Research Article

USE OF CHROMIC DYES IN TEXTILE DESIGN AND A SAMPLE DESIGN WITH CHROMIC DYES

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ABSTRACT

In today's global markets with quite hard competitive conditions, countries should serve different highly competitive products and designs to the markets. Textile industry has adapted itself to ever changing consumptive behaviors of the consumers and has expanded its product range including various high value-added innovative products and smart textiles. Chromic textiles are among these innovative designs. In this study, initially information was provided about chromic dyes placed in smart textiles and potential use of chromic dyes in textile industry and sample designs were presented for the use of chromic dyes over the textile surfaces with screen printing method. It was proved in this study that screen printing could conveniently be used in smart textile design and chromic and classical dyes could together be used in the same design. It was finally concluded that this and similar designs may improve the competitive power of the textile industry in global markets.

Keywords: Chromic dye, Photochromic, Thermochromic, Textile design, Chromism

INTRODUCTION

History of textile materials is as old as history of humanity and the oldest extant textile surface remnant belongs to B.C. 6000s (Tez, 2009: 21). Relevant surveys revealed that these textile surface remnants belonged to Anatolian geography and had waving surface characteristics (Uğurlu and Uğurlu, 2006). Textile production process starts with the production of yarn and surfaces from cotton, wool, linen and silk-like natural fibers or starts with the direct use of animal skins as textile surfaces and goes on with the use of weaving, knitting, felting-like surface formation methods. Coloring of textile surfaces have also advanced through the history of textile surfaces. Historical surveys revealed that natural dyes were used to color textile surfaces in Mesopotamia and Indian regions in B.C. 4000s (Karadağ, 2007: 8).

While natural dye sources were used in textile coloring until the years 1800s, with the invention of synthetic pigments by Perkin in 1856, synthetic pigments have started to be used in textile colorings since then (Cristea and Vilarem, 2006: 238). Together with great progress in industry and technology, quite different products have started to be produced in textile industry. Invention of synthetic fibers, progress in nanotechnology and inventions in the science of chemistry all allowed the manufacturers to produce quite functional textile products. Technical textiles are the primary innovative products brought by advanced technologies in textile industry. Technical textiles are defined as the textile products and materials produced primarily for performance and technological characteristics instead of esthetic and decorative characteristics (Horrocks and Anands, 2003: 1-2). Such technical textiles include agricultural textiles, construction textiles, health textiles, smart textiles and several other product groups (Wulfhorst, Gries and Veit 2006: 265-266). Among the technical textiles, smart textiles are defined as the textile materials and manufactures able to sense through an active control mechanism in case of environmental stimulants and react accordingly (Dadi and Sweden 2010). History of smart textiles goes back to 1850s, but great progress have been achieved since years 1990s through the progress in electronics and chemistry. With this progress in different industries, pliable and washable electric circuits, conductive fibers and yarns, conductive paints, metachromatic textiles with changing colors based on various activators were able to be produced (Bilir, 2016: 28-29).

In this study, background information was provided about chromic dyes placed in smart textiles and potential use of chromic dyes in textile industry and sample designs were presented for the use of chromic dyes over the textile surfaces with screen printing method.

CHROMIC DYES

Photochemistry researches of the years 1900s mostly focused on photochromism and photochromic behaviors of organic/inorganic materials (Periyasamy et al, 2017: 53; Khudyakov et al, 1992: 25). Progress of chromic materials started with photochromism advanced in years. Chromic materials are defined as the dyes or pigments able to change their color when they were exposed to certain external stimulants (Ghosh et al, 2018: 723). Color change in chromic dyes is bilateral and realized based on the status of molecules (Frumkin and

Weiss, 2012: 65). Color change in chromic materials is generally provided by external stimulants like light, heat, electric and etc. and the materials get their previous color when the external stimulant disappeared (Christie, 2015: 304). Chromatic materials are included in smart materials and classified based on the external stimulants (Table 1).

Table 1. External Stimulant-Based Classification of Chromism (Christie, 2015: 304)

Type of Chromism	External Stimulant
Ionachromism	Ions
Thermochromism	Heat
Photochromism	Light
Electrochromism	Electric
Solventchromism	Solvent
Hydrochromism	Humidity, water
Mekanochromism	Deformation
Chronochromism	Time
Radiochromism	Radiation
Magneticchromism	Magnetic field
Biochromism	Biological sources

Among the chromic dyes, photochromic, thermochromic and ionochromic dyes are the most common ones used in textile industry.

Photochromic Dyes

Photochromism of photochromic dyes was defined for the first time by Von Grothus and Draper in the years 1800s. According to Grothus and Draper, when the molecule absorbed the light, the light then generates photochemical changes in the relevant molecule (Periyasamy et al, 2017: 54). Photochromic dyes turn into color forms from colorless forms with the aid of UV light and they turn back to colorless forms when the UV light exposure was ended. Photochromism is divided into two processes as of positive and negative photochromism. Coloring of the colorless material with UV light is defined as positive photochromism and tuning colored material into a colorless material again with UV light is defined as negative photochromism (Akovalı, 2012: 341). Spirooxazine is the most significant photochromic dye group. Colorless and non-planar molecule structures of these colorants open up under UV light and the color turns into a blue-toned color. When the UV light is removed, the circle close back and the molecule turns into previous colorless status (Bilir, 2016: 65) (Image 1.)

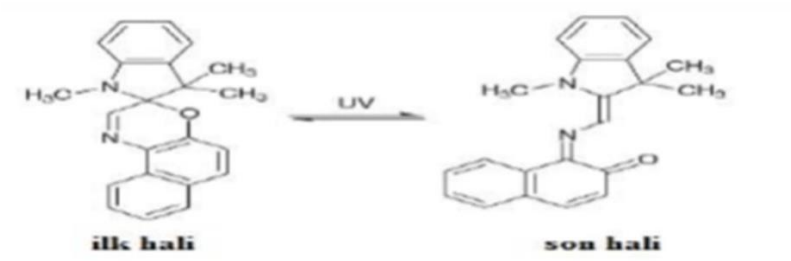

Image 1. Changing Chemical Structure Of Spirooxazine Dye With UV Light (Christie, 2001: 188)

Thermochromic Dyes

Thermochromic dyes are able to change their color based on the temperature (Christie, 2008: 149). The thermochromic dyes used in textiles are classified into liquid crystal and leuco dyes. Leuco dyes switch to a single specified color, but liquid crystal dyes switch to any colors of a color palette (Bilir, 2016: 66-67; Christie, 2008: 149). Thermochromic dye and pigments are generally used in thermometer strips and medical thermography applications (Christie, 2015: 305).

Ionochromic Dyes

Ionochromic dyes undergo a color change based on external stimulant ions from colored to colorless or between the colors. Halochromic dyes are the most common ionochromic dyes. They are sensitive top H changes and undergo a color change based on the changes in H^+ ion concentration (Narayanaswamy and Wolfbeis, 2004; Christie, 2015:304-305). In Image 2, molecular conversion indicating conversion of protonation methyl orange color into red color with the aid an acidic indicator.

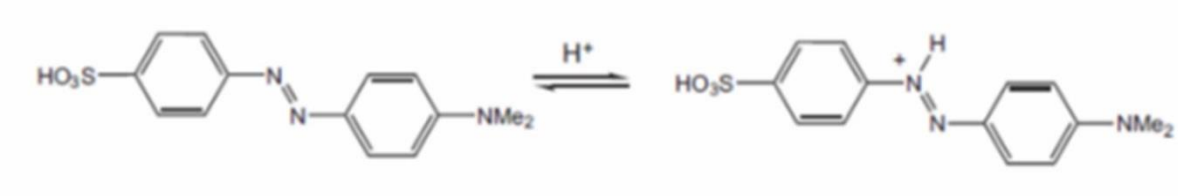

Image 2. Ionochromism Process Indicating Conversion Of Orange Color Into Red Color (Christie, 2015: 304)

CHROMIC TEXTILES

Chromic textiles are generally generated with photochromic and thermochromic dyes. Chromic applications are come across in every stage of textile production from the yarn to final product clothes.

Chromic Yarns

Synthetic yarn production methods are more frequent in chromic textile for adding chromism to textile yarns. As a general method of production, synthetic polymer is mixed with chromic dye before extrusion and then the

yarn become chromic after extrusion. Photochromic and thermochromic products are more frequently produced from chromic yarns (Image 3).

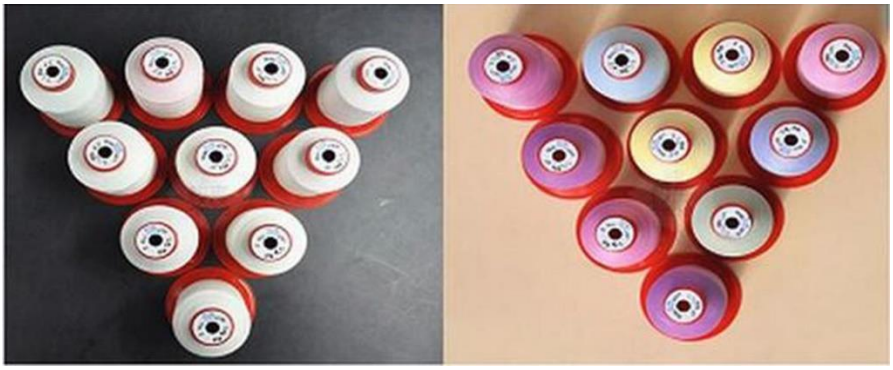

Image 3. Color Changes In Photochromic Yarn Bobbin Before And After Sun Light (Smarol, 2018)

Chromic Fabrics

There are two production methods to have chromic characteristics on fabric and weaving surfaces. One of these methods is to weave with chromic yarns and the other one is to create chromic surfaces over the woven fabrics or weavings. The fabric woven with Permalight yarns by Anne Mieke Kooper does not have any differences in color under normal light, but they are shining under artificial light (Image 4) (İşmal and Yüksel, 2016: 95; Esiroğlu, 2006: 1).

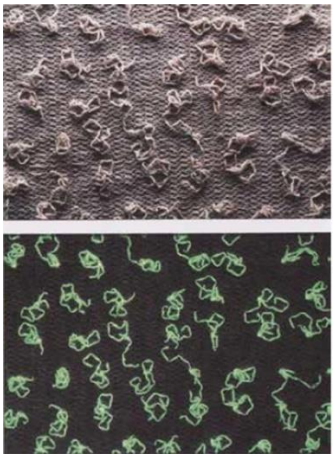

Image 4. Chromic Fabric Design Of Anne Mieke Kooper (Upper: Before Light, Lower: After Light) (İşmal and Yüksel, 2016: 95; Esiroğlu, 2006: 1)

Chromic Dying

Dying surface with chromic dyes is a method used to have chromic characteristics over textile surfaces. Such a production process is not much different from conventional dying processes, but they are incomparably different in affections they left. Amy Konstanze Mercedes designed textiles with thermochromic and hydrochromic dyes and used chromic dyes over textile surfaces (Image 5, İşmal and Yüksel, 2016: 96)

Image 5. Chromic Dye Textile Designs Of Amy Konstanze Mercedes (İşmal and Yüksel, 2016: 96)

CHROMIC DYE PRINTING DESIGNS

Screen printing (serigraphy) technique was used for chromic dye textile design. The term 'Serigraphy' comes from the Latin word "seli" which means silk and the Greek word "grophos" which means writing-drawing and history of the technique goes back to quite old ages (Togay et al, 2005: 199). Screen printing is a printing technique whereby a mesh is used to transfer dye onto a substrate, except in areas made impermeable to the dye by a blocking stencil. A blade or squeegee is moved across the screen to fill the open mesh apertures with the dye (Akgül, 2012: 1; Sözen, 2011: 1-2). In chromic textile design, initially the pattern to be applied over the textile surface should be designed with a software. For this purpose, the vectorial drawing software Adobe Illustrator CC was used. Within Illustrator software, 21 cm x 29 cm "birds and flowers" stencil was drawn with three different colors (Image 6).

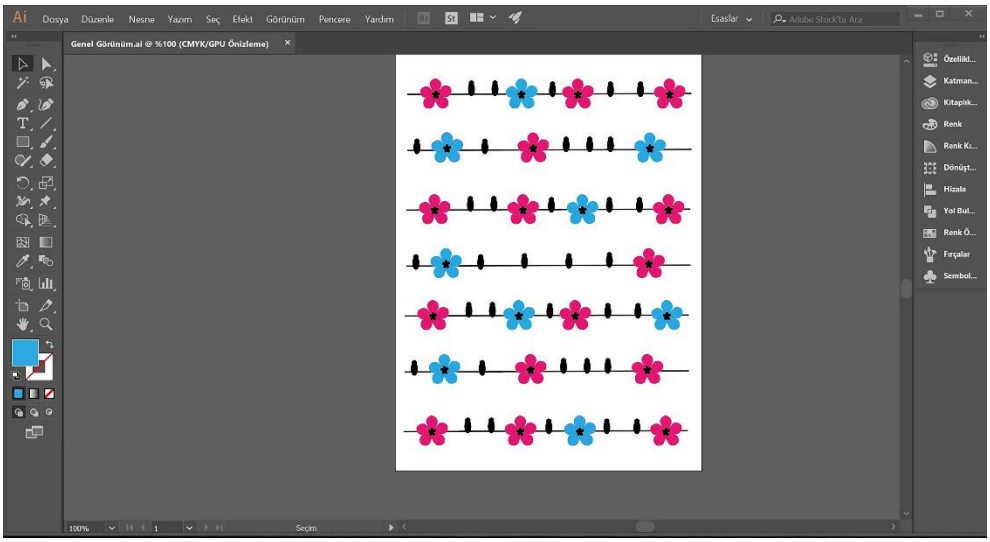

Image 6. Design Made In Adobe Illustrator CC Software

In the next stage after drawing the pattern with Adobe Illustrator CC software, this pattern should be made ready to be transferred to textile surface with the aid of screen printing technique. Since a separate stencil is needed for each color in screen printing technique and there are three colors in this design, three stencils were prepared through following the stages below.

Image 7. Preparation Stages Of Different Pattern Stencils

At the end of stencil formation stages (Image 7), the stencils to be used in passing the dye into the textile surface were obtained (Image 8).

Image 8. Serigraphy Stencils For The Pattern

Printing is the next stage after preparation of stencils. For this purpose, initially printing paste should be prepared. Photochromic red, photochromic blue and black normal pigment dyes were used to prepare printing paste. Printing pastes were made at 1/5 dye/paste ratio for photochromic pastes and at 1/20 dye/paste ratio for normal pigment dyes. Following the preparation of printing pastes, these pastes were printed through the stencils with a serigraphy ragle device over the 100% cotton tricot t-shirt. Printing fixation process was performed at 150 ℃ for 3 minutes. Final product was achieved after printing and fixation processes for three different colors. Final product was able to change color with sun light (Image 9).

Image 9. 'Birds And Flowers' Chromic Textile Design (Left: Without Sunlight, Right: With Sunlight)

CONCLUSION

In today's world with ever-increasing competition, decreasing distances and intervening societies, the way to get greater shares from the global cake is to have different innovative designs able to compete with world brands. Designs generate brands and seriously increase profitability ratios of the products. In textile industry, it is quite hard to compete in global markets with present conventional products. Therefore, producers should have high value-added designs. Chromic textiles with special, distinctive and alluring designs are esoteric to kids and youth which constitute large portion of consumer profile. Especially the photochromic and thermochromic products in hold unlimited design opportunities. In present design, a story was portrayed over the textile surface with photochromic dyes and normal pigment dyes. The flowers disappeared and there were birds on wires in the absence of sun light. But, flowers were blooming by the birds under day light. It was proved in this study that screen printing could conveniently be used in smart textile design and chromic and classical dyes could together be used in the same design. It was finally concluded that this and similar designs may improve the competitive power of the textile industry in global markets.

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