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# Properties of Superhydrophobic and Acid–Alkali-Resistant Polyester Fabric Produced Using Plasma Processing

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**Abstract:** During the processes of production, storage, transportation and use of hazardous chemicals, acid–alkali corrosive liquid spatter and leakage would cause serious casualties. In order to protect the lives and health of staff, the surface of fabrics should be treated to obtain hydrophobicity and acid–alkali resistance. In this paper, polyester fabric was used as the base cloth, and polydimethylsiloxane (PDMS) and polytetrafluoroethylene (PTFE) micro-powder were used as the functional materials to fabricate waterproof and breathable fabric with good acid–alkali resistance using a method of plasma pretreatment-impregnation- and plasma-induced crosslinking. The effects of PDMS, PTFE powder and plasma-induced crosslinking on the surface and physical and chemical properties of fabric were investigated. It was found that the use of PDMS and PTFE powder had little effect on the mechanical and wearing comfort properties. However, it could significantly improve the acid–alkali resistance, as the liquid repellent rate of the treated fabric surface was higher than 80%, and the penetration index was lower than 2%.

**Keywords:** polydimethylsiloxane; polytetrafluoroethylene micro-powder; plasma; acid–alkali resistance; waterproof and breathable

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## 1. Introduction

Strong acids and strong alkalis have strong corrosive effects on fabrics. During their production, storage and use within applications such as chemical engineering, electroplating, batteries and military, accidents involving personnel injury or even death often occurred due to splashing or leakage of acid or alkaline liquids. In order to protect the lives and health of workers, it is necessary to modify the surface of fabrics to prevent direct contact between fibers and acidic or alkaline substances.

Treating a fabric surface with waterproofing can effectively prevent the adhesion of acidic and alkaline liquids, thus preventing harm to the human body caused by acidic and alkaline chemicals like sulfuric acid ($H_2SO_4$) and sodium hydroxide (NaOH) [1,2]. Xia Y et al. [3] fabricated a superhydrophobic PET fabric through a plasma pretreatment-dipping-heat crosslinking method; PDMS was used as a low-surface-energy monomer and water-borne polyurethane (WPU) as a dispersing aid. The coated PET fabric exhibited excellent waterproof properties and mechanical stability. Xue L. et al. [4] made a CA-Fe-SH-PET superhydrophobic fabric by treating PET fabric with caffeic acid (CA), $Fe^{2+}$ intermediate and n-octadecyl mercaptan (SH) using a UV radiation method. For non-volatile acids and alkalis, such as $H_2SO_4$ and NaOH, liquid droplets could not penetrate small gaps in the fabric; however, for highly volatile acids like hydrochloric acid (HCl) and nitric acid ($HNO_3$), molecules evaporated into the air and were small enough to pass through the

gaps between fibers and fabrics. Hasanzadeh M. et al. [5] used tetraethoxysilane (TEOS) and silica nanoparticles to enhance fabric surface roughness, using PDMS and aminopropyltriethoxysilane (APTES) as low-surface-energy materials to treat the polyester/viscose fabric surface by using an immersion technique. The WCA of the treated fabric surface was about 151°, with very low SAs. Mohammadshahi S et al. [6] manufactured a series of superhydrophobic surfaces by spraying hydrophobic nanoparticles onto sandpaper with micrometer-sized abrasive particles. They discovered that spraying nanomaterial on a micrometer-scale rough surface could create micro–nano hierarchical rough structures, which imparted water-repellent properties to the material surface. Therefore, domestic and foreign experts have utilized multi-component composite coating materials to modify fabric surfaces, aiming to improve a fabric's overall acid–alkali resistance. Pan GG et al. [7] utilized PDMS and copper stearate ($CuSA_2$) as raw materials, employing in situ growth and impregnation methods to create a superhydrophobic (with a water contact angle WCA of approximately 158°) cotton fabric. This modified fabric exhibited excellent chemical stability against strong acid solution: after treatment for 48 h with HCl solution, WCA remained at 156°. However, treatment for 48 h with NaOH solution damaged the superhydrophobic structure and introduced some hydrophilic hydroxyls on the surface of fibers. Wu Y et al. [8] treated cotton fabric with a UV-curable water-based coating, nano-silver, and stearic acid, providing the fabric with good acid–alkali resistance, water repellency, and antibacterial properties. Chen XP et al. [9] achieved a superhydrophobic PET fabric using a dip-coating method with reacted natural polyphenols, ferrous sulfate heptahydrate and hexadecyltrimethoxysilane. Their results demonstrated that, after coating treatment, PET fabrics obtained good resistance to acids and alkalis; after immersion in solutions at varying pH levels (1, 3, 5, 7, 9, 11 and 13) for 24 h, the WCA and WSA of treated PET fabrics remained above 150° and below 10°, respectively. Wang H B et al. [10] pointed out that, as a nanomaterial to increase surface roughness, the superhydrophobic film formed by PTFE micro-powder was better than $SiO_2$ nanoparticles, with a denser structure and improved hydrophobicity and acid–alkali resistance. Moreover, PTFE micro-powder has the advantages of good chemical stability, low surface tension, low surface friction coefficient, good sliding properties, and excellent heat and cold resistance, which can give the material a good anti-ice function [11–13]. Huang J et al. [14] fabricated a solid surface with impressive superhydrophobic, self-cleaning and anti-icing functions by performing three steps: first, they mixed and cured PTFE, polymer and curing agent, and then they ground them into powder, which was sprayed on solid surfaces using a powder spraying process, followed by heating and melting curing. Often, the superhydrophobic and acid–alkali resistance was obtained at the expense of the comfort of fabrics, but as a textile and clothing material, the breathability and wearing comfort of the fabric are equally important. Plasma technology is often used for coating modification of a material surface, and this can not only produce a polymer-crosslinking film but can also introduce a nanoscale structure to provide specific functions without changing the overall properties of base materials [15,16].

Based on the research mentioned above, this study utilized low-surface-energy polydimethylsiloxane (PDMS) and polytetrafluoroethylene (PTFE) micro-powder with different particle sizes as raw materials. Using an impregnation-plasma-induced crosslinking process, a micro–nano hierarchical rough structure with low surface energy was constructed on the surface of PET fabric, imparting the fabric with water-repellent and acid–alkali resistance properties without changing the wearing comfort and mechanical properties of PET fabrics. This study also analyzed the surface morphology, chemical composition, mechanical properties and wearing comfort of the treated PET fabric.

## 2. Experimental Procedure

The knitted polyester fabric (PET, 100%, 120 $g/m^2$) was purchased from Miandu Textile Co., Ltd. (Nantong, China) and used as samples. Polydimethylsiloxane (PDMS, 201-10) was supplied by Jiashan Jiangnan Textile Materials Co., Ltd. (Jiashan, China) as the

monomer. Tetrafluoroethylene micro-powder (PTFE, 200 nm and 1 μm) was purchased from Shanghai Maclin Biochemical Technology Co., Ltd. (Shanghai, China). Standard soapflake was purchased from China Textile Institute of Science and Technology (Beijing, China) and detergent 209 was supplied by Wangnilai Co., Ltd. (Guangzhou, China). Ethanol (AR, ≥99.7%), hydrochloric acid (HCl, AR, 30%,), nitric acid ($HNO_3$, AR, 40%), sulfuric acid ($H_2SO_4$, AR, 80%) and sodium hydroxide (NaOH, AR, 30%) were purchased from Changzhou Hongsheng Fine Detail Co., Ltd. (Changzhou, China), and argon gas was supplied by Canghai industry Gas Co., Ltd. (Shanghai, China).

Before the experiments, all PET fabrics were washed in an ultrasonic bath in a detergent 209 solution at a concentration of 2 g/L (diluted with deionized water). Washing conditions were as follows: an bath ratio of 50:1, a temperature of 40 °C and a wash time of 40 min. The PET fabrics were then washed repeatedly with deionized water and dried in an oven at a temperature of 70 °C for 2 h to remove any possible dust or chemical residues that could affect the surface treatment [17].

In order to increase the interface bonding performance between the coating and the fabric fibers, the scoured PET fabric was pretreated with atmospheric pressure plasma (CTP-2000A, Nanjing Suman Plasma Technology Co., Ltd., Nanjing, China) to increase the surface roughness.

The functional monomer dispersion was prepared by mixing PDMS (concentration 20 g/L) together with PTFE micro-powder with a particle size of 200 nm or 1 μm (concentration 1.2 g/L) suspended in ethanol within an ultrasonic bath for 30 min.

The pretreated PET samples were dipped into the functional monomer dispersion in an ultrasonic bath at an bath ratio of 40:1 for 5 min. Subsequently, the samples were dried in an oven at 70 °C for 30 min to evaporate the ethanol. The dipped PET samples were then modified using the CCP plasma equipment, and the processing of plasma treatment for superhydrophobic fabrics was the same as in our previous article [18]. The PDMS-modified PET fabric was referred to as PDMS-*g*-PET fabric, PTFE micro-powder with a particle size of 200 nm or 1 μm, and the PDMS-modified PET fabrics were referred to as PTFE (200 nm)@PDMS-*g*-PET fabric or PTFE (1 μm)@PDMS-*g*-PET, respectively.

Surface morphology was characterized using a scanning electron microscope (Gemini SEM 300, ZEISS, Oberkochen, Germany). The surface chemical compositions of samples were analyzed using a Fourier transform infrared spectrometer (Nicolet$^{TM}$ IS50 FTIR, Thermo, Donaueschingen, Germany). The water repellency of the control and treated PET fabrics was evaluated for WCA and waterproof level. The WCA was tested at room temperature and ambient humidity using an OCA15EC (Dataphysics, Filderstadt, Germany) with the volume of droplets set as 5 μL, whereas the waterproof level was tested using a fabric waterproof tester (CSI-232, Shanghai Chengsi intelligent Technology Co., Ltd., Shanghai, China) according to GB/T 4745-2012. The waterproof level was divided into 5 levels and determined by the proportion of the surface wet area to the measured area, and the higher the proportion of wet area, the lower the waterproof level. The acid–alkali resistance was tested using CSI-W031B (Shanghai Cheng Si Intelligent Technology Co., Ltd., Shanghai, China) according to GB/T 24540-2009. The wearing comfort of the fabric was determined by the measured water vapor transmission (YG601H, Ningbo Textile Instrument Factory, Ningbo, China) according to GB/T 12704.2-2009, and air permeability was tested (YG(B)461E, Wenzhou Baien Instrument Co., Ltd., Wenzhou, China) according to GB/T 5453-1997 [19]. The mechanical strength of the samples was determined on a WDW-10 multi-function electronic fabric strength machine (according to GB/T3923.1-2013 [20]) and a YG065 fabric strength tester (according to GB/T 19976-2005). All the samples were conditioned for 48 h in atmospheric conditions of 20 ± 2 °C temperature and 65 ± 2% relative humidity before tests were performed.

## 3. Results and Discussion

### *3.1. Surface Morphology and Chemical Composition*

The surface morphology and chemical components of PET fabrics before and after treatment were tested, and the results are shown in Figure 1. It was found that after treatment, the surface morphology of the PET fiber was significantly changed (Figure 1a): PET fiber had a smooth surface, whereas plasma-pretreated PET fiber had a relatively uniform grooved surface, which was beneficial to the uniform distribution of PDMS and PTFE micropowder on the fiber surface. The surfaces of PDMS-*g*-PET, PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fiber showed relatively uniform micro-fold films. However, the surface roughness of PTFE (<1 μm) @PDMS-g-PET fabric was greater than that of PTFE (200 nm) @PDMS-*g*-PET fabric, and the uniformity was slightly decreased. The existence of micro-fold structure and the increase in roughness were the main structural factors for the formation of superhydrophobic properties of fabric surfaces. Combined with the chemical components of the fabric surface (Figure 1b), the curve of plasma-pretreated PET fabrics was almost identical to that of the untreated PET fabric, which means that plasma pretreatment changed the surface morphology without changing the surface chemical composition. However, the enhancement of Si–$CH_3$ (C–$CH_{3)}$ peaks at 780 $cm^{-1}$, 1250 $cm^{-1}$, 1410 $cm^{-1}$ and 2970 $cm^{-1}$ [21], and C–O–C (Si–O–Si) peaks in the 1200–1000 $cm^{-1}$ region was attributed to the crosslinking of PDMS on the surface of PET fabrics [22]. The infrared absorption peak frequency of functional groups of PTFE was mainly in the 1400–400 $cm^{-1}$ region, the infrared absorption peak in 1300–1100 $cm^{-1}$ region was mainly attributed to F–C–F stretching vibration mode (vcr), and the infrared absorption peak in the 700–400 $cm^{-1}$ region was mainly attributed to F–C–F bending vibration mode (8CF1). It was also demonstrated that PTFE was successfully attached to the PET fiber surface. The increase in $CH_3$ and F–C–F functional groups on the surface of PET fabrics was the main chemical factor promoting the formation of superhydrophobic properties on the surface [23,24].

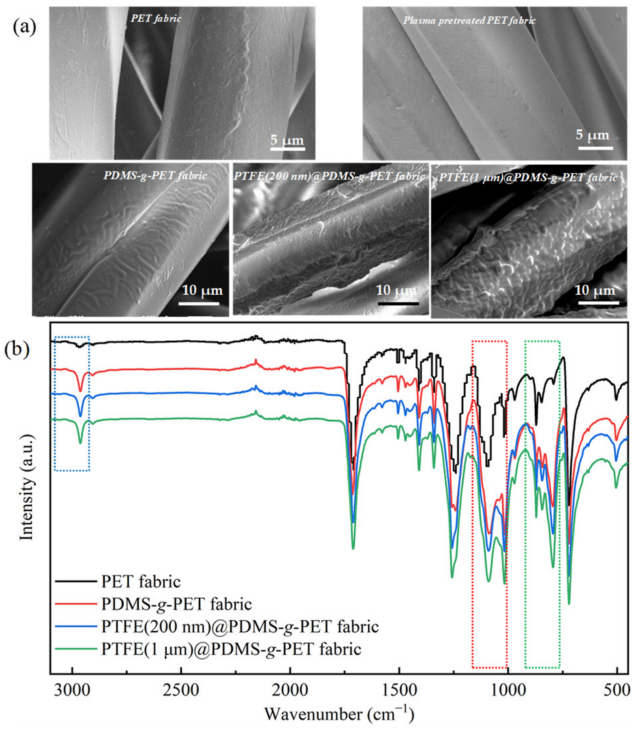


**Figure 1.** (**a**) Surface morphology and (**b**) chemical composition of different PET fabrics.

### *3.2. Water Repellency and Acid–Alkali Resistance*

The water repellency and acid–alkali resistance of PET fabrics were tested, and the results are shown in Table 1 and Figure 2. As shown in Table 1, the WCA and waterproofing level of PET, PDMS-*g*-PET, PTFE (200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabrics were 121°, 150°, 152° and 153°, and level 2, level 5, level 5 and level 5, respectively. This indicates that, after plasma treatment, PET fabrics showed great water repellency. The acid–alkali resistance of PET fabrics was determined by penetration index and liquid rejection efficiency together, and it was found that the acid–alkali resistance of PDMS-*g*-PET, PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabrics were improved to different degrees, and the detailed results are listed in Figure 2. This was due to the presence of PDMS and PTFE on the surface of PET fabric after plasma treatment, which could effectively reduce the surface energy of the fabric and construct a multistage rough structure, which greatly increased the surface roughness of PET fabrics. According to the explanation of Cassie–Baxter theory, which held that when the liquid droplet formed compound contact with the micro–nano rough structure on the surface of the solid phase, liquid phase and gas phase, there was a large amount of air trapped in the solid phase microstructure, which made it difficult for the liquid droplet to penetrate into the micro–nano composite structure, so that the droplet rolled down after contact with the fabric, rather than infiltrating into the fabric [25], thus improving the waterproof and acid–alkali resistance of the fabric. Moreover, the nitration reaction occurs between PET fibers and $HNO_3$ and gives hydrophilicity to PET fabric [26], which seriously reduces the acid–alkali resistance. Additionally, the acid–alkali resistance of PTFE(200 nm)@PDMS-g-PET and PTFE(1 μm)@PDMS-g-PET fabrics were better than that of PET-*g*-PDMS fabric, which was due to the existence of fluorinated groups in PTFE micro-powder.

**Table 1.** Water repellency of different PET fabrics.

| Project | PET Fabric | PDMS-*g*-PET Fabric | PTFE(200 nm)@ PDMS-*g*-PET Fabric | PTFE(1 μm)@ PDMS-*g*-PET Fabric |
|---|---|---|---|---|
| WCA | 121° | 150° | 152° | 153° |
| Spray Test |  |  |  |  |
| Waterproofing Level | Level 2 | Level 5 | Level 5 | Level 5 |

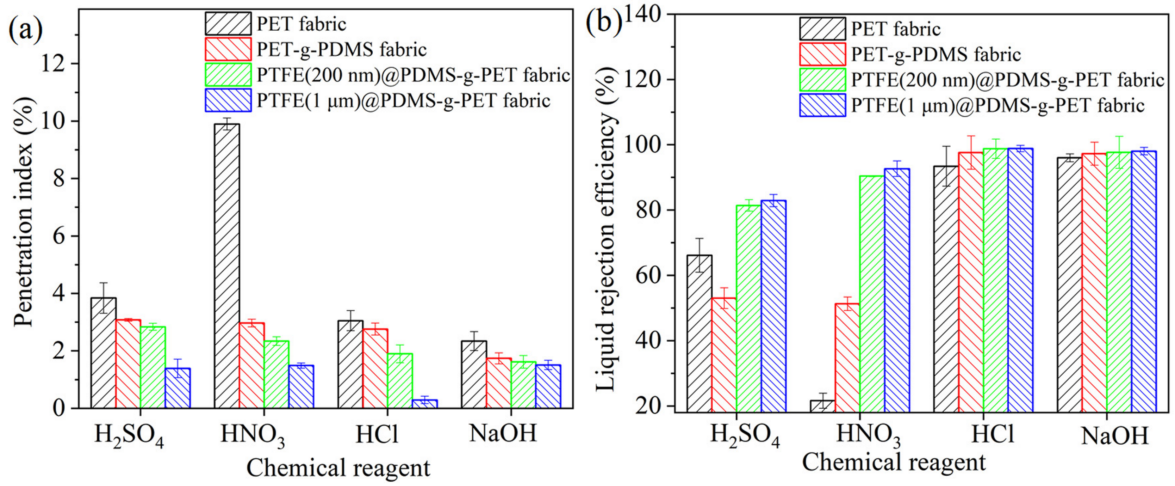


**Figure 2.** (**a**) Penetration index and (**b**) liquid rejection efficiency of different PET fabrics.

### 3.3. Mechanical Properties

In order to clarify the influences of the addition of PDMS and PTFE and of plasma treatment on the mechanical properties of PET fabrics, the tensile and bursting properties of different PET fabrics were tested, and the results are shown in Table 2. As we can see, compared to the PET fabric, for tensile breaking strength, the performance of PET-*g*-PDMS and PTFE(200 nm)@PDMS-*g*-PET fabric increased by 1.5% and 3.8%, respectively, whereas the performance of PTFE(1 μm)@PDMS-*g*-PET fabric decreased by 9.3%. For tensile elongation at break, the performance of PET-*g*-PDMS increased by 2.0%, whereas the performance of PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabric decreased by 7.6% and 10.5%, respectively. For bursting strength, whereas the performance of PTFE(200 nm)@PDMS-g-PET fabric increased by 2.4%, respectively, the properties of PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabrics decreased by 5.1% and 3.6%, respectively.

**Table 2.** Mechanical properties of different PET fabrics.

| | Tensile Breaking Strength (N) | Tensile Elongation at Break (%) | Bursting Strength (N) |
|---|---|---|---|
| PET fabric | 507.1 | 48.4 | 1180 |
| PET-*g*-PDMS fabric | 514.8 | 49.4 | 1119.5 |
| PTFE(200 nm)@PDMS-*g*-PET fabric | 526.4 | 44.7 | 1208.7 |
| PTFE(1 μm)@PDMS-*g*-PET fabric | 460.0 | 43.3 | 1137.3 |

Combined with the surface morphology and chemical composition test results in Figure 1, the change in PET fabric mechanical properties might be due to the presence of a superhydrophobic coating, composed of PDMS cross-linked film and PTFE micropowder. The existence of a PDMS uniform film could increase the lubrication of fiber and yarn, reducing friction, so that PET-*g*-PDMS fabric under tensile force caused the yarn to slip inward, reducing the friction loss between fiber and yarn and improving the tensile breaking strength and tensile breaking elongation. However, when the yarn is subjected to the bursting force, the yarn slips to both sides, which eventually leads to the decline of the bursting strength of the fabric. The addition of PTFE micro-powder could increase the friction between fiber and yarn to a certain extent, which caused PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabric to have higher bursting strengths than that of PDMS-*g*-PET fabric. When the particle size decreased to 200 nm, PTFE@PDMS film had better uniformity, and PTFE particles were in full contact with the fabric and PDMS films causing smaller friction losses between fiber and yarn under the action of mechanical external force. When the particle size was 1 μm, the uniformity of PTFE@PDMS film became worse, which resulted in large pores between PTFE, PET fabric and PDMS film, and caused larger friction loss between fiber and yarn under the action of a mechanical external force [27]. Therefore, the tensile and bursting properties of PTFE(1 μm)@PDMS-g-PET fabric were decreased, whereas the tensile breaking strength of PTFE(200 nm)@PDMS-g-PET fabric was slightly decreased, and the tensile breaking strength and bursting strength of the fabric were increased.

### 3.4. Wearing Comfort

As a very important property for clothing textiles, the wearing comfort of waterproof fabrics is often ignored. Both the air permeability and the moisture permeability of fabrics can affect their wearing comfort [28]. Therefore, we tested the air permeability and moisture permeability of different PET fabrics. As shown in Table 3 compared to PET fabrics, the rise in air permeability (13.21%, 12.11% and 3.21%) of PET-*g*-PDMS, PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabric might be caused by the etching of plasma increasing the porosity of fabric, and the use of PTFE micro-powder would partially reduce

the porosity of PET fabric and lead to the reduction of air permeability. Therefore, the air permeability of PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-*g*-PET fabrics was lower than that of PET-*g*-PDMS fabric. Conversely, water vapor is transferred in the fabric in three ways: through the diffusion of micropores in the fabric; the moisture absorption of the fiber itself and the escape on the side of the fabric with low water pressure; and the diffusion and volatilization after a large number of water vapor molecules produce condensation. So, the decline of water vapor transmission (−4.21%, −11.77% and −10.49%) of PET-g-PDMS, PTFE(200 nm)@PDMS-*g*-PET and PTFE(1 μm)@PDMS-g-PET fabrics was due to the reduction in pore size and porosity of PET fabrics after coating treatment, and the existence of hydrophobic PDMS and PTFE@PDMS film affected the absorption of water vapor by the PET fibers and also the transportation to the low vapor pressure side of capillary water through capillary action between pores. In summary, it could be seen that plasma treatment had little impact on the wearing comfort of PET fabrics.

**Table 3.** Wearing comfort of different PET fabrics.

| | **Air Penetrability (mm/s)** | **Moisture Permeability (g/(m$^2$·h)** |
|---|---|---|
| PET fabric | 1027.21 | 48.41 |
| PET-*g*-PDMS fabric | 1162.94 | 46.37 |
| PTFE(200 nm)@PDMS-*g*-PET fabric | 1151.64 | 42.71 |
| PTFE(1 μm)@PDMS-*g*-PET fabric | 1060.18 | 43.33 |

## 4. Conclusions

In this paper, a waterproof and breathable fabric with good acid–alkali resistance was fabricated using a method of plasma pretreatment-impregnation and plasma-induced crosslinking, and the relationships between PTFE micro-powder size, surface morphology and the properties of PET fabrics were also investigated. It was observed that the use of PDMS and PTFE micro-powder could effectively improve the waterproof grade and acid–alkali resistance of PET fabric. PTFE(200 nm)@PDMS-*g*-PET fabric had the best comprehensive performance. It had a waterproof grade of level 5, the liquid repellent rate was higher than 80%, the penetration index was lower than 2%, and the tensile breaking strength and bursting strength were increased by 3.8% and 2.4%, respectively. The permeability and moisture permeability of the fabric could still be maintained at 1151.64 mm/s and 42.71 g/(m$^2$·h). The surface morphology and chemical composition tests proved that PTFE(200 nm)@PDMS formed a relatively uniform film on the surface of the fabric. The addition of PTFE micro-powder with a 200 nm particle size could increase the roughness and acid–alkali resistance of PET fabric to a certain extent, in addition to having little impact on the wearing comfort and mechanical properties of PET fabric.

**Author Contributions:** B.Z. and H.Z. contributed to the project management; P.L., X.H. and L.X. contributed to the experiment and characterization of fabrics; T.J., L.X. and Y.Z. contributed to the choice of materials. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## References


1. Hu, D. Preparing weathering-resistant superhydrophobic polymer/bentonite nano-composites for waterproof garment textiles via electrospinning. *J. Aust. Ceram. Soc.* **2022**, *58*, 1509–1517. [CrossRef]
2. Peng, S.; Meng, W.H.; Guo, J.X. Photocatalytically Stable Superhydrophobic and Translucent Coatings Generated from PDMS-Grafted-$SiO_2$/$TiO_2$@PDMS with Multiple Applications. *Langmuir* **2019**, *35*, 2760–2771. [CrossRef] [PubMed]
3. Xia, Y.; Zhu, N.; Zhao, Y.; Zhu, J.; Chen, H.; Xu, L.; Yao, L. Construction of Durable Self-Cleaning PDMS Film on Polyester Fabric Surface. *Materials* **2023**, *16*, 52. [CrossRef]
4. Lei, X.; Xie, A.; Yuan, X.; Hou, X.; Lu, J.; Liu, P.; Xiang, Z.; Chen, G.; Xing, T. Fabrication of Superhydrophobic and Light-Absorbing Polyester Fabric Based on Caffeic Acid. *Polymers* **2022**, *14*, 5536. [CrossRef] [PubMed]
5. Hasanzadeh, M.; Far, H.S.; Haji, A.; Rosace, G. Surface Modification of Polyester/Viscose Fabric with Silica Hydrosol and Amino-Functionalized Polydimethylsiloxane for the Preparation of a Fluorine-Free Superhydrophobic and Breathable Textile. *Coatings* **2022**, *12*, 398. [CrossRef]
6. Mohammadshahi, S.; Breveleri, J.; Ling, H. Fabrication and characterization of super-hydrophobic surfaces based on sandpapers and nano-particle coatings. *Colloids Surf. A* **2023**, *666*, 131358. [CrossRef]
7. Pan, G.G.; Xiao, X.Y.; Ye, Z.H. Fabrication of stable superhydrophobic coating on fabric with mechanical durability, UV resistance and high oil-water separation efficiency. *Surf. Coat. Technol.* **2019**, *360*, 318–328. [CrossRef]
8. Wu, Y.; Wu, X.; Yang, F.; Gan, J.; Jia, H. The preparation of cotton fabric with super-hydrophobicity and antibacterial properties by the modification of the stearic acid. *J. Appl. Polym. Sci.* **2021**, *138*, 50717. [CrossRef]
9. Chen, X.; Wang, J.; Xie, A.; Wang, B.; Wu, J.; Chen, G.; Xing, T. Fabrication of Robust Superhydrophobic Polyester Fabrics with Photothermal Conversion and Oil-Water Separation Performance through Deposition of Natural Polyphenols. *Langmuir* **2023**, *39*, 15817–158127. [CrossRef]
10. Pratiwi, N.; Zulhadjri; Arief, S.; Admi; Wellia, D.V. Self-cleaning material based on superhydrophobic coatings through an environmentally friendly sol–gel method. *J. Sol-Gel Sci. Technol.* **2020**, *96*, 669–678. [CrossRef]
11. Wang, H.; Chen, E.; Jia, X.; Liang, L.; Wang, Q. Superhydrophobic coatings fabricated with polytetrafluoroethylene and $SiO_2$ nanoparticles by spraying process on carbon steel surfaces. *Appl. Surf. Sci.* **2015**, *349*, 724–732. [CrossRef]
12. Wang, S.; Wang, Y.; Zou, Y.; Wu, Y.; Chen, G.; Ouyang, J.; Jia, D.; Zhou, Y. A self-adjusting PTFE/$TiO_2$ hydrophobic double-layer coating for corrosion resistance and electrical insulation. *Chem. Eng. J.* **2020**, *402*, 126116. [CrossRef]
13. Yeerken, T.; Wang, G.; Li, H.; Liu, H.; Yu, W. Chemical stable, superhydrophobic and self-cleaning fabrics prepared by two-step coating of a polytetrafluoroethylene membrane and silica nanoparticles. *Text. Res. J.* **2019**, *89*, 4827–4841. [CrossRef]
14. Ma, L.; Wang, J.; Zhao, F.; Wu, D.; Huang, Y.; Zhang, D.; Zhang, Z.; Fu, W.; Li, X.; Fan, Y. Plasmon-mediated photothermaland superhydrophobic TiN-PTFE film for anti-icing/deicing applications. *Compos. Sci. Technol.* **2019**, *181*, 107696. [CrossRef]
15. Huang, J.; Yang, M.; Zhang, H.; Zhu, J. Solvent-Free Fabrication of Robust Superhydrophobic Powder Coatings. *ACS Appl. Mater. Interfaces* **2021**, *13*, 1323–1332. [CrossRef]
16. Zhu, Y.P.; Guo, C.; Zheng, Y.; Qiao, S.-Z. Surface and Interface Engineering of Noble-Metal-Free Electrocatalysts for Efficient Energy Conversion Processes. *Acc. Chem. Res.* **2017**, *50*, 915–923. [CrossRef]
17. De Geyter, N.; Morent, R.; Leys, C. Influence of ambient conditions on the ageingbehaviour of plasma-treated PET surfaces. *Nucl. Instrum. Methods Phys. Res. B* **2008**, *266*, 12–13. [CrossRef]
18. Xu, L.; Zhang, Y.; Guo, Y.; Zhang, R.; Shi, J.; Shen, Y.; Yu, J. The Effect of Hydroxyl on the Superhydrophobicity of Dodecyl Methacrylate (LMA) Coated Fabrics through Simple Dipping-Plasma Crosslinked Method. *Coatings* **2020**, *10*, 1263. [CrossRef]
19. Xu, L.; Yang, L.; Yang, S.; Xu, Z.; Lin, G.; Shi, J.; Zhang, R.; Yu, J.; Ge, D.; Guo, Y. Earthworm-Inspired Ultra-Durable Superhydrophobic Fabrics from Adaptive Wrinkled Skin. *ACS Appl. Mater. Interfaces* **2021**, *13*, 6758–6766. [CrossRef]
20. Phuong, N.T.; Funda, A.; Nam, N.; Tuduri, L.; Ouellet-Plamondon, C.M.; Prud'homme, R.E. Robust superhydrophobic cotton fibers prepared by simple dip- coating approach using chemical and plasma-etching pretreatments. *Acs Omega* **2019**, *4*, 7829–7837. [CrossRef]
21. Tian, X.T.V.; Ras, R. Moving superhydrophobic surfaces toward realworld applications. *Science* **2016**, *352*, 142–143. [CrossRef] [PubMed]
22. Zheng, Y.; Lai, D.; Yang, L. Construction of h-bn based coating towards the flame retardancy of cotton fabrics: Based on the guidance of mesoscopic simulation. In *MATEC Web of Conferences*; EDP Sciences: Les Ulis, France, 2019; Volume 303, p. 06001. [CrossRef]
23. Li, Q.; Zhang, S.; Mahmood, K.; Jin, Y.; Huang, C.; Huang, Z.; Zhang, S.; Ming, W. Fabrication of multifunctional PET fabrics with flame retardant, antibacterial and super-hydrophobic properties. *Prog. Org. Coat.* **2021**, *157*, 106296. [CrossRef]
24. Li, J.; Muto, F.; Miura, T.; Oshima, A.; Washio, M.; Ikeda, S.; Iida, M.; Tabata, Y.; Matsuura, C.; Katsumura, Y. Improving the properties of the proton exchange membranes by introducing α-methylstyrene in the pre-irradiation induced graft polymerization. *Eur. Polym. J.* **2006**, *42*, 1222–1228. [CrossRef]
25. Chen, S.; Liu, F.; Cui, R.; Zhu, B.; You, X. Removal of tetracycline hydrochloride using S–g-$C_3N_4$/PTFE membrane under visible light irradiation. *Water Cycle* **2022**, *3*, 8–17. [CrossRef]
26. Wang, X.; Lu, Y.; Zhang, Q.; Wang, K.; Carmalt, C.J.; Parkin, I.P.; Zhang, Z.; Zhang, X. Durable fire retardant, superhydrophobic, abrasive resistant and air/UV stable coatings. *J. Colloid Interface Sci.* **2012**, *582*, 301–311. [CrossRef]

27. Khalil, A.E.G.M.; Berghot, M.A.; Gouda, M.A. Synthesis and antibacterial activity of some new 3-hydroxy-2-naphthoic acid hydra-zide derivatives for dyeing polyester fabrics. *J. Saudi Chem. Soc.* **2016**, *20*, 165–172. [CrossRef]
28. Huang, G.; Liang, Y.; Wang, J.; Zeng, X.; Li, Z.; Zhang, X. Effect of asymmetric wettability on directional transport of water through Janus fabrics pre-pared by an electrospinning technique. *Mater. Lett.* **2019**, *246*, 76–79. [CrossRef]

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