Wearable Wonder of Color Changing with Photochromic Technology

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***Abstract*—his study examines the technical performance of commercial photochromic pigments applied to textiles via screen printing. The results show limited photostability of the pigments, but incorporation of ultraviolet absorbers. The preparation technology of photochromic screen printing on the fabric. Which applying a special "photochromic pigment" to the substrate using a screen-printing technique, where the pigment change color when exposed to the ultraviolet (UV) light. They can also change from one color to a different color by combination with a permanent pigment. Essentially the design creating that appears or changes color depending on the light condition, it is achieved by using a light sensitive emulsion on the screen to create the desired stencil design for the pigment transfer. This research contributes to the growing interest in chromic textiles for creative design, functional, and smart applications, and provides a foundation for further investigation into photochromic pigments on textiles.**

***Index Terms*—Ultraviolet absorbers, Reversible color change, UV light-sensitive, Color-changing effect.**

I.INTRODUCTION

The incorporation of intelligent materials into textiles is transforming the fashion and apparel sector, resulting in clothing that is both fashionable and interactive. A notable advancement in this area is the application of photochromic technology, which allows fabrics to alter their color in response to ultraviolet (UV) light exposure. The use of photochromic inks applied via screen printing on single jersey knitted T-shirts represents a fascinating field of study. Single jersey fabric, celebrated for its softness, elasticity, and lightweight characteristics, is commonly utilized in casual apparel, rendering it an excellent medium for innovative fashion experiments. The screen-printing technique provides meticulous control over the positioning of designs and the depth of ink application, enabling the creation of striking, bold, and reproducible patterns that react dynamically to sunlight.

II.METHODOLOGY

2.1 SELECTION OF DESIGN

Chosen the proper design based on the adventure theme. The complex or elaborate designs with many gradients and small elements are used. The design is best done using vector-based designs developed in CorelDRAW software.

Figure 01 (Adventure theme design)

2.2 DESIGN CREATION

After designed the design for printing in mesh sheet, then have to transfer the designed pattern to the mesh sheet. The mesh count 120 to 140 is used for the preparing the designed mesh sheet.

2.3 PREPARATION OF SCREEN

The selected screen frame type is metal. Thus, the physical dimensions of the frame which can range from the small (for the smaller design) to larger (for the larger design). The used metal screen size is 20” x 20”. After that wash the screen with a degreaser to remove the dirt and oil in the screen and then rinse it

Figure 02 (Screen)

2.4 EXPOSE EMULSION

Apply thin even layer light-sensitive emulsion using the scoop coater. Coat both sides (inside and outside) of the screen. Dry the coated screen and place the screen in dark, dust free environment. Use the drying rack or fan to speed up the drying process. Wash out the unexposed emulsion with the water to reveal the design. Let the screen dry completely. Final inspects the screen for the imperfections of design or pinholes in the screen.

2.5 PREPARATION OF PRINT

Prepare the surface area for the screen-printing process. First get every product we need for the screen printing like fabric (t-shirt), dye pigment (photochromic dye pigment), manual screen-printing machine, squeegees. It is essential to ensure that the screen is adequately prepared, the substrate is primed, the inks are properly mixed, and all equipment is correctly set up.

Figure 03 (Process of preparing the print)

2.6 SELECTION OF FABRIC

The selected fabric for screen printing is single jersey knitted. Single jersey Knitted fabrics, I used the t-shirts fabric, have a stretchy nature. This can make them more prone to distortion during the printing process, so it’s essential to properly secure them on the printing press.

Figure 04 (Single jersey knitted fabric)

2.7 APPLY THE DESIGN

Prepare the fabric- prewash the fabric to remove the dirt and oil. The fabric is stretched on the flat surface evenly on the printing area of machine. The dye pigment (photochromic dye pigment) is applied on the fabric (t-shirt) using the squeegees is used to push the ink pigment through mesh on the fabric and which used to apply the ink pigment evenly on the fabric surface. Depending on the design and ink opacity, multiple squeegee passes may be necessary to achieve a solid and uniform print. After the application of the pigment in fabric (t-shirt) check whether the design is applied perfectly or there any smudges on the fabric.

Figure 05 (Fit the screen in machine)

Figure 06 (Apply the pigment in the screen)

Figure 07 (Spread the pigment through the screen using the squeegee)

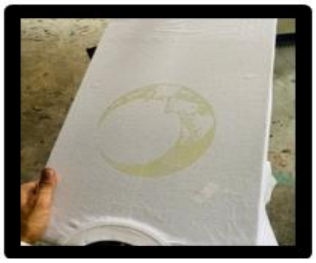

Figure 08 (The pigment is transferred through the screen in fabric)

2.8 DRYING

The drying process is crucial to prevent the ink from smudging or blending with subsequent layers when additional colors or layers are applied. After completing the printing, it is essential to dry the printed ink layer before adding more layers. This is typically achieved with a flash dryer, which applies intense heat for a brief period to dry the ink's surface.

Figure 09 (Drying)

2.9 QUALITY CONTROL CHECK

Check the screen preparation is proper, any bleeding, smudging after the process of drying the printed fabric. The coverage of ink, inspect on the print after the printing design- misalignment, pinholes or smudging, etc. Finally check the any defects on the fabric and print to get the final product.

2.10 SAMPLE EVALUATION

2.10.1 WASHING TEST

A washing test is an essential method for assessing the durability and functionality of printed fabrics, with a particular emphasis on the resilience of designs, including photochromic pigment prints, against the challenges posed by regular washing. Conducting this test is vital as it offers significant information regarding the longevity of a print, whether it is a conventional design, to evaluate the durability of printed designs after multiple wash cycles.

2.10.2 PROCEDURE FOR CONDUCTING THE WASHING TEST

2.10.2.1. PURPOSE: The textile washing test is performed to assess the appearance, color change, durability of print.

2.10.2.2. MATERIALS AND EQUIPMENT: Sample (printed white t-shirt), Standard detergent, Air Drying Rack, Washing machine, grey scale.

2.10.2.3 SAMPLE PREPARATION: Take the Single jersey knitted fabric (t-shirt) garments that will be used for the test. The garments, use parts of the fabric that have been printed.

2.10.2.4 WASHING MACHINE SETUP

The Washing Machine used is Front loaded washing machine used with 2kg make weights. And wash cycle is 30-45 minutes. The water temperature Cold water (20°C to 30°C), Warm water (30°C to 40°C). The detergent and 77 parts ece non phosphate, 20 parts sodium perborate, 3 parts of taed are used.

2.10.2.5 WASHING PROCESS

First Load the fabric samples into the washing machine. Start the wash cycle with the length of time 30-45 minutes. After the wash cycle complete, rinse the fabric thoroughly. After that spin dry the fabric with moderate speed.

2.10 PRODUCT DEVELOPMENT

The process of creating a photochromic pigment (color-B2 blue) print through screen printing in single jersey knitted fabric, entails the development of a product capable of altering its color in response to ultraviolet (UV) light exposure. Employing the screen-printing techniques to apply photochromic pigments enables the transfer of complex designs or patterns onto various surfaces, including textiles, plastics, and other materials.

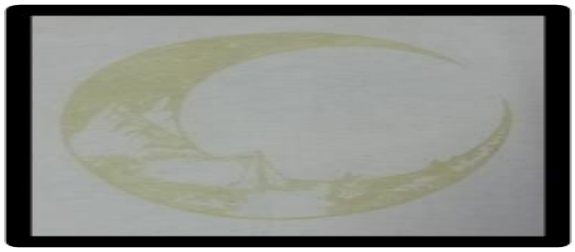

Figure 10 Before sunlight (yellowish color)

Figure 11 After sunlight (B2- blue color)

III. RESULT AND DISCUSSION

WASHING TEST RESULT TEST METHOD: ISO
RESULT: PASS

S.NO.	PARTICULARS	RESULT OBSERVED	CLIENT REQUIREMENT	RESULT
1.	Significant change	No significant change	No significant change	satisfactory
2.	Visual appearance	satisfactory	good	Satisfactory
3.	Color change	Slightly color change was observed on base and print grade:4	Grade 3-4or better	Satisfactory
4.	Print	Slightly removal of print was observed grade:4	Grade 3-4 or better	Satisfactory
5.	Cross staining	No cross staining was observed grade:4-5	Grade 4-5 or better	Satisfactory
6.	Spirality	NA	5.0%	NA
7.	Staining on cotton/ multi fibre	Staining: Acetate: 4-5 Cotton:4-5 Nylon: 4-5 Polyester: 4-5 Acrylic: 4-5 Wool: 4-5	Multi fibre staining Grade 3-4 or better	Satisfactory
8.	Surface fuzziness/pilling	Slight surface fuzziness was observed grade:4	Grade 4 or better	Satisfactory

IV. SUMMARY AND CONCLUSION

A T-shirt featuring a photochromic pigment print created through screen printing utilizes a specialized ink that alters its color upon exposure to ultraviolet (UV) light. The screen-printing technique involves the creation of a stencil to facilitate the transfer of the pigment onto the fabric. When subjected to UV light, the photochromic pigment undergoes a reaction that results in a color change, particularly when the garment is worn outdoors or in sunlight. This method introduces an engaging and dynamic element to the clothing, enhancing its visual appeal and enjoyment.

V. ANNEXURE

BEFORE SUNLIGHT

AFTER SUNLIGHT

BIBLIOGRAPHY

[1] Abdelrahman, M. S., & Khattab, T. A. (2024). Recent advances in photoresponsive printing inks for security encoding applications. *Luminescence*, *39*(6), e4800.

[2] Aldib, M. and Christie, R.M., "Textile Applications of Photochromic Dyes. Part 4: Application of Commercial Photochromic Dyes as Disperse Dyes to Polyester by Exhaust Dyeing". Coloration Technology, 127(5) 282-287 (2011)

[3] Biegeleisen, J. I. (1963). *The complete book of silk screen printing production* (Vol. 1100). Courier Corporation.

[4] Chowdhury, M., Joshi, M. and Butola, B., "Photochromic and Thermochromic Colorants in Textile Applications". Journal of Engineered Fibers and Fabrics, 9 107-123 (2014)

[5] Cheng, T., Lin, T., Brady, R., & Wang, X. (2008). Photochromic fabrics with improved durability and photochromic performance. *Fibers and Polymers*, *9*, 521-526.

[6] Clark, R. H. (1985). Screen Printing. In *Handbook of Printed Circuit Manufacturing* (pp. 216-244). Dordrecht: Springer Netherlands.

[7] Dürr, H., & Bouas-Laurent, H. (Eds.). (2003). *Photochromism: molecules and systems*. Elsevier.

[8] Durr H, Bouas-Laurent H, editors. *Photochromism: Molecules and Systems*. Amsterdam, Netherlands: Elsevier BV.; 2003.

[9] Eds J.C. Crano and R.J. Guglielmetti, Organic Photochromic and thermochromic compounds, Volume 1, Main photochromic families, Kluwer academic press. New Yark, N.Y.1999

[10] Fan, J., Bao, B., Wang, Z., Li, H., Wang, Y., Chen, Y., ... & Yu, D. (2021). Flexible, switchable and wearable image storage device based on light responsive textiles. *Chemical Engineering Journal*, *404*, 126488.

[11] Gupta, V. K. (2021). Photochromic dyes for smart textiles. In Dyes and pigments-novel applications and waste treatment. IntechOpen.

[12] 12.Jago, D., Gaschk, E. E., & Koutsantonis, G. A. (2023). History and fundamentals of molecular photochromism. Australian Journal of Chemistry.

[13] Lee E.M., Gwon S.Y., Ji B.C.,Wany S. and Kim S.H., Dyes Pigments 92(2012)542

[14] Little, A.F. and Christie, R.M., "Textile Applications of Photochromic Dyes. Part 1: Establishment of a Methodology for Evaluation of Photochromic Textiles Using Traditional Colour Measurement Instrumentation". Coloration Technology, 126(3) 157-163 (2010).