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Flame Retardant and Water Repellent Finishing of Polyester Fabric

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Abstract

A well-known commercial flame-retardant called pyrovatex is frequently used on polyester fibers. In this study, we present a straightforward method for coating polyester textiles to make them hydrophobic and flame-resistant. Utilizing Pyrovtex (as a flame-resistant finishing compound) and RTV-silica rubber, we use the one-bath pad-dry-cure procedure (as water-repellent finishing material). The increased bonding of Pyrovatex with both polyester fibers and RTV, which in turn was bound to polyester fibers as well, enhanced the fabric's flame retardancy. RTV silicone also enhanced the fabric's surface's capacity to resist water. We investigated the treated polyester's surface morphology and contact angle.

Keywords: Flame-Retardant, Water-Repellent Finishing, Polyester Fabric, Pyrovatex.

Introduction

The textile industry sector is as vast and varied as the items it presents, and new uses are constantly being created within it. The production of textiles, including yarns, fabrics, garments, textile raw materials, and home furnishings, is competitive on a global scale. [1-3] Technical textiles are textile items created for non-aesthetic purposes, where their duties serve as the primary criterion. [4-7] Enhancing human safety is the main goal of technological protective textiles including flame-retardant, antimicrobial, and super hydrophobic clothing. [8-20]

A crucial performance trait for textiles is provided by flame-retardant procedures. Flame-retardant textiles are necessary for floor coverings, upholstery, drapery, commercial carpet, transportation, military and professional racers' clothing, bedding, and children's sleepwear in addition to protecting firefighters and emergency personnel while they perform their duties. [21-23] A successful flame retardant textile product must satisfy the following criteria in addition to meeting flammability standards: maintaining the aesthetics and physiological characteristics of the textile; being produced using a straightforward process using standard equipment and affordable chemicals; and being non-toxic and environmentally friendly. [4, 24-26]

Although PET is flammable and has a weak anti-dripping feature, polyester has outstanding thermal stability, chemical resistance, and great mechanical capabilities, which limit the range of applications where particular fire-resistant performance is required. [27-29] Additionally, the mechanical properties of the textiles that are protected are unaffected by the flame retardant coatings that are applied to the substrate surface. Additionally, flame retardant coatings on the substrate surface can be purposefully combined with other useful elements to carry out a variety of tasks, such as water repellency, UV defense, and antibacterial qualities. [16, 30-35]

The variety of uses for textiles is significantly reduced by both hydrophobicity and flammability,

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notably in the shipping, crafting, and packing industries. The lotus effect has inspired researchers to focus on ultra hydrophobic surfaces for the past few decades. [36]

The deposition of hydrophobic substances on the surface of the fiber is what gives something its water repellency. In other words, the surface still has pores that allow for the passage of air and water vapor. Typically, water droplets develop on the fabric's surface (like lotus leaves). Although it isn't completely waterproof, it does lessen how much water the cloth absorbs. [11, 37-39]

In this paper, the authors aimed to impart flame retardant and water repellent finishing on polyester fabric using RTV silicone rubber (as a water repellent finishingmaterial) and Pyrovatex (as a flame retardant finishing material). All the required measurements will be carried out and included in the paper.

Material and Methods

Materials

(100%) The polyester fabric was kindly obtained from El-Mahala Company for Spinning and Weaving, El-Mahala, Egypt. Decoseal-RTV-silicone-rubber supplied by ADMICO, Egypt. Pyrovatex (flame retardant finishingmaterial) and Toluene are provided by Huntsman Chemicals, Egypt. The following chemicals are selected for the study (all laboratory grade), and are all supplied by El-Gomhorya Pharmaceutical Company:

Pigment color, Diammonium phosphate, Synthetic Thickener, and Binder

Methods

Flame Retardant and Water Repellent Finishing

A mixture is prepared by adding 222 g ofsilicone rubber (water-repellent finishing material) to a beaker filled with 245 g of toluene, to prevent its polymerization. 5, 10, and 15 g of pyrovatex (flame retardant finishing material) are then added to the mixture after it has been evenly split among three beakers. Following that, the beakers are filled with 1.7 g of polyester fabric. The padding process continued for 10 minutes at room temperature while stirring, then the samples are removed from the mixture and left to dry.

Printing Technique

The treated polyester fabric is printed with the pigment paste, using the conventional silk screen printing technique.

Pigment paste recipe for each 1 kg of paste:

- 40 g Pigment color
- 22g Diammonium phosphate
- 30 g Synthetic Thickener
- 120 g Binder
- 788 g Water

Printing – Drying at room temperature – Thermofixation at 150°C for 5 min.

Measurements

SEM Scan

The morphological examination of the materials is investigated using a field emission scanning electron microscope (FE-SEM) on a Quanta FEG 250 (Czech Republic) with SEM HV: 20.0Kv, WD: 4.86mm, View field: 139m, Det: SE, and SEM MAG: 1.00 kx.

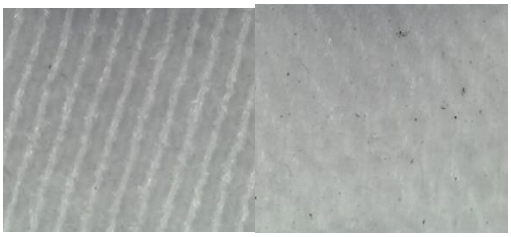
Contact angle

Water contact angles were reported on OCA 15EC DATAPHYSICS is used to investigate the contact angle of the samples.

Results and Discussion

These are zoomed pictures with high resolution of the polyester fabric before andafter treatment.

As we can see, there are empty pores before the treatment which have been cured by silicone rubber. This means that the fabric successfully absorbed the mixture.



Before After

Fig.1. images of polyester fabric before and after treated

Evaluation of the Flame Retardancy of the Treated Fabric

SEM Scan (Scanning Electron Microscope) test is applied to the fabric. The morphology and the microstructure of the treated fabric can be seen in Fig.2. [27]

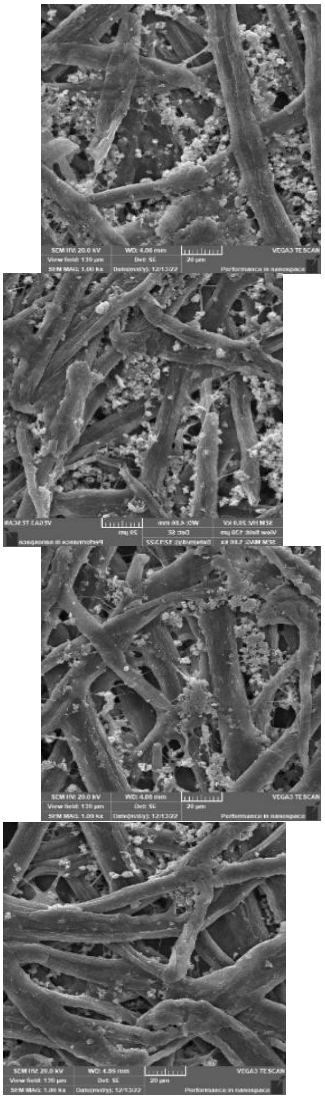


Fig. 2. SEM images of polyester fabric that is treated with pyrovatex and silicone rubber

RTV filled the surface holes between threads in addition to covering the surface fibers. Additionally, the treated polyester surface's rough morphology significantly diminished.

Evaluation of the water repellence of the treated fabric

The angle created when a fabric surface makes contact with a liquid, creating a fabric-liquid interface, is known as the contact angle. The contact angle is measured by the tangent that is drawn to the droplet profile at the point of contact. These measures are used to categorize the surfaces into hydrophilic, hydrophobic, and ultra hydrophobic types (as shown in Fig. 2). [28]

Fig.3. Static water contact angles of polyester fabric treated with pyrovatex and silicone rubber

As it is shown in Fig. 3, the contact angle of the sample varies between 117.5°- 128.5° which is >90°. This means that the fabric is successfully treated to be hydrophobic according to Fig.2.

Conclusion

To provide a flame-retardant and water-repellent finish, a smart coating was applied to polyester fabric using ecologically friendly RTV silicone rubber combined with pyrovatex. SEM (scanning electron microscopy) analysis of the surface morphology of the treated polyester and contact angle measurements were used to validate the findings.

The findings of the SEM scan and contact angle showed that the treated polyester fabric has long-lasting water-repellent and flame-retardant qualities. This creates an excellent opportunity for the mass manufacture of textile materials that are water and flame resistant for use in a range of industrial applications.

Conflicts of interest

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

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This paper is dedicated to the memory of Dr. Ahmed Noubi and Mr. Nabil Mahmoud may they rest in peace.

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التجهيز المثبط للهب والمقاوم للمياه لأقمشة البوليستر

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المستخلص:

Pyrovatex هو مثبط للهب تجاري معروف يتم تطبيقه بشكل شائع على ألياف البوليستر. في الورقة ، قمنا بتطوير نهج بسيط تجاه الطلاء الكارهة للماء والمثبطة للهب لأقمشة البوليستر. نحن نطبق تقنية المعالجة الجافة للحمام الواحد باستخدام Pyrovtex (كمواد تشطيب مثبطة للهب) ومطاط RTV-sillicone (كمواد تشطيب مقاومة للماء). تم تحسين تثبيط اللهب للنسيج نتيجة الترابط العالي ل Pyrovatex مع كل من ألياف البوليستر و RTV والتي بدورها كانت مرتبطة بألياف البوليستر أيضا. علاوة على ذلك ، قام سيليكون RTV بتحسين تأثير طارد الماء على سطح القماش. تم استكشاف مورفولوجيا السطح وزاوية التلامس للبوليستر المعالج.

الكلمات الدالة: مثبطات اللهب ، تجهيز طارد للماء ، نسيج بوليستر ، بيروفاتكس.