

Smart clothes using hydrochromic printing pastes with the interactive ability for swimming clothes

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Abstract:

Changing in colour of the fabric is a new kind of smart textiles that current distinctive properties relative to pigment paste. When the printed material subjected to a specific stimulus, these materials display reversible colour changes, giving these materials dynamic and interactive properties. Recently, different of chromic materials presents in textiles filed. The objective of this work is to study smart clothes using one of the interactive printing pastes that can be applied in printing on swimming wear to add a esthetic and functional form, namely hydrochromic printing paste, it is characterized by changing its color when exposed to water or moisture. These pastes were applied to polyester material, and it was chosen because of its widely used in swimwear fabrics. The experimental work conducted demonstrates the effect of fastness properties such as washing and friction, and a comparison was made between hydrochromic paste and pigment paste, and the hydrochromic paste gave good results.

Keywords:

Smart textiles,
hydrochromic pastes,
pigment pastes,
swimming wear

Paper received June 15, 2023, Accepted August 11, 2023, Published on line September 1, 2023

Introduction:

Recently, a modern term appeared in the field of textiles, that is smart textiles which are considered to be the next generation of fibers, and fabrics¹. These textiles are distinguished from traditional textiles in that they have an interactive and functional role that adapt and respond to that external environment.² This kind of textiles are being developed rapidly which create new functions and application for textiles. One of the most important materials used for smart textiles is chromic materials.³ The future of smart textiles will strongly count on inventions that add new objects and functions to the old and obsolete idea.⁴

Research problem:

- 1- Taking advantage of modern smart materials such as hydrochromic pastes and applying it to swimwear which stimuli to water.
- 2- Studying the fastness properties of washing and friction of these pastes compared pigment pastes.

Research objective:

- 1- Printing smart swimsuits with hydrochromic pastes, in which have the ability to change color when exposed to water or humidity
- 2- Finding out the extent to which these pastes are affected by friction and washing.

Importance of research:

- 1- Print smart swimming suits changes its color when exposed to water
- 2- Compare between pigment and hydrochromic pastes in fastness of washing and rubbing

Research methodology:

The research follows the Analytical experimental methodology

Framework: The purpose of using hydrochromic paste is to make printing on the swimming suits stimuli to water.

Hydrochromic paste was used in printing on polyester fabrics to be applied to swimwear, as these pastes have an interactive function. It was first applied with pigment paste, and then printed on it with the same design with hydrochromic paste, which makes the design disappear, but when the fabric is exposed to water or moisture, the design appears again and returns. In disappearance when dry and so on

Classification of textiles

- 1- Conventional textiles: they are used in our daily life and without having any special characteristics. Mostly used to cover and protect our body from the surrounding environment.⁵
- 2- Technical textile and Functional textile : the term functional textiles mean the textile materials that express some functions for a special purpose and have comfort and a great look, they applied in different industries such as agriculture, civil engineering and construction, footwear and garments geotextiles, home textiles, manufacturing sectors, healthcare and medical, automobiles, environmental protection, packaging, personal protection, and sports, The functions of these textiles can be developed by either mixing fibers and polymers or adding some applications of surface as finishing agents and making treatments to surface. These modifications add a new function as barriers, protection, comfort, medical, sensors, and actuation.⁶
- 3- Smart textiles: they characterized by high performance and quality with special functions, and they are becoming increasingly outstanding.⁷ For the latest five years, a

prospect of increasing using of smart textiles to 30.4% is expected ⁸. These increases

confirm the importance of these textiles ⁹

Types of Smart Textiles:

Kind	Manner	Ex.
Passive smart textiles	These textiles work as sensors, by sensing the environment	Conductive material
Active smart textiles	These textiles not only sensors but also have a functional manner	Chromic materials
Very or ultra smart textiles	they adjust their behavior according to the surrounding environment	Monitoring apparel

Chromic materials or “chameleon” materials, are branch of active smart textiles; chromic derivatives have the ability to change the visual properties of colours and reflect various colors due to the stimulation of external factors ¹⁰. their changes of colours occur according to the place conditions or induced stimuli ¹¹. The probability of using chromic materials applications in the textile fields as garment and design pieces and also in aforementioned fields, such as protection medical textiles and workwear/kids wear. ¹²

Chromic materials have the unique capacity for changing colours in response to outer stimuli ¹³

Examples of chromic materials in textiles field:

Phenomena	External effect
Photochromic	Light
Thermochromic	Heat
Halochromic	pH
Electrochromic	Electricity
Hydrochromic	Humidity
Chronochromic	Time
Piezochromic	Pressure
Solventochromic	Solvent polarity
Vapochromic	steam
Chemochromic	Chemical reaction
Ionochromic	Ions
Radiochromic	Ionizing radiation

Chromic dyes can discover their surroundings and adapt their behavior appropriately as consists of chromogenic materials that can change the color according to changes in environmental factors, as well as artificially created stimuli.

Chromism is a reversible color convey due to different environmental elements such as pH, temperature, sun, light, touch, humidity, or water, which led to changes in the colours of the prints due to changes in its molecular structure ¹⁴, but when not exposed to external effects, it is not showing any changes. ¹⁵

Chromophore compounds enable smart dyes to obtain a new function for the textiles, as they alert the users of the changing in outer environment, like changes in humidity, light, pH, and temperature etc., also smart dyes can change their colour, due to any alteration in the surrounding environment. This

study is focused on hydrochromic pigments: their functioning and application on synthetic fibers. ¹⁶

The word "chromo" means the color of something and relates to the Greek language. Dyes should have a chromogen transmitted by chemical reaction to a coloured compound due to containing a chromophore, A chromophore is the part of a molecule that absorb some wavelengths of visible light while immersing wavelengths that are not absorbed. ¹⁵

The most common in the smart textile filed is Hydrochromic materials (hydro-chromic and aqua-chromic). They are materials which change color properties with the moisture presence ¹⁷. They are called “solvatochromic,” as they changes their colour characterizes because of their sensitive properties to a certain liquid, and due to its polarity. Hydrochromatic agents can be reversible or irreversible. The reversible ones are more popular, and they normally change their color from white to transparent (when wet) and return to white when they get dry again. The surface on which the printing paste of hydrochromic is applied must be flat when can be covered by the ink. ¹⁰

The printed surface should uniform to not impact the translucence of the wetted area because the non-uniform can get clogged by the paste in a part that obstacle absorption of water. ¹⁸

Many materials can be used such as soft sheet vinyl, paper, textiles, and styrene sheet, among others. They can be applied by screen printing or spray coating, followed by hot air ¹⁹. In the textile industry, studies using hydrochromic materials were printed onto many fabrics like polyester, cotton, polyamide and blended; elastane and polyester ²⁰⁻²¹. The ink or the printing paste of hydrochromic assets, when printed and dried completely, turns to opaque print such that it will preferably seek a previously printed design. However, when a liquid such as water or humidity contact with the coated design it becomes transparent allowing the implicit design to be seen.

In this context, hydrochromic printing paste was applied to the polyester fabric which used in traditional swimsuit manufacturing²² because of its wet- related properties to demonstrate the recent advances regarding smart fabric textiles.

Experimental:

Materials:

Materials In the present work 100% polyester knitted fabric (white color)

The hydrochromic and pigment (water based) printing paste utilized were obtained from SPI Company

Methods:

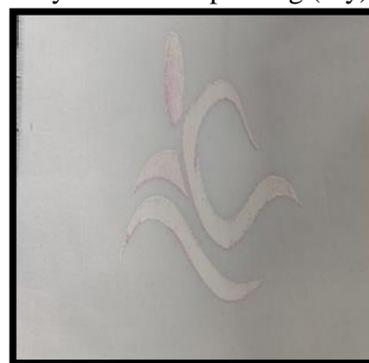
The hydrochromic materials were applied on the fabric by using the technique of the silk screen printing. The polyester screen frame used in the printing process (25 cm×25 cm) was manufactured with a 45 mesh (holes / cm) fixed on a square wood frame. First, the polyester fabric to be printed is put under the printing screen and pigment printing paste (water base) is applied by using a squeegee (a wooden applicator with a rubber edge), and then dried at room temperature. Secondly, the previously printed design was printed again with the same silk screen using hydrochromic paste.

After the samples were printed they are placed in the lab oven at approximately 100°C for 2 minutes. The printed fabrics were rinsed in cold water and air dried.

Original design pigment paste



Hydrochromic printing (dry)



Hydrochromic printing (Wet)



Tests and Measurements

2 -Fastness properties:

The fastness properties of colour for washing and rubbing fastness were done according to standard procedure:

2.1. Color fastness of rubbing: was done according to test method 8-2015 for dry and wet.

2.2. Color fastness to washing: was done according to test method 61-2020.

Results and Discussion

The results obtained are visualized in the next table.

Table (1): fastness properties of washing and rubbing for both hydrochromic and pigment printing pastes

Sample	rubbing		Washing
	dry	wet	
Pigment paste	3	3	4
Hydrochromic paste	5	4	5

Rubbing fastness

It is noticeable from the previous table that the hydrochromic paste have good for rubbing results (4 to wet and 5 to dry,) as hydrochromic paste still remained in the polyester, And these may relate to interact between the fiber surface and the hydrochromic paste, with the consideration of both the morphologic and chemical properties.

Washing fastness

The samples presented excellent washing fastness, showing no significant color variation.

Conclusion:

By comparing the results of hydrochromic ink and pigment paste, it is found that the application of hydrochromic ink on polyester fabric by screen printing method has good washing and rubbing fastness. The color of prints changes with water, and after drying turns back again to its original color, the results of washing and rubbing fastness

were good. The results pointed to that the hydrochromic paste gives good adherence to the polyester surface and keeps its function after washing and rubbing. In this context, the Polyester fabric can become a smart textile material when printed by hydrochromic printing paste that reacts to a specific stimulus as subjected to water and humidity, which increases its ability to apply it for swimming wear.

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