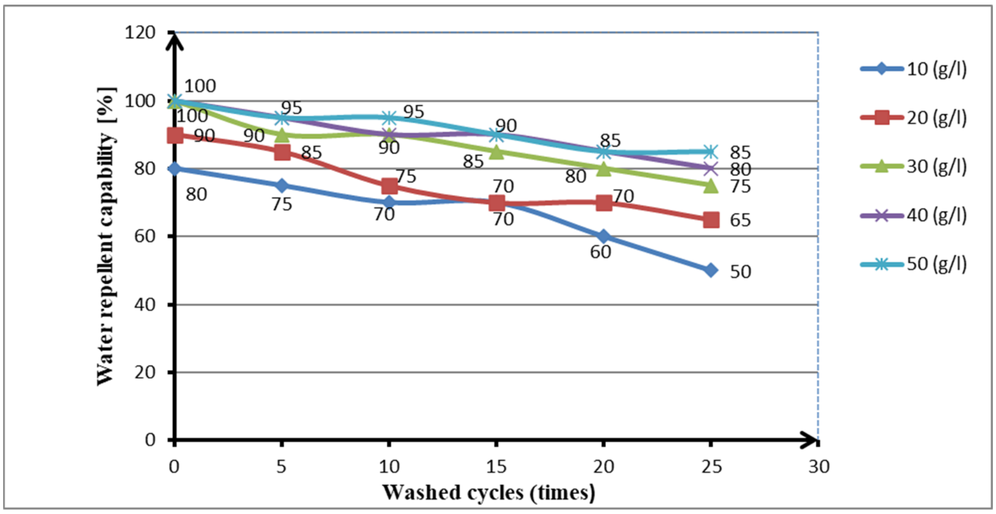

Figure 4. Influence of the water resistant concentration on fabric water repellent capability after washing cycles.

permeability demonstrated that the fabric treated by TP – Phob FC 2904 had the most porosity, so it showed the highest thickness as discussed above. We supposed that the TP – Phob FC 2904 reacted only to the fibre surface but not between fibres and yarns, so it may prevent water absorption throughout the fibres while the fabric thickness and porosity were kept unchanged.

The result showed that the water resistant TP – Phob FC 2904 was the most effective among the four investigated water resistants with the highest water repellent and air permeability as explication above. The order of the water repellent capability of the fabric samples (Table 3 and Table 4) was the same order of quantity of the appeared particles on the fabric surface (Fig. 1), which unified to the order of the fabric thickness (Fig. 2) and fabric air permeability (Fig. 3). So that the water resistant TP – Phob FC 2904 was chosen for our further research.

Influence of the water resistant concentration

Influence of the water resistant concentration on fabric water repellent capability

IIn this research the fabric samples were treated by the water resistant TP – Phob FC 2904 with 5 concentrations of 10 g/l, 20 g/l, 30 g/l, 40 g/l, and 50 g/l in the same technological conditions: pressure level of 80%, drying at 150 °C for 60 seconds and curing at 190 °C for 60 seconds. The fabric water repellent capability was evaluated by the standard AATCC 22-2017 before and after treatment by the water resistant TP – Phob FC 2904. The results are presented in Table 5.

The results showed that in applying the water resistant TP – Phob FC 2904 at a concentration of 30 [g/l] the fabric water repellent capability reached 100% and the same level was obtained for the concentration of 40 g/l and 50 g/l. The influence of the water resistant concentration on fabric water repellent capability after washed cycles has been carried on in the following research to find the suitable concentration.

Influence of the water resistant concentration on fabric water repellent capability after washed cycles

The 100% polyester fabric samples were treated by water resistant TP – Phob FC 2904 with 5 different concentrations (10 g/l, 20 g/l, 30 g/l, 40 g/l, and 50 g/l) and by the same technological condition: the pressure of 0.8 kg/cm^2 (80% pressure level); drying process at 150 °C for 60 seconds; curing at 190 °C during 60 seconds. The fabric samples were washed by the standard AATCC 187 – 2013 with a different number of cycles: 5, 10, 15, 20, and 25 times to evaluate the influence of the water resistant concentration on fabric water repellent capability after applied washing cycles (Fig. 4).

The results showed that the water resistant concentration had influenced the fabric water repellent capability which decreased after washed cycles. The fabric water repellent capability before washing, after 5 washed cycles, and after 25 washed cycles were 80%, 75%, and 50 %; 90%, 80%, and 65%; 100%, 95%, and 75%; 100%, 90%, and 80%; 100 %, 90% and 85% for the water resistant concentration of 10 g/l, 20 g/l, 30 g/l, 40 g/l, 50 g/l respectively. So, the concentration of 50 g/l presented the best duration of fabric water repellent.

Morphology and EDX analyses of the fabric surface

Morphology analyses of the fabric surface before and after treatment by the water resistant

The 100% polyester fabric samples were analyzed by SEM with magnification x1000 (Fig. 5(a) and Fig. 5(c)) and x50 000 (Fig. 5(b) and Fig. 5(d)) to observe the fabric surface change after water resistant treatment. In fact, with the magnification scale x 1000 and x 50 000, only the fibre surface of yarn from fabric could be observed.

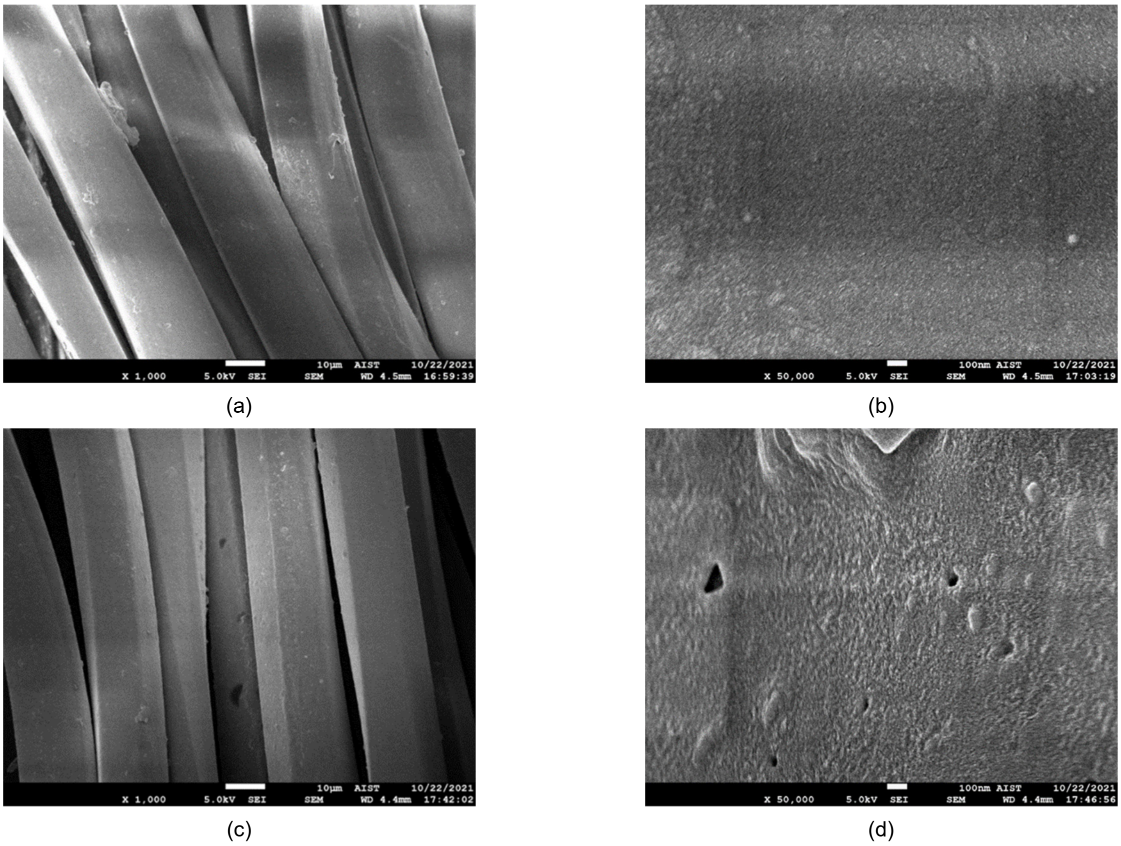

Figure 5. SEM images of: (a,b) the initial fabric and (c,d) TP – Phob FC 2904 water resistant treated fabric.

The results showed that there was no clear difference between the treated fibre surface and the initial fibre in the SEM image with a magnification of 1000, but at the magnification of 50 000, the fibre surface smooth could be observed before treatment and a thin polymer membrane was appeared in the fibre surface after treating. The thin polymer membrane may be the water resistant chemical that helps to improve the fabric water repellent capability as the hypotheses indicated above.

To demonstrate the presentation of TP – Phob FC 2904 water resistant chemical in the fabric surface, the treated sample fabric then was measured the chemical element content by FE-SEM analysis (Fig. 6).

<u>EDX analysis of the fabric surface before and after being treated by the water resistant</u>

EDX is proven as an effective technique for the elemental analysis of a given material. In this case, the EDX spectrum of the initial fabric showed that before water resistant treatment, the fabric sample surface consisted of only carbon and oxygen elements with 69.4 % and 30.6 %, respectively. They are the chemical contents of polyester fabric. The element content fabric became 74.1%, 20.9 %, and 5.0 % for carbon, oxygen, and fluor, respectively after water resistant treatment. The fluor element was the content of the water resistant TP – Phob FC 2904, and the apparition of this element at 0.35 keV in the treated fabric sample demonstrated the membrane in the fabric was the water resistant TP – Phob FC 2904 as observed by the SEM images. That was the reason which improved the fabric water repellent.

FTIR spectra were obtained for TP-Phob FC 2904 water resistant, cross link P E xan, initial fabric, and the treated fabric to examine the chemical differences between the blank and the treated fabric (Fig. 7). The FTIR spectrum revealed that the intensity of the band frequency at 1504 cm^{-1} which were assigned to the C–H stretching vibration of the skeletal vibration of the aromatic systems in the polyester chains was almost not different for the initial fabric and the treated fabric. The peak at 1715 cm^{-1} showed C=O vibration, at 1409 cm^{-1} of the aromatic ring, 1338 cm^{-1} showed carboxylic ester, and at 1021 cm^{-1} indicated the presence of O=C–O–C or secondary alcohol. The peak at 967 cm^{-1} was attributed to the C=C stretching vibration [15-16].

The assignments of FTIR spectra of untreated fabric and TP-Pho FC 2904 water resistant treated polyester fabric with the same intensity of the typical pick of polyester fabric suggested that there were no clear chemical interactions during fabric padding or the concentration of TP – Phob FC 2904 chemicals was too small to reveal the chemical differences between the blank and the treated fabric.

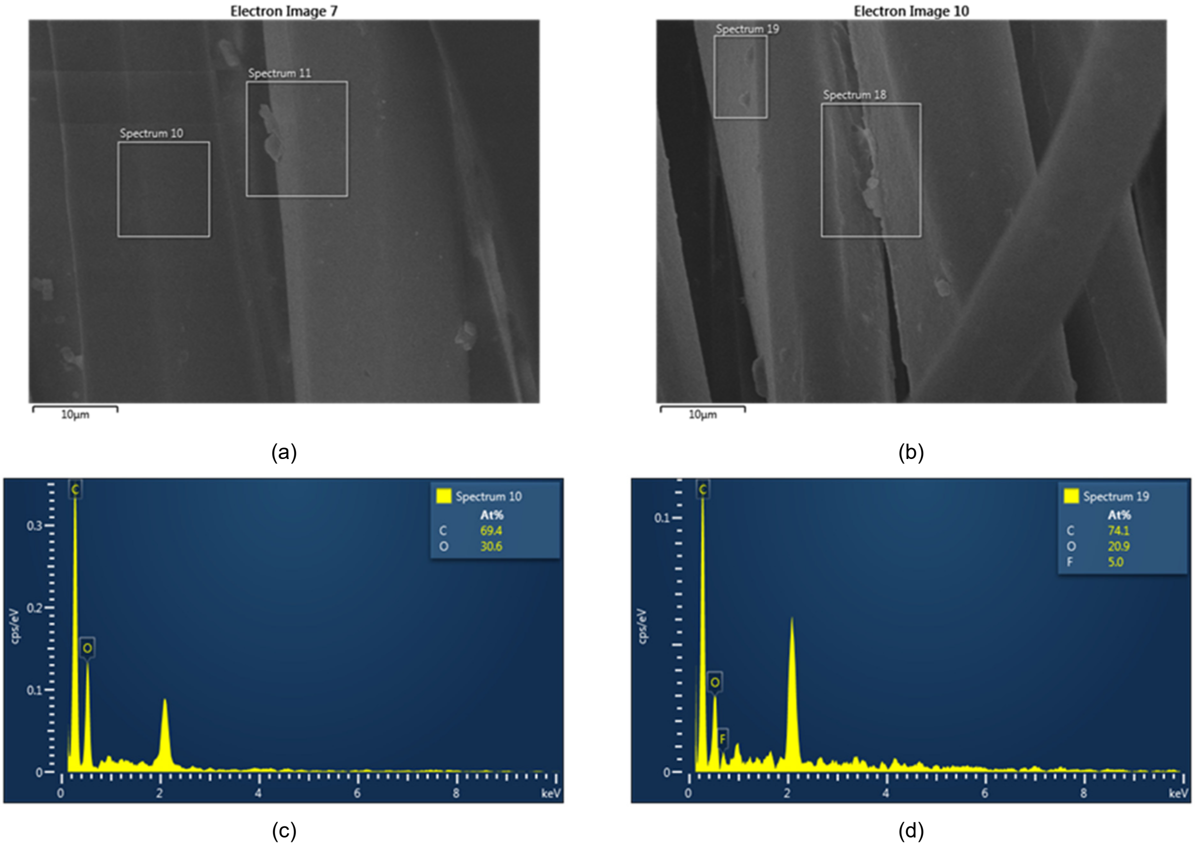

Figure 6. EDX spectra of 100% polyester fabric before (A) and after water resistant treatment (B).

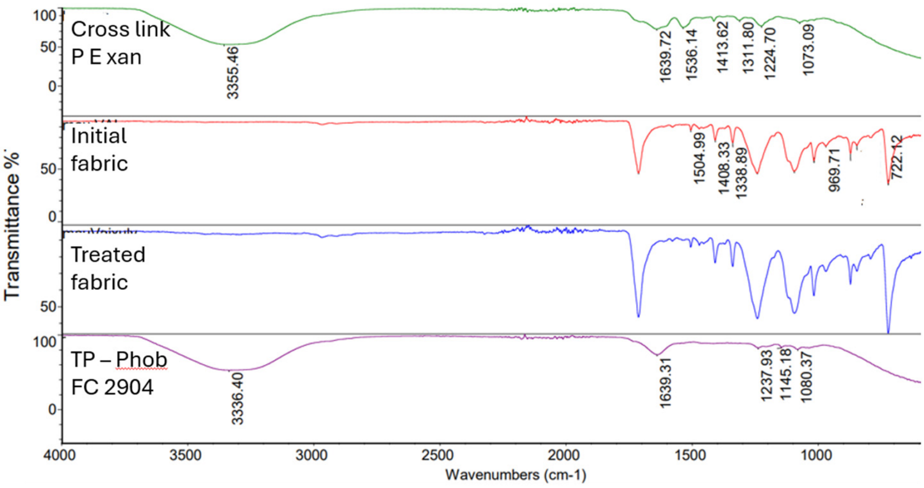

Figure 7. FT-IR spectra of initial chemicals and of the fabric before and after TP- Phob FC 2904 water resistant treatment.

CONCLUSION

The water resistant type influenced the water repellent capability of fabrics and their duration. Among four investigated commercial water resistance, the TP – Phob FC 2904 gave fabric the best water repellent characteristic and the best air permeability with almost unchanged fabric thickness for the 100% polyester woven fabric. The water resistant TP – Phob FC 2904 concentration of 50 g/l was the most efficacy with 85 % water repellent capability after 25 washed cycles. The SEM image showed the membrane in the surface fabric after water resistant treatment and EDX spectra demonstrated the apparition of flour element (5% in w/w proportion) which came from water resistant TP – Phob FC 2904 in the treated fabric. So, we could conclude that the water resistant TP – Phob FC 2904 was presented in the fabric surface, even in the fibre surface and it improved the efficacy of the water repellent characteristic for the 100% polyester woven fabric in the study.

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