 J. Text. Color. Polym. Sci., **Vol. 21,** No. 1, pp. 91-95 (2024)

Journal of Textiles, Coloration and Polymer Science

https://jtcps.journals.ekb.eg/

Egyptian Society for Textile Science and Technology
الجمعية المصرية لعلوم وتكنولوجيا النسيج

Enhancing the Self-Cleaning Properties of Polyester Fabric with RTV – Silicone Rubber

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Abstract

It was reported on a straightforward method for creating a mechanically robust water-repellent layer on polyester fabric by treating the cloth with silicon rubber. It was possible to obtain surfaces with hierarchical morphology, depending on the concentration of the silicon rubber solution. Toluene was combined with extracted silicone, and the mixture was effectively applied to polyester fabric. By using a scanning electron microscope, energy dispersive X-ray analysis, measurements of static water contact and sliding angle, as well as other methods, the surface properties of the coated polyester fabric were investigated. This document includes all the elements and metrics.

Keywords: RTV-silicone rubber, toluene, self-cleaning, water repellent.

Introduction

Self-cleaning textiles are not only water-repellent but also resistant to stains, filth, odor, and microbes. These surfaces allow water to roll off effortlessly, fully cleaning the surface in the process. Self-cleaning properties of textiles enable efficient material usage, which is consistent with the principles of sustainable development. [1-8]

Self-cleaning textiles can be prepared using one of two main techniques. It may be made either by coating the textile surface with very hydrophobic compounds (such as silicones, fluorocarbons, etc.) or by using nanotechnology to cover certain useful hydrophilic materials. [4, 6, 9]

RTV silicone, also known as room-temperature vulcanized silicone, cures at room temperature. [10] It can be purchased as a single-component product or combined with two other components (a base and a curative). It is offered by manufacturers in a variety of hardnesses, often between 15 and 40 Shore A, ranging from extremely soft to medium. A catalyst made of either platinum or a tin compound like dibutyltin dilaurate can be used to cure RTV silicones. Low-temperature over-molding, creating molds for replication, and lens applications for select optically clear grades are other uses. RTV silicones are employed because of their resilience to thermal and mechanical stress. [11-15]

In this study, we present a low-cost and straightforward method for chemically creating a long-lasting water-repellent surface on polyester fabric. This method involved coating the polyester cloth with a toluene/RTV silicone rubber mixture. All necessary measures are carefully examined.

Materials, Methods, and Measurements

Materials

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

2- Decoseal RTV - silicone rubber was supplied by ADMICO, Egypt.

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Receive Date: 12 July 2023, **Accept Date:** 06 August 2023
DOI: 10.21608/JTCPS.2023.222676.1218

3- Toluene is obtained from EL-Gomhouria Pharmaceutical Company, Egypt.

Methods

The following recipe was used in coating polyester fabric with RTV silicone rubber

L: R	1:50
W.O.S (polyester substrate)	4.5 gm
RTV-Silicone rubber	Xg/L=(25, 30, 35)
Toluene	600 ml
Time	20 min
Temperature	room temperature

1- The Samples were cut 10 cm x 10 cm, each of the samples weigh 4.5 gm.
2- Toluene is divided into 3 equal amounts (of 200 ml in each standard).
3-RTV silicone is used in 3 different concentrations (25,30,35 ml) and then added to toluene.
4- The solution was mixed until the RTV gets dissolved.
5- The 3 polyester samples were put in the solution and were left for 10 min. at room temperature.
6- The samples are gotten out and left to dry.

Measurements

Contact Angle Measurement

The effectiveness of water-resistant textiles in preventing seepage of water through fabric surfaces is evaluated using the characterization technique known as contact angle measurement. On the OCA-15EC (Dataphysics GmbH, Germany), water contact and sliding angles were measured using the software. With 10 lL of triple-distilled water, contact angle qualities were tested. To generate a flat surface, polyester substrates were attached to glass coverslips using double-sided adhesive tape (4).

Microscope for Field Emission Scanning Electron (FE-SEM)

Using a Quanta FEG-250 field emission scanning electron microscope, the morphological characteristics of both uncoated and coated polyester samples were examined (Czech Republic). The surface Energy - Dispersive X-ray Analysis (EDAX) unit (TEAM-EDX Model) linked to the electron microscope was used to analyze the elemental composition. A scanning electron microscope imaging software tool was used to measure the distribution of particle diameter.

Energy-Dispersive X-ray spectroscopy (EDAX)

EDS, sometimes referred to as EDX or XEDS, is an analytical method that allows for the chemical characterization and elemental analysis of materials. A material that has been activated by an energy source (such as the electron beam of an electron microscope) releases a core-shell electron that helps to release part of the energy that has been absorbed. The difference in energy is subsequently released as an X-ray with a distinctive spectrum depending on its parent atom when a higher energy outer-shell electron moves in to take its place. As a result, it is possible to analyze the composition of a sample volume that has been stimulated by an energy source. The element is identified by the position of the peaks in the spectrum, and the strength of the signal reflects the element's concentration.

Elemental Analysis

Elemental analysis is the process of determining the elements and occasionally the isotopic composition of a sample of a substance, such as soil, waste or drinking water, body fluids, minerals, or chemical compounds. There are two types of elemental analysis: qualitative (identifying the components present) and quantitative (determining how much of each is present). Elemental analysis is a branch of analytical chemistry, which uses tools to understand the chemistry of our environment.

Results and Discussion

Contact and Sliding Angles

The findings demonstrate that contact angle depends on process variables such as layer count, coating thickness, coating method, and moisture content in addition to the hydrophobic properties of polyester fabric. The pressures exerted on the coating material's surface primarily affect the coated surface's contact angle. As the static contact angle rises, the water repellency also grows (8). Figure (1) displays the findings of contact angle tests conducted on a polyester sample that has been silicone rubber-treated.

The prior figure makes it evident that after being treated with silicone rubber at a concentration of 35 gram, the fabric's water contact angle rose. The findings of the static contact angle measurements show that the left contact angle is 147,2 and the right contact angle is 147,2.

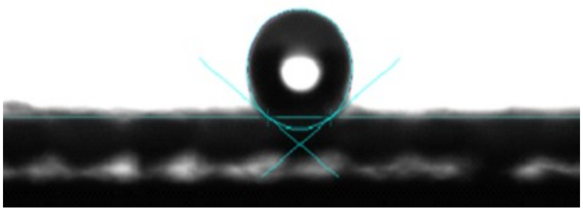

Fig. 1. The result in the static contact angle of treated polyester fabric with silicone rubber.

Morphological Properties

SEM was used to evaluate the morphological characterization of RTV integrated onto a polyester surface (SEM). The hydrophobic properties of textiles treated with silicon rubber might be explained by looking at the fiber morphology of the treated polyester fabrics. Figure (2) makes it clear that silicone rubber (35g) treatment of polyester textiles produced a hydrophobic surface (9).

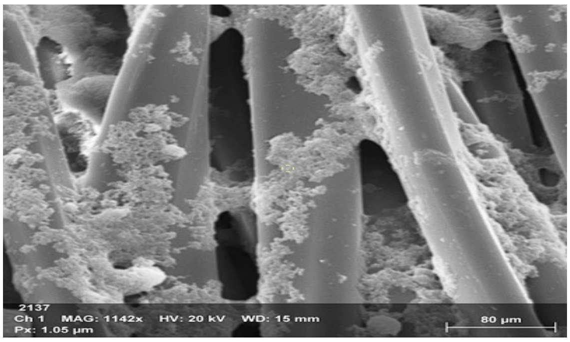

Fig. 2. Scanning Electron Microscopy of treated polyester fabric with silicone rubber

Energy-Dispersive X-Ray Spectroscopy (EDAX)

By using energy dispersive X-ray spectroscopy, the morphological characterization of RTV integrated onto polyester surfaces was examined (EDAX). The hydrophobic properties of textiles treated with silicon rubber may be explained by looking at the fiber morphology of the treated polyester fabrics using RTV concentration (35 grams). Figure 3 demonstrates how treating polyester materials produced a hydrophobic surface (9).

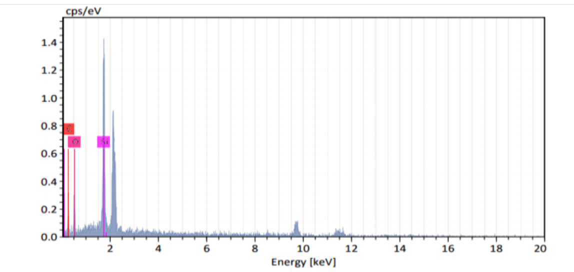

Fig. 3. EDAX diagram of silicone rubber (35 gm) - treated polyester fabric at three different positions on the surface of the substrate

Elemental Analysis

The treated polyester sample's elemental analysis (in weight percent) at three separate locations is displayed in the table below.

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
Oxygen	8	376	5.83	34.38	35.70	1.81	31.06
Silicon	14	2455	5.68	33.45	19.79	0.31	5.54
Carbon	6	157	5.46	32.17	44.51	2.31	42.35
		Sum	16.97	100.00	100.00		

Surfaces Scanning

Figures 4 show magnified images of polyester textiles that have been treated with RTV silicone rubber as well as untreated fabrics. which shows the difference in the structure of polyester. These variations in fiber surface are caused by the treatment of polyester fabric with silicone rubber. The pores show different filling percentages which are moderately filled with silicone rubber. This gives good air permeability and good antimicrobial protection, unlike other treatments, where the pores are almost filled, which makes it unbreathable. The untreated sample gives bad water resistance.

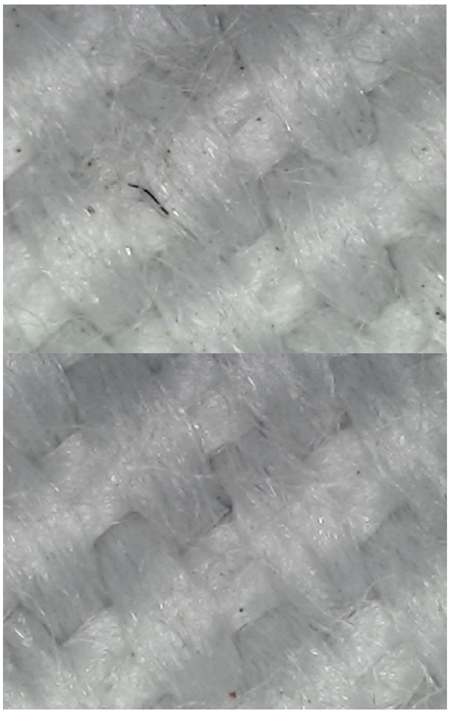

Fig. 4. (a) Untreated polyester sample image and b) Treated polyester sample using RTV silicone.

Conclusion

We have prepared a self-cleaning polyester fabric to suit our project (a fabric book for blind and normal children), by treating the fabric with silicone rubber. In our project, the book is treated to impart its fabric a waterproof finish. Improved kid safety is the main goal of high-performance protective fabrics, such as those that are water-repellent. In addition, this treatment provides the fabric with more durability, which fits the main purpose of our research, which makes the children enjoy the book for a long time.

Conflicts of interest

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

Funding sources

There is no external fund for this article

Acknowledgments

The authors are gratefully-grateful to acknowledge the Faculty of Applied Arts, Helwan University. Furthermore, the authors are gratefully grateful to acknowledge the Central Labs Services (CLS) and Centre of Excellence for Innovative

Textiles Technology (CEITT) in Textile Research and Technology Institute (TRTI), National Research Centre (NRC) for the facilities provided.

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تعزيز خصائص التنظيف الذاتي لنسيج البوليستر مع RTV - مطاط السيليكون

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المستخلص:

تم الإبلاغ عن تقنية بسيطة لإنتاج طبقة مقاومة للماء متينة ميكانيكيا على نسيج البوليستر عن طريق الطلاء باستخدام مطاط السيليكون. اعتمادا على تركيز محلول مطاط السيليكون ، كان من الممكن الحصول على أسطح ذات مورفولوجيا هرمية. تم خلط السيليكون المستخرج مع التولوين الذي تم تطبيقه بنجاح على نسيج البوليستر. تمت دراسة خصائص سطح نسيج البوليستر المطلي بواسطة المجهر الإلكتروني الماسح وتحليل الأشعة السينية المشتتة للطاقة وكذلك ملامسة الماء الساكن وقياسات زاوية الانزلاق. يتم تضمين جميع العوامل والقياسات في هذه الورقة.

الكلمات الدالة: مطاط سيليكون RTV ، تولوين ، تنظيف ذاتي ، طارد للماء.