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Anti-Microbial Finishing of Polyamide Fabric Using Titanium Dioxide Nanoparticles

Khadiga A. Abdel Salam [1], Nada A. Ibrahim [1], Dalia Maamoun [1], Sh. H. Abdel Salam [1], Abeer I. Fathallah [1], Meram S. Abdelrahman [2], Hamada Mashaly [2], Ahmed G. Hassabo [3*] and Tawfik A. Khattab [2]

[1] *Textile Printing, Dyeing, and Finishing Department, Faculty of Applied Arts, Helwan University, Egypt*

[2] *National Research Centre (Scopus affiliation ID 60014618), Textile Research and Technology Institute, Dyeing, Printing, and Intermediate Auxiliaries Department, 33 El-Behouth St. (former El-Tahrir str.), Dokki, P.O. 12622, Giza, Egypt*

[3] *National Research Centre (Scopus affiliation ID 60014618), Textile Research and Technology Institute, Pre-treatment, and Finishing of Cellulose-based Fibres Department, 33 El-Behouth St. (former El-Tahrir str.), Dokki, P.O 12622, Giza, Egypt*

Abstract

THE authors seek to investigate antimicrobial finishing of polyamide fabrics using titanium dioxide nanoparticles because consumers are becoming more aware of the importance of leading hygienic lives and because there is a need for and expectation for a wide range of textile products finished with antimicrobial characteristics. In the article, all necessary measures are used and explored.
Keywords: Titanium Dioxide Nanoparticles; Polyamide fabric; Antimicrobial finishing

Introduction

An antimicrobial fabric is a fabric that is treated with an active ingredient to protect it from bacterial growth, which causes the fabric to inhibit the growth of microbes. [1-3] Where the cloth is worn near to the skin, microbial infestation can result in pathogen cross-infection and the production of odour. [4] The great majority of antimicrobials function by leaching or migrating off the surface on which they are put; antimicrobials do not all function in the same way. [3, 5-8]

Leaching technologies have the potential to harm clothing in a number of additional ways besides reducing durability and useful life. These include their negative effects, which might lead to rashes and other skin irritations since they can come into touch with the skin and perhaps disturb the natural skin flora. [9]

Due to their hydrophobicity, synthetic fibres have been shown to be more microbially resistant than natural fibres, which are more susceptible to microbial assault. In addition, bacteria may get nutrients from dirt, perspiration, and dust. [10] About 85% of the entire manufacturing of antimicrobial textiles is made up of lingerie, activewear, socks, and shoe linings. Antimicrobial fibres have also lately had a significant market in air filters, outdoor textiles, furniture, and medical textiles. [11]

Materials, Methods and Measurements

Materials

- Titanium dioxide nanoparticles (Tioxide A-DM) of 700 nm particle size is purchased from Sigma-Aldrich, Egypt**.**
- Binder additive (Clariant) of Poly acrylic acid is collected from Dystar, Egypt
- We gratefully received 100% Polyamide 66 cloth in plain weave from El-Mahalla Company for Spinning and Weaving, El-Mahala, Egypt. These were the fabric's specifications: Fabric with a weight of 150 g/m^2, a thickness of 0.40 mm, a micro density of 3.88 g/inch, weft of 30 cm and warp of 36 cm

Methods

Recipe: Three samples of Polyamide 66 fabric 100% (Plain weave), Three different concentrations of Tioxide A-DM titanium dioxide nanoparticles

*Corresponding author: Ahmed G. Hassabo, e-mail: aga.hassabo@hotmail.com, Tel. 01102255513
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were prepared 1%, 2% and 3%, 10 ml of Clariant of Poly acrylic acid binder of 3% concentration and 40 ml of water. 40 ml of water was added at room-temperature after mixing 1 percent titanium dioxide with 3 percent binder, and a sample of polyamide fabric was then submerged. Additionally, combine 2 percent titanium dioxide concentration with 3 percent binder. After adding 40 ml of room temperature water, the polyamide fabric sample was submerged. Additionally, combine 3 percent binder concentration with 3 percent titanium dioxide concentration. After adding 40 ml of room temperature water, the polyamide fabric sample was submerged. The three samples were then fixed for 10 minutes at 150°C in the oven. Finally, the polyamide sample was put through the test for bacteria.

Measurements

Anti-bacterial test

In the case of bacteria and yeast, nutrient agar plates were severely injected on a regular basis with 0.1 ml of 105-106 cells/ml. To assess the antifungal effects, 0.1 ml (106 cells/ml) of the fungal inoculum was planted into potato dextrose agar plates.Textile treated discs (15mm diameter) were placed over the inoculated plates. To allow for maximal diffusion, plates were then maintained at a low temperature (4°C) for 2-4 hours. The plates were then incubated for the bacteria at 37°C for 24 hours and for the organisms to develop as much as possible at 30°C for 48 hours in an upright posture. The diameter of the inhibition zone, stated in millimetres, was used to measure the test agent's antimicrobial activity (mm). The experiment was run many times, and the average reading was recorded. The disc agar diffusion technique was used to examine the antibacterial activity. The four representative test organisms were Aspergillus niger NRRL-A326 (fungus), Staphylococcus aureus ATCC 6538-P (G+ve), Escherichia coli ATCC 25933 (G-ve), and Candida albicans ATCC 10231 (yeast) (fungus).

SEM Test

In scanning electron microscopy (SEM), Stuttgart, Germany, a concentrated stream of high-energy electrons is utilised to produce a range of signals at the surface of solid objects.

Results and Discussion

Antibacterial test

Microscopic examination of the treated polyamide fabric samples with titanium dioxide nanoparticles and binder of 3% concentration shows measuring the width of the zone of inhibition expressed in millimetres (mm) of four pathogens to determine the antibacterial effectiveness of polyamide fabric samples against various test bacteria.: positive gram bacteria Staphylococcus aureus with diameter of zone of inhibition 17 nm, gram negative bacteria Escherichia coli with diameter of zone of inhibition 0 nm, Yeast Candida albicans with diameter of zone of inhibition 29 nm and fungi Aspergillus niger with diameter of zone of inhibition 12 nm

Table 1 the antibacterial activity against several test microorganisms of G+ve bacteria (S. aureus), G-ve bacteria (E. coli), yeast (C. albicans), and fungus (A. niger).

Staphylococcus aureus	***Escherichia coli***	***Candida albicans***	***Aspergillus niger***
17	0	29	12

The fabrics also were printed with glow in dark pigment (Strontium Aluminate). This glow-in-the-dark material continues to emit a strong green-yellow light after absorbing light for a while even when there is no light source present. For the polyamide fabric, the morphological characteristics, elemental analysis, and mechanical measures were discussed. Finally, we described a new method to produce eco-friendly printed smart textiles with multifunctional properties.

Table shows the antibacterial activity against different test microbes representing G+ve bacteria (S.aureus), G-ve bacterium (E.coli), Yeast (C.albicans) and fungi (A.niger) by clear Zone (ϕmm).

SEM test

Antimicrobial finishing of polyamide fabrics with titanium dioxide nanoparticles is successful against positive gram bacteria, yeast and fungi.

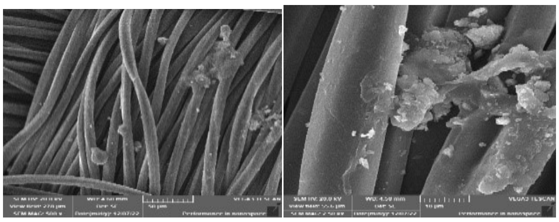

Figure 1 Polyamide fabrics before and after treating with titanium dioxide nanoparticles

Samples were treated with anti-static agents and the table shows the results. In all samples which are pre-printed and treated with antistatic agents like (sodium carbonate and acetic acid), it was noticed that the colors became brighter.

The dip-pad-dry-cure process is often used to create bonds between nanoparticles and a fabric. [12]

In all samples which are pre-printed and treated with antistatic agents and Tio2, it was noticed that the colors faded and mixed with each other. Therefore, samples should not be printed before self-cleaning finishing.

The photocatalytic self-cleaning performance of polyamide organza fabric which were treated with titanium dioxide nanoparticles and sodium carbonate as anti-static agents, gives best result.

The greatest results are produced by the polyamide organza fabric's (AA) antibacterial activity against various test microorganisms that represent G+ve bacteria (S. aureus) and yeast (C. albicans).

the fabrics were treated with antistatic agents namely sodium carbonate, acetic acid and TiO_2. Titanium dioxide nanoparticles was prepared and applied to polyamide.

Measurements are applied on cotton samples treated with silicon rubber, using 2 concentrations of chitosan which are: 3% and 5% (of fabric weight). Table 1 shows examples of the antibacterial activity of G+ve bacteria (S. aureus), G-ve bacteria (E. coli), yeast (C. albicans), and fungus against various test microorganisms (A. niger).

SEM images of the surface morphology of an RTV silicon/chitosan film on cotton fibres at various chitosan concentrations (0, 3, 5, and 10%). It is clear from the previous figure that, using a 3% silicon /chitosan treatment is considered the best concentration. A rough surface was prepared by applying a pad-dry-cure method of treatment on the cotton samples. The treated fabric showed excellent hydrophobic properties as the droplets of water rolled off.

The cloth underwent morphological, contact angle, and antimicrobial testing; the results are shown in our study. Cotton may be given an antimicrobial finish that is effective against both Gram-positive and Gram-negative bacteria, including S. aureus and E. coli.Thus, cotton fabrics may be given an eco-friendly, multipurpose finish using the suggested process.

The fabrics before and after running the printing process. By treating the textiles, it was possible to improve their hydrophobic performance, which in turn improved the photocatalytic self-cleaning activity, improved the antibacterial performance, and increased the UV protection activity.

Conclusion

This study clearly demonstrates that the polyamide fabrics which treated with titanium dioxide nanoparticles are resistant to many types of microbes under the electron microscope, which meets the needs of the market in providing fabrics suitable for daily life when exposed to bacteria and various microbes, which help to reduce the spread of infection among children and adults.

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التجهيز المضاد للميكروبات لأقمشة البوليستر باستخدام جسيمات ثاني أكسيد التيتانيوم النانوية

خديجة عبد السلام [1]، ندى إبراهيم [1]، داليا مأمون [1]، شريف عبد السلام [1]، عبير إبراهيم فتح الله [1]، ميرام سيد عبد الرحمن [2]، حمادة مشالي [2]، أحمد جمعه حسبو [3]* و توفيق خطاب [2]

[1] قسم طباعة المنسوجات والصباغة والتجهيز - كلية الفنون التطبيقية - جامعة حلوان - الجيزة - مصر
[2] المركز القومي للبحوث (Scopus ID 60014618) ، معهد بحوث وتكنولوجيا النسيج ، قسم الصباغة والطباعة والمواد الوسيطة، 33 شارع البحوث (شارع التحرير سابقاً) ، الدقي ، ص.ب 12622 ، الجيزة، مصر
[3] المركز القومي للبحوث (Scopus ID 60014618) ، معهد بحوث وتكنولوجيا النسيج، قسم التحضيرات والتجهيزات للالياف السليلوزية ، 33 شارع البحوث (شارع التحرير سابقاً) ، الدقي ، ص.ب 12622 ، الجيزة، مصر

**المؤلف المراسل: البريد الإلكتروني*: aga.hassabo@hotmail.com

المستخلص: نظرا لأن المستهلكين أصبحوا الآن على دراية متزايدة بأسلوب الحياة الصحي ، وهناك ضرورة وتوقع لمجموعة واسعة من المنتجات النسيجية التي تم الانتهاء منها بخصائص مضادة للميكروبات ، يهدف المؤلفون إلى التحقيق في التشطيب المضاد للميكروبات لأقمشة البوليستر باستخدام جزيئات ثاني أكسيد التيتانيوم النانوية. يتم تطبيق جميع القياسات المطلوبة والتحقيق فيها في هذ البحث.

الكلمات المفتاحية: الجسيمات النانوية لثاني أكسيد التيتانيوم - نسيج بوليستر التشطيب - مضادات الميكروبات.