 J. Text. Color. Polym. Sci., **Vol. 18,** No. 2, pp. 247-252 (2021)

Journal of Textiles, Coloration and Polymer Science

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

A Recent Study for Printing Polyester Fabric with Different Techniques

Marina Y. Soliman [a], Hanan A. Othman [a] and Ahmed G. Hassabo [b]*

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

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

THE study tries to stress that the transfer printing of polyester textiles can be done using natural colours. Turmeric, alkanet, and rhubarb were the colours utilised. Colour intensity, dye penetration percentage and rapidity characteristics were also evaluated. On polyester fabric, a nanoparticle size disperse dye was applied with an ultrasonic. The colour depth of the prints is greatly increased by nanosized dye particles without adding additional chemicals to the printing paste. The use of nanosized dye particles increases the colours of the prints considerably. San Diego has developed a biotreatment approach for polyester fabrics as a team from the University of California. By combining enzyme and inkjet pretreatment stages in one solution, the researchers achieved a time and energy reduction. They also identified a significant increase in the colours of digitally printed polyester samples. A new study shows a simple way for synthesising new thiazole colours. The dyes are used for printing polyester fabrics and are strong in colour, bright in colour and highly durable. Spectral data confirmed findings (IR,1H-NMR, 13C- and Mass spectra.

Keywords: Polyester fabric, Natural Dyes, Dye nanoparticles, Enzymatic Treatment, Digitally Printed

Introduction

Transfer printing is an indirect approach that only exploits sublimating capabilities of dispersed pigments. It's also a tidy and straightforward to use method. In this research, natural eco-friendly printing technology is developed by merging transmission printing with natural colouring.

In the textile industry, disperse dyes are mostly utilised as non-ionic dyes. They must be melted and dispersed in water using a surfactant to low particle size. The mechanisms by which a carrier speeds up the colouring of textiles were under discussion.

The cloth is printed with a 100% polyester dye with nanosized particles. The colour is milled and processed a variety of times using ultrasonic to achieve small particles which can disperse in the paper paste without adding a dispersing agent. The analytical grade was employed in all items. The enzyme processing of natural fibres extends from cleansing preparations to concluding a wide range of processes. In addition to natural fibres, the use of lipases has led to enzyme hydrolysis in synthetic fibres. Two types of heterogeneous atoms, nitrogen and sulfur are present in thiazole molecules. They may be anti-inflammatory, analgesic, antibacterial, antihistamine, schistosomicide, antiviral and anti-inflammatory. The biological importance of these chemicals was represented in recent research.

*Corresponding author: Ahmed G. Hassabo, Email: aga.hassabo@hotmail.com, Tel.: +20 110 22 555 13
(Received 07/07/2021, accepted 26/07/2021)
DOI: 10.21608/jtcps.2021.84754.1072

Polyester

Polyester is a polymer category containing the main chain ester functional group. Natural substances, such as plant cuticles, as well as synthetics, can be found in polyesters through the gradual progression of the polymerization process such as polybutyrate. The type of polyethene terephthalate (PET) is most generally referred to as a specific material since it consists of groups of ethylene and terephthalate.

Physical Properties

PET is a colourless, semi-crystalline resin in its original condition. PET can be semi-rigid to rigid and relatively easy to process, based on how it is handled. It is an excellent barrier to gas, fair moisture and a good barrier to alcohol and solvents (needs further "barrier" treatment). It is powerful and resistant to impact.

Uses

PET is an excellent water and humidity barrier material; soft drinks are commonly utilised in PET plastic bottles. Biaxial oriented PET film (also called 'Mylar' by a brand name), can be aluminized to lower its permeability and make it reflective and opaque by evaporating a thin film of metal into it (MPET). In many different applications, including flexible food packaging and heat insulation, these qualities are important. PET film is often used in tape applications, including the magnetic tape carrier or backrest for pressure-resistant adhesive tapes due to its great mechanical strength. Thermoforming of non-oriented PET boards can be done to manufacture packaging packs. The plates can be used for frozen meals if crystallizable PET is used, as they stand both freezing temperatures and baking ovens. In thin-film solar cells, PET is also employed as a substrate. The terylene is also split into bell cords to avoid wear on the cords as they cross the ceiling.

Printing techniques for Polyester

Transfer Printing of Polyester Fabrics with Natural Dyes

There were three natural dyes. The dry plants that produced the colours were crushed into a fine powder and put to the printing paste with Tanatex Sybron and medium-viscosity sodium alginate according to the following recipe

Recipe (1): Paste based on alginate * X gm Dye*, 500 g alginate, Y g water up to 1000 g in total. In cold water sodium was added to and left overnight, the dyestuff was then added and the solution was mixed up for a couple of minutes. [1-4]

Recipe (2): Paste based on Dicothick. X gm Dye, 500 g dioxide Y g water up to 1000 g in total. Dicothick was gradually added to the cold water and swirled and added a few minutes of the dyestuff and continuous stirring. The three natural dyes with concentrations ranging from 40 g/kg were utilised. [5-7]

A flatbed press 40X25 was the heat source for transfer printing. At 180-200°C, the period of printing ranged from 10-50 seconds. Before the transfer printing paper was removed, the samples were let to cool at room temperature.[8]

Printing of Polyester Fabrics with disperse dye nanoparticles

Disperse dye is a water-insoluble dye with similarity to one or more hydrophobic fibres. Disperse colours are nonionic colours; they are the most often used dyes in the textile industry in the colouring of synthetic fibres as a significantly water-insoluble colourant with an affinity for one or more hydrophobic fibres.**[9]** Disperse dyes are fundamentally nonionic dyes, the most frequent colouring of synthetic fibres such as polyester, acrylic and acetate used by dyes in the textile sector. There is a widespread dispute over the current process by which a carrier employed in dying promotes textile colouring. Fibres of polyester absorb the body and swell.**[10]**

This swelling might prevent the fluid flow in packaging that leads to discomfort. The action, in general, reduces the transition temperature of the polymer glass) Tg, hence increasing polymer chain motions and creating free volume. This accelerates the spread of the colour to the fibre. The carriers can also generate a fluid film around the fibre surface in which the dye is highly soluble and therefore increase the transfer rate into the fibre.**[11]** Power Ultrasound (US) can enhance a broad range of chemical and physical processes mostly because of the cavitation phenomena recognised in a liquid medium, which causes small bubbles to explore and expand. Sudden and violent collapse of such bubbles can lead to high temperatures, high pressure, shock waves and extreme shear forces, which can disrupt chemical connections.**[12]**

This is a textile colouring technology, as the main wet process, which consumes a great deal of energy and water and releases significant waste into the environment, has been investigated in numerous ways. **[13]**Improvements seen in ULT are often related to cavitation Phenomena and consequently, as demonstrated below, additional mechanical and chemical effects:

- degassing (explosion of air dissolved or captured from fibres of capillaries) •dispersion of aggregates with high relative molecular weight, degreasing;
    - Fibre diffusion (accelerate dye spread rate within the fibre; • Intensive liquid agitation; • Destroy dye/fibre spread layer;
    - generation of free radicals; and
    - Dilution of amorphous polymeric areas.

100% polyester is printed on a dispersed dye with nanosized particles in the present The colouring is molten and ultrasound for different times to get microscopic particles that can spread in the printable paste without adding a dispersant because the nanoparticle's dimensions are small enough to diffuse well into the hydrophobic fibres.

All the utilised materials were of analytical quality. One hundred percent of the 185 g/m2 single fabric in polyester that El Mahalla El Kobra, Egypt has purchased was used. Dystar Textile Farben, Germany, employed the dispersive dye Dianix Yellow-Brown HRSLSE 150. Dystar was also produced and supplied. A thickening agent (a low-concentration acrylic synthetic polymer, with the trading name Alcoprit PTF, supplied and produced by Ciba Speciality Chemicals, Switzerland) has been employed.

Preparation of Dye Nanoparticles

The dispersed colour was ground at a rate of 50 cycles/min by an energy ball mill. The dye powder was sealed utilizing hardened steel balls of 6 mm diameter into a hardened steel vial (AISI 44°C stainless steel) A ball: 4:1 powder mass ratio has been used to mount it. The colour was ground at varying ranges, such as four, six, nine and 25 days. The particle size of the dye powder produced was measured after every friction interval. 25-day milling of the dye powder was the smallest particle size of 23nm chosen for use in the present study. The particle size of the resulting dye powder was determined after each milling interval. From the milling of the dye powder 25 days the smallest particle size of 23 nm, chosen in this investigation. Two stock solutions have been made with 1 and 3 percent milling nanoparticles dye powder, where 1 and 3 g of dye powder have been dispersed respectively in 99 and 97 mL of distilled water. Different times at 80°C, including 4, 6 and 8 hours, each dispersion was irradiated with ultrasound waves (720 kHz) and stirred. **[14-18]**

Printing Procedure

Two printing pastes with two different dye concentrations were created to analyse each factor. The following recipe is provided for the press paste: Foundation solution for stock dye: 300 ml of Thickener: 50 g Alcoprint PTF. Floating water: X mL Total kinds of pasta weight: 1000 g The pH of dihydrogen phosphate with sodium was adjusted to 6. Through the flat screen printing process, the printing paste is put in the material and samples are then kept dry at room temperature. Two procedures were applied for fixing the dye, i.e. steaming at 130°C for the next 30 minutes, thermofixing at 140°C for 10 minutes, to establish the best K/S fixing method. Finally, the samples have been washed out with a 1:50 ratio of liquor with 2g/L non-ionic detergent (Sera Wash M-RK). For 10 minutes, soap was made at 60°C.

Effect of Ultrasonic Irradiation and Particle Size

Both of the stock solutions are exposed to ultrasonic radiation for 4, 6 and 8 hours, with a varying dye concentration of nanoparticles. Both the steamed and the thermofixed K/S values of the prints. The ultra-sound handling of both stock colour solutions plays a major role in the colour output of the polyester printed textiles. Damping and thermo-fixation on prints are applied independently using both concentrations of dye to identify the optimal dye-fixing procedure. The optimal improvement in damp prints is 85.4%, and 53.9% for polyester prints with 1% and 3% stock solutions compared to the untreated ultrasonic dye solution.

These outstanding results are because ultrasound improves the dispersion of the dye molecule in fibers8,9. Ultrasound also has a substantial impact on decreasing the dissipation dye particle size. The figure illustrates, on the other hand, that the thermafixation had a detrimental effect on the printed K/S values. Throughout the steaming process, the steam condenses in the cold fabric, increases its temperature to 100 °C and swells the thickening foil, as a result of thermofixation without a carrier fixes only 50-70% dye. During exposure to vapour, the condensed water is largely evaporated again but the thickening does not rebound in the cloth, as it gets smoother with dry fixation. The capacity to absorb (construct) grows according to the steam pressure and the respective temperature. With longer times at lower pressures, the colour depth achieved at high pressures cannot be achieved. **[19]** It reveals that steaming is the best way to fix the dye and is then chosen to be used in the ensuing work.

Enzymatic Treatment of Polyester Fabrics Digitally Printed

A 100 percent scrubbed and polyester fabric with 1/1, 80 g/m2 weight fabric, supplied to Spinning & Weaving Company- Egypt by Happy Tex. was used throughout this investigation. In this work, the original inkjet dye (CMYK for red hue) was developed by Ink Tec. Co. Ltd, Korea was used to make hydrophobic spreading dye. Lipase MP Enzyme from LLC France supplied with commercial-grade, thickeners of sodium alginate and formic acid. **[20]**

Pretreatment with enzyme before inkjet:

Polyester samples were previously treated with different doses of lipase enzymes at room temperatures at level 7 of 30 mins at a separate biotreatment bath of polyester fabrics using different amounts of lipase enzymes (0, 0.5, 0.9, 1.5 and 2 g/L). [21] Following enzyme therapy, the temperature of the bath was increased to stop the activity of the enzyme, and the samples were then dried with warm water and cold water. The sample of polyesters was then added and digitally printed and then fixed in the inkjet pretreatment bath: (Sodium alginate of 100 g/l 4%, 900 g/kg, water up to 1 L, pH 6.2 (using formic acid), then the padding will take place roughly 70% wet pickup. Allow the blend to dry at room temp). **[22, 23]**

The pretreatment polyester samples were printed digitally followed by air drying. Once the samples had been dried, they were attached for two minutes to 180°C by use of a thermo-fixer developed. Finally, the fixed printed samples were washed off as follows: Rinse with the cold water running, Soap with 60°C (4 g/l soap) for 15 minutes, rinse with running cold water and finally sample dry at room temperature.

Enzyme treatment in the inkjet bath

Polyester textiles, treated at various pH levels with varying storage times and with a variable plastic bag at room temperature. Inkjet Pretreatment Components, including the X g/l (0, 1, 2, 3 and 4 g/l) lipase enzymes, Sodium alginate 100 g/l 4%, and water up to 1 litre. The samples were dried with hot air and then inactivated with typical techniques to ensure the inactivation of the enzyme and inkjet jet.

References

1. Shokry, G.M., "Curcuma Long E Clorofilla-100-Wsp". *Tinctoria*, **7** 25-32 (2004)

2. Gulrajani, M.L., Gupta, D., Agarwal, V. and Jain, M., "Some Studies on Natural Yellow Dyes, Part Iii Quinones: Henna, Dolu". *The Indian Textile Journal*, **102**(3) 76-83 (1992)

3. Ebrahim, S.A., Hassabo, A.G. and Othman, H., "Natural Thickener in Textile Printing (a Mini Review)". *Journal of Textiles, Coloration and Polymer Science*, **18**(1) 55-64 (2021)

4. Hamdy, D.M., Hassabo, A.G. and Othman, H., "Recent Use of Natural Thickeners in the Printing Process". *Journal of Textiles, Coloration and Polymer Science*, **18**(2) 75-81 (2021)

5. Jaiswal, G. and Paul, S., "Resist Printing of Silk Using Natural Dyes". *Indian Silk*, **42**(2) 18-20 (2003)

6. Deo, H.T. and Paul, R., "Eco-Friendly Mordant for Natural Dyeing of Denim". *International Dyer*, **188**(11) 49-52 (2003)

7. Ragab, M.M., Hassabo, A.G. and Othman, H., "Synthetic Thickeners in Textile Printing". *Journal of Textiles, Coloration and Polymer Science*, **18**(1) 65-74 (2021)

8. Tsatsaroni, E.G. and Eledftheriadis, I.C., "The Colour and Fastness of Natural Saffron". *Coloration Technology*, **110**(9) 313-315 (2008)

9. Burekinshaw, S.M., "Chemical Principles of Synthetic Fibre Dyeing". Springer London, 133 (1995)

10. Lachapelle, J.M. and Maibach, H., "Patch Testing and Prick Testing". Springer, Japan Ltd, 182 (2009)

11. Miles, L.W.C., "Textile Printing". 2nd edn ed.: Society of Dyers & Colorist, U.K, 174 & 175 (1994)

12. Lee, K.W., Chung, Y.S. and Kim, J.P., "Characteristics of Ultrasonic Dyeing on Poly (Ethylene Terephthalate)". *Textile Research Journal*, **73**(9) 751-755 (2003)

13. Osman, H. and Omran, M.K.A.-F., "Optimization of Polyester Printing with Disperse Dye Nanoparticles". *Indian Journal of Fibre and Textile Research*, **38**(2) 202-206 (2013).

14. Hebeish, A., Ragheb, A.A., Rekaby, M., El-Hennawi, H.M. and Shahin, A.A., "Chitosan/ Disperse Dye Nanoparticles for Concomitant Printing and Antibacterial Finishing". *Nanotechnologies in Russia*, **14**(9) 462-470 (2019)

15. Hebeish, A., Shahin, A.A., Ragheb, A.A., El-Thalouth, I.A., Allam, E.E. and Shaban, H.A., "Innovation of Radically New Colorant Hybrid Nanocomposite for Printing Various Textile Fabrics". *Fibers and Polymers*, **20**(1) 69-79 (2019)

16. Hebeish, A., Shahin, A.A., Ragheb, A.A., El-Thalouth, I.A., Allam, E.E. and Shaban, H.A., "Fabrication of Radically New Colorants Based on Indigo Blue Vat Dye/Polymer/Layered Silicate Intercalated Nanocomposites Induced Cotton Prints with Batik and Denim Effects". *Bioscience Research*, **16**(2) 2076-2093 (2019)

17. Hebeish, A.A., Shahin, A.A., Ragheb, A.A., Abd El-Thalouth, I., Allam, E.E. and Shaban, H.A., "Novel Hybrid Nanocomposite Containing Natural Clay (Montmorillonite) and Indigo Blue Vat Dye for Textile Materials". *BIOSCIENCE RESEARCH*, **16**(1) 573-595 (2019)

18. Ahmed, K., Shahin, A., Ragheb, A. and El-Hennawi, H., "A Facile Synthesis with One Step of Disperse Azo Dyes to Be Applied as Nano-Inks in Textile Printing". *Biointerface Research in Applied Chemistry*, **11**(4) 11713-11723 (2020)

19. Hebeish, A., Shaarawy, S., Hassabo, A.G. and El-Shafei, A., "Eco-Friendly Multifinishing of Cotton through Inclusion of Motmorillonite/Chitosan Hybrid Nanocomposite". *Der Pharma Chemica*, **8**(20) 259-271 (2016)

20. Tawiah, B., Howard, E.K. and Asinyo, B.K., "The Chemistry of Inkjet Inks for Digital Textile Printing -Review". *Indian Textile Journa*, (2019)

21. Wilkinso, J.H., "Diagnostic Enzymology". Edward Arnold Ltd London, 3-40 (1976)

22. Abd El-Thalouth, I., Ragheb, A.A., Nassar, S.H., Ibrahim, M.A. and Shahin, A.A., "Evaluation of Enzymatic Hydrolyzed Starches in Discharge, Discharge - Resist and Burn - out Printing Styles". *Indian Journal of Fibre and Textile Research*, **38**(2) 173-179 (2013)

23. Ragheb, A.A., Haggag, K., Rekaby, M., Abd El-Thalouth, I., El-Hennawi, H.M. and Shahin, A.A., "Bio-Discharge Printing on Cotton Knitted Fabrics Using Enzyme and Brewers Yeast". *Journal of Applied Sciences Research*, **9**(1) 205-225 (2013)

دراسة حديثة لطباعة أقمشة البوليستر بتقنيات مختلفة

مارينا يوسف سليمان [١]،حنان علي عثمان [١]، احمد جمعه حسبو [٢]

[١] قسم طباعة المنسوجات والصباغة والتجهيز كلية الفنون التطبيقية - جامعة بنها - بنها - مصر
[٢] المركز القومي للبحوث - شعبة بحوث الصناعات النسيجية - قسم التحضيرات والتجهيزات للألياف السليلوزية
- ٣٣ شارع البحوث (شارع التحرير سابقاً) - الدقي - ص.ب ١٢٦٢٢ - الجيزة - مصر

تحاول الدراسة التأكيد على أن طباعة منسوجات البوليستر يمكن أن تتم باستخدام الألوان الطبيعية. كانت الألوان المستخدمة هي الكركم والكانيت والراوند. كما تم تقييم كثافة اللون ونسبة تغلغل الصبغة وخصائص السرعة. على نسيج البوليستر ، تم تطبيق صبغة تفريق بحجم الجسيمات النانوية باستخدام الموجات فوق الصوتية. يتم زيادة عمق ألوان المطبوعات بشكل كبير بواسطة جزيئات الصبغة النانوية دون إضافة مواد كيميائية إضافية إلى عجينة الطباعة. يزيد استخدام جزيئات الصبغة المتناهية الصغر من ألوان المطبوعات بشكل كبير. طورت سان دييغو أسلوب المعالجة الحيوية لأقمشة البوليستر. من خلال الجمع بين مراحل المعالجة المسبقة بالإنزيم ونفث الحبر في محلول واحد ، حقق الباحثون تقليلًا للوقت والطاقة. كما حددوا زيادة كبيرة في ألوان عينات البوليستر المطبوعة رقميًا. أظهرت دراسة جديدة طريقة بسيطة لتركيب ألوان ثيازول جديدة. تستخدم الأصباغ لطباعة أقمشة البوليستر وهي قوية في اللون وساطعة اللون ومتينة للغاية. أكدت البيانات الطيفية النتائج

الكلمات المفتاحية: أقمشة بوليستر ، أصباغ طبيعية ، جزيئات صبغ نانوية ، معالجة إنزيمية ، مطبوعة رقمياً.