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# UV Protection and Water Repellent Finishing of Polyester Fabric Printed with Photochromic dyes

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**Abstract**

Silicone rubber is a well-known commercial water repellent, which is commonly applied on polyester fabrics. Herein, we are developing a simple approach toward imparting polyester fabrics' water-repellent and UV protection properties. Polyester fabrics are treated with RTV silicone rubber as a water-repellent finishing material and titanium dioxide nanoparticles as a UV protection finishing material using the pad-dry-cure technique. The treated fabrics are afterward printed with a photochromic dye. All the required measurements are investigated and discussed in detail.
**Keywords**: Silicone rubber, UV Protection, Water Repellent, Polyester Fabric, Printing

## Introduction

Because of its great durability and toughness, polyester is frequently utilized in outerwear. [1, 2]. Because it is a robust fiber, it can resist vigorous and continuous motion. Its hydrophobic nature makes it perfect for clothing and coats that will be used in wet settings. To further this impact, the fabric is finished with a water-resistant treatment.[3, 4]

UV absorbers used in dyeing reduce dye absorption, except in post-treatment applications. They may be applied using the standard padding, exhaust, pad-thermos, and pad-dry-cure processes and are dye-compatible. The primary drawback of UV-blocking substances is that they cannot be used in a single bath with other finishing substances.

A way to create highly active surfaces with UV-blocking capabilities is to coat the surface of fabrics and garments with nanoparticles. [5, 6]. Because they are more stable than organic UV-blocking substances, zinc oxide nanoparticles (ZnONPs) embedded in polymer matrices, such as soluble starch, are an excellent example of functional nanostructures with the potential to be used. As a result of their expanded surface area and strong UV absorption, nano ZnO will improve the UV blocking performance. [7-10]

Dye or pigments that change color when subjected to outside stimuli are known as chromic materials, especially when the color shift is reversible and manageable. [11-14] Photochromic dyes change color when UV light activates them. The most significant commercial dyes undergo a transformation from colorless to colored, and when the UV source is withdrawn, they thermally return to their original colorless state. [15-19] The business significance of photochromism in responsive eyewear is intriguing. Applications for it include biological systems, optical data storage, optical switching technology, cosmetics, solar energy storage, and security printing. [11, 20-23]

In the present work, Polyester fabrics are treated with RTV silicone rubber as a water-repellent finishing material and titanium dioxide nanoparticles as a UV protection finishing material. The treated fabrics are afterward printed with a photochromic dye. All the required measurements are investigated and discussed in detail.

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## Materials, Methods

### *Materials*

Polyester fabric (100%) was kindly obtained from El-Mahalla Company for Spinning and Weaving, El-Mahalla, Egypt.

The following chemicals were selected for the study: Silicone rubber was kindly supplied by ADMICO, Egypt. Toluene is provided by Huntsman Chemicals,Egypt. $TiO_2$ NPs (700 nm of particle size) and Strontium aluminum oxide doped with europium and dysprosium, were purchased from Sigma-Aldrich, Egypt. Alcoprint PTP thickener additive (gum) was kindly supplied by Dystar Company, Egypt.

### *Methods*

***Padding using silicon rubber***

A beaker filled with 50 ml of toluene and 20 gm of silicone rubber is mixed. The polyester sample is added to the solution. The process continued for 30 min. at room temperature while stirring. The sample is then removed to be dried.

***Printing using $TiO_2$***

The sample has been evenly split among three pieces. Each of them will be printed with a printing paste that contains different concentrations of titanium oxide (1, 2, and 3%). 25 gm of thickening agent will be added to the three beakers. [24]

Printing paste
2 gm disperse dye
4 gm gum thickener
2 gm urea
2 gm binder
200 ml water

The treated polyester fabric is printed with a dispersed dye printing paste that contains TiO2 using a manual conventional silk screen.

## Results and Discussion

***Scanning electron microscope (SEM)* test**

This test is applied on the fabric that is treated with silicone rubber, TiO2 NPs (3%). The morphology and the microstructure of the treated fabric can be seen in Fig.1

It is clear from Fig.1 that, in the treatment of polyester fabric with silicon rubber and TiO2 NPs (3%) for coating fiber surfaces, the surface pores between fibers were also filled with silicon rubber. Besides, the rough morphology of the treated polyester surface decreased noticeably.

***Evaluation of water repellency of thetreated fabric***

**The contact angle is the angle formed when**

a fabric surface comes in contact with the liquid, which will immediately indicate the wettability of the fabric. If the measured contact angle is above 90°, the fabric is said to have poor wetting and is termed hydrophobic. If the contact angle is below 90°, the term hydrophilic is used. Figer 2 represents the contact angle values of treated polyester fabrics.

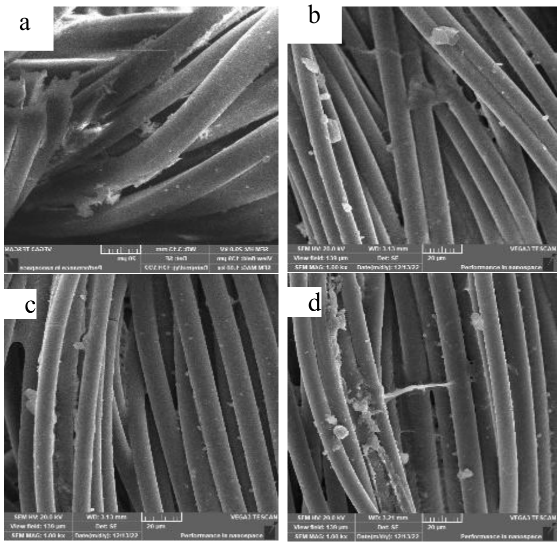


**Fig.1. SEM images of the treated polyester fabric withsilicone rubber and $TiO_2$NPs (3%)**

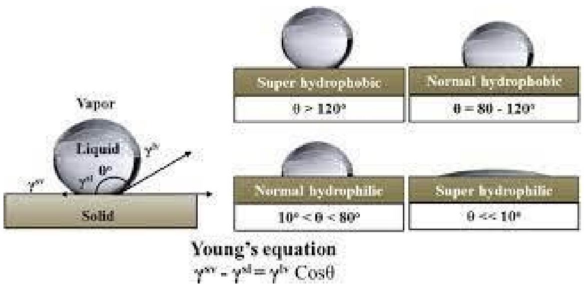


**Fig.2. Contact angle and classification of the treated fabrics' surfaces.**

According to the contact angle test conducted, the contact angle for the sample is 139.5° which is >90°. This means that the fabric has been successfully treated to be water-repellent according to figure 2.

***Evaluation of photochromic properties***

Due to the bright greenish-yellow tint that is created during UV irradiation being particularly perceptible on a dark surface, the photochromic effect is more noticeable to the human eye on dark fabric. Under UV light, every printed cloth displayed immediate and reversible photochromic and luminous qualities. (As seen in Fig.3)

## Conclusion

The purpose of this research is to impart UV protection as well as water repellency to polyester fabrics. Polyester fabric is treated with silicon rubber a s well as TiO2 NPs after which it was printed with photochromic dye. Based on the obtained measurements it can be concluded that the properties of samples had improved in terms of resistance to water and UV rays. Using nanoparticles and printing with photochromic dyes gives instant and reversible photochromic properties.

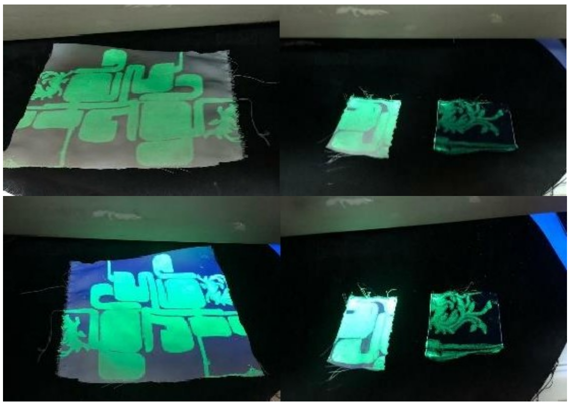

**Fig.3. Images of photochromic dyes on the surfaces of polyester fabric that is treated with silicone rubber polymer and TiO2 NPs.**

**Conflicts of interest**

There is no conflict of interest in the publication of this article.

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# الحماية من الأشعة فوق البنفسجية التجهيز الطارد للماء لأقمشة البوليستر المطبوع بأصباغ فوتوكرومية


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**المستخلص:**

مطاط السيليكون هو طارد تجاري معروف للماء ، والذي يتم تطبيقه بشكل شائع على أقمشة البوليستر. هنا ، نقوم بتطوير نهج بسيط نحو نقل أقمشة البوليستر المقاومة للماء وخصائص الحماية من الأشعة فوق البنفسجية. يتم التعامل مع أقمشة البوليستر بمطاط السيليكون RTV كمواد تشطيب طاردة للماء وجزيئات نانو ثاني أكسيد التيتانيوم كمواد تشطيب للحماية من الأشعة فوق البنفسجية باستخدام تقنية المعالجة الجافة للوسادة. تتم طباعة الأقمشة المعالجة بعد ذلك بصبغة فوتوكرومية. يتم التحقيق في جميع القياسات المطلوبة ومناقشتها بالتفصيل.



**الكلمات الدالة**: مطاط السيليكون ، الحماية من الأشعة فوق البنفسجية ، طارد الماء ، نسيج البوليستر ، الطباعة.