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Light-Sensitive Colorants & its Utilization in Smart Chameleonic Textiles

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Abstract

Most of the chromic textile applications today are in the fields of fashion and design, as well as in apparel for leisure and sports. In work wear and the furnishing sector a variety of studies and investigations are in the process by industrial companies, universities, and research centers. Most photo chromic materials are based on organic materials or silver particles. For industrial applications, these compositions have a rather short lifetime. In addition, some materials that are currently available are toxic and easily extracted from most plastics and therefore not approved for use in articles that come into contact with food products. The present article discusses the concept of Chromism & photochromism, Photochromic Materials, Application & Limitation Photochromic Materials in Textiles.

Keywords: Photo chromic; Textile Materials; Application & Limitation

Introduction

Smart fabrics are defined as fabrics that can smell and reply to environmental conditions or stimulants from mechanical, thermal, chemical, electrical, or glamorous sources. According to functional exertion, smart fabrics can be classified into three orders.

a) Passive Smart fabrics: The first generations of smart fabrics, which can only smell the environmental conditions or encouragement, are called Passive Smart fabrics.

b) Active Smart fabrics: The alternate generation has both selectors and detectors. The selectors act upon the detected signal either directly or from a central control unit. Ex: chameleonic.

c) Ultra Smart Textiles: These smart fabrics are the third generation of smart fabrics, which can smell, reply, and borrow themselves to environmental conditions or stimulants. Traditionally, industry has been concerned not only with color trace and intensity but also with maintaining the color regardless of environmental influences. Yet there are infinite incitive and important requests, which bear accessories, which alter their color on demand. Chameleon filaments will allow for the creation of value-added products in traditional application needs, as well as entry into entirely new areas. It is the objective of this article to provide the textile and fiber industry with new "smart" materials that can quickly change their colour hue, depth of shade, or optical transparency.

Chromism

Chromism is a chemical process that causes a change in the colour of compounds that is typically reversible. Chromic phenomena are those phenomena in which color is produced when light interacts with materials in a variety of ways. Chromism as a suffix means reversible change of colour and by extension, a reversible change of other physical properties. Due to colour changing properties, chromic materials also are called chameleon materials. This colour changing phenomenon is caused by the external stimulus and chromic materials can be classified depending on the external stimulus of induction.

The phenomenon of a change in the colour of a chemical substance is termed by the external stimulus that causes the reaction, either physically or chemically. Many, but not all of these reactions are reversible. The classification are : Photochromism (Light), Thermochromism (heat), Electrochromism (electrical current), Solavtochromism (solvent polarity), Ionochromism (ion induced), Halochromism (pH), Tribochromism (friction), Piezochromism (pressure), Mechanochromism: (mechanical actions), Hygrochromism (moisture), Chemochromism (specific

chemical agents i.e. toxic gasses, detergents etc.), Carsolchromic (electron beam), Gasochromism (Gas) ,Vapochromism (vapour of an organic compound), Cathodochromism (electron beam irradiation), Radiochromism (ionising radiation), Magnetochromism (magnetic field), Biochromism (interfacing with biological entity), Chronochromism (passage of time), Aggregachromism (dimerisation/aggregation of chromophores), Crystallochromism (changes in crystal structure of a chromophore). This article covers photochromism and its application as a smart textile product.

Photochromism

Photochromism is a phenomenon in which a substance undergoes a reversible change in its color or optical properties when exposed to light, typically ultraviolet (UV) or visible light. This means that the substance can shift between two different states, often referred to as the "colored" and "uncolored" states, depending on the presence or absence of light. In the colored state, the substance absorbs light and appears to have a specific color. When exposed to the triggering light (UV or visible light), it undergoes a chemical or structural change, causing it to transition to the uncolored state, where it no longer absorbs the light and appears colorless or transparent. Photochromic materials have various applications, including photochromic eyeglass lenses that darken in bright sunlight and lighten in low light conditions, light-sensitive toys, and even some security features in currency and documents.

Photochromic Materials

Photochromic materials change colour in response to variations in light intensity in a reversible manner. Usually, they are colourless in a dark place and when sunlight or UV-radiation is applied the molecular structure of the material changes, and it exhibits colour. The colour vanishes when the relevant light source is removed. By combining photochromic and base colours, it is possible to transition from one colour to another. For industrial or building applications, the lifetime of these compounds is relatively short. Inorganic and organic photochromic materials are the two basic types; most inorganic materials are based on silver particles. Photochromic materials are used in lenses, paints, inks and mixed to mould or cast materials for different applications. Photochromic compounds in textiles are used mainly for decorative effects in jacquard fabrics, embroideries and prints in different garments. Vivimed Revesacol, Americos Industries (India) and various china-based companies are the supplier of photochromic colourants.

Applications of Photochromic Materials in Textiles

Photochromic phenomena are presently also being used in many textile applications like T-shirts, handbags, and caps. There is, e.g., nightwear, which indoors is white while in daylight the colour changes to blue, green, purple or whatever. The California-based company Solar Active International manufactures a wide variety of photochromic products including colour changing textured yarns for textile knitting and weaving and embroidery threads stimulated by UV-light. The Swedish Interactive Institute has created a curtain consisted of a UV-sensitive color-changing polymer (Figure 1). A computer-controlled UV lamp dynamically illuminates various components of the curtain, leading to a dynamic textile design based on a computational interpretation of specific provided information. As a result, the cloth can be used as a display on a computer.

One commercial application of photochromic textiles includes the fabrics of Taiwan company Super textile Corp. These high-tech photochromic fabrics utilize a special microcapsule dye technology that changes colour upon absorbing sunlight and UV radiation. The fabrics can be combined with other coating materials and dyestuffs to help produce a colourful effect. These products are non-hazardous, and they can be used in general applications such as knapsacks, dolls and warning signs (Figure 2).

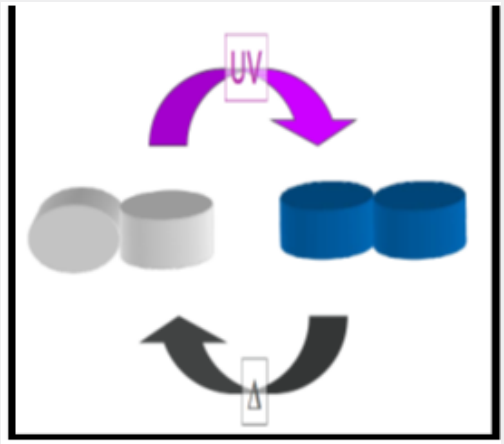

Figure 1: Colour changing behaviour of photochromic material.

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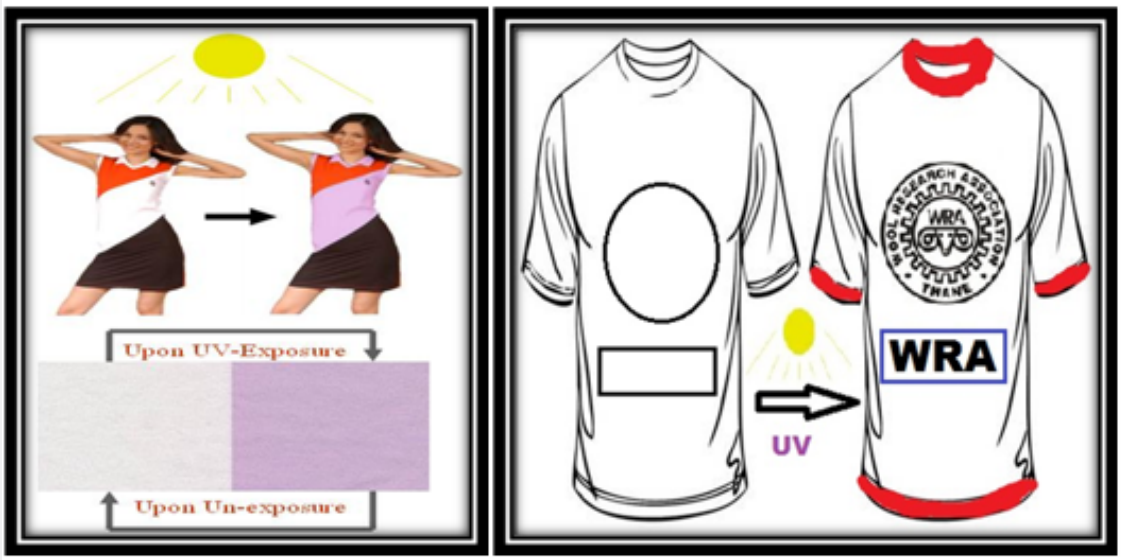

Figure 2: Smart Textile with Color changing property.

Photochromic colourants have been created for usage in textiles as well as non-textile industries. On textiles, they are mostly utilized to create unique colour effects in a variety of applications such as T-shirts, purses, and caps. For example, there is this nightwear that remains white at night but takes on colours such as purple, blue, green, and so on during the day. Camouflage patterns for military protective equipment are being developed using photochromic colourants. To resemble the surrounding environment, this design can change from one colour to another when exposed to sunlight. The Swedish Interactive Institute created a UV-light sensitive curtain utilizing photochromic colourants that are UV-sensitive [1]. A computer-controlled UV lamp dynamically illuminates various portions of the curtain, generating a dynamic textile design that is operated by an electric motor. Since these colours are non-hazardous, they can be utilized in typical applications for example knapsacks, dolls, and so on. Photochromism has also piqued the curiosity of non-textile uses such as ophthalmic like spectacles that transform into sunglasses when activated by sunlight, information recording materials, surface coating applications, dye lasers, and other applications [2].

Limitations of Photochromic Colorants on Textiles

Even though photochromatic colourants have created an extensive variety of new possibilities for creating unique effects in clothing, they haven't been a commercial success. The principal technical causes of this situation are the challenges associated with using industrial photochromic colourants via conventional textile colouring methods [3]. Such colourants are frequently delivered as a slurry of tiny pigments suspended in a liquid that is difficult to dilute with water or even with ordinary organic solvents. Because of this, applying them to fabrics using traditional exhaust or pad-dry-cure procedures is challenging [4]. Additionally, they perform poorly in terms of washability and light fastness. It is difficult to evaluate photochromatic colourants using conventional colour measurement equipment because of their dynamic color-changing characteristics. They need to be exposed to UV radiation at the same time. Their high cost is also a hindrance. Other Limitations are as follows:

a) Medium: certain polymers

b) Photostability: use of additives

c) Mixtures: activation and fatigue

d) Application method: mass coloration, screen printing

e) Reversibility

To generate cost-effective, long-lasting effects of acceptable intensities and kinetics using coloration by conventional dyeing procedures, it appears that customization of colourant molecule structure and/or coloration process design will be necessary for wider application and commercial viability.

Conclusion

Colour changing textiles are interesting, not only in fashion, where colour changing phenomena will exploit for fun all the rainbow colours, but also in useful and significant applications in workwear and in protection (Ex: few special photochromic colourants shows UV protection) and medical textiles. The creation of field-responsive fibers, chameleon fibers, is a multi-disciplinary endeavor. In addition to chromophores, polymeric materials can generate a uniform, stable field for excitation of the colour change processes. This may lead to micro devices encapsulated in fibers

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for a variety of technical applications. There are a large number of patents, especially in Japan and in the USA, in different ranges of chromic materials, but many innovations still await their commercial applications. So, future research should focus on the ecological behaviour of this functional colourants [5].

But the application of these colorants in India is restricted at R&D lab scale stage or in very small-scale application area but not in commercially successful in textile industry. It is may be due to the high cost and availability of these functional colorants as there is very few suppliers are available in India. Most of these dyes are mainly manufactured in US or China based company. So, it is very essential to give more attention for commercialization of these technologies in which huge support from industries as well as Govt. is required. It is thus expected that in future, many of these chromic textiles would dominate the fashion as well as technical textiles sector [6-9].

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