Using Luminous Fabric in Creating Fashion Designs for Women inspired by Greek's Costumes

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Abstract:

Fabric has always been one of the indispensables of human's lives. The concept of design was always there, and then the technology was involved. With the inclusion of technology to the textile world, vision of design expanded beyond dreams and now illuminated fashion products are introduced. A growing number of designers and apparel manufacturers are attempting to integrate lighting into their products.
The two domains need to be brought together, to bridge the division between aesthetics and technology because whenever technology signifies change, fashion realizes this change, and vice versa. When high-tech meets high-fashion, every design ought to incorporate practical functions and features as well as having a fine and fashionable look. The research aims to evaluate the luminous fabric comfort properties (surface roughness and air permeability) and add aesthetics to fashion designs by using luminous fabric in creating fashion designs for women inspired by Greek's costumes. According to investigations, luminous fabric has a smoother surface compared with cotton and polyester fabrics and has very high porosity. It can be assumed that it is permeable. Luminous fabric adds aesthetics to designs, which enhances the objective of technology/design.

Keywords:

Fiber Optics, Luminous Fabric, Fashion Designs, Greek's Costumes.

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1 Introduction

Clothing has yet to take full advantage from the potential of smart technology. And from the integration of science and art point of view, the essential requirement is harmonization of multidisciplinary instead of compromised collaboration. Consequently it is not only the functionality of the technology that needs to be considered, but also the aesthetics of the design. The objective of design/technology is to explore the scientific side as well as the artistic side at the same time. In this way, a new breed of smart clothing is presented. [1]

Advances in textile technology, computer engineering, and materials science are promoting a new breed of functional fabrics. Fashion designers are adding wires, circuits, and optical fibers to traditional textiles, [2] allowed them to be given their own luminescence rather than just being reflective or 'glow in the dark'. Indeed the fibers themselves do not emit light, but the way they act as a conduit for the light source built into the fabric gave it a magical look, [3] For example, Husssein Chalayan created a video dress in 2007 that was even more exciting, showing a time lapse of a rose opening and closing up, in a spectacular display of colors and light, created from 15,000 LEDs that were embedded in the fabric. [4]

1.1 Illuminative devices for fashion

The importance of using lighting in fashion the development devices that are not only highly flexible but also be woven into textiles to offer a truly integrated solution, such as: light-emitting diode (LED), fiber optics and luminous fabrics.

1.1.1 Light-emitting diode (LED)

It is a p-n junction diode made of doped semiconductors that emits light when a suitable electric current is passing from anode to cathode (forward bias), electrons recombines with holes and releases photons. We can control the emitted light color of LEDs as the wave length of emitted photons depends on electroluminescence inorganic semi-conductor materials.[5] An advantage of LED lighting that is often highlighted is the long lifetime of the devices. A typical high power LED will have a useful service life of 50,000 hours. In an LED system heat is conducted away from the LED via the mounting opposite to the direction of light emission. This is an advantage in situations where heating of illuminated objects is unwanted. [6]

LED is installed easily into clothes offering the wearer free movement. They are shock resistant, difficult to be damaged and very small in size. So, the fabrics keep their flexibility after the LED

installation and the garments will stay durable. [5]

1.1.2 Fiber optics

Fiber optics are long, thin strands of very pure glass about the diameter of a human hair. They are arranged in bundles called optical cables and used to transmit light signals over long distances. Fiber optic construction is characterized by: core, cladding and coating. [7]

Optical fibers are used in a variety of materials and at various types and sizes for different applications. It is not possible to make an optical fiber to behave like a textile fiber or yarn. Therefore, modification by chemical, mechanical and other means is important for increasing the optical fiber's structure for use as a fabric, and at the same time performs the optimum illuminating properties. [1]

1.1.3 Luminous fabrics

Luminous fabric is woven from ultra-thin optical fibers, directly interwoven with man-made fiber. The optical fibers are specially treated so that they can emit light along their entire length (laterally-emitting fibers). They are then connected to LEDs (concealed in the edging, at the perimeter of the fabric, or in rails), which "inject" light into the fabric. The glowing fabric is also available in Jacquard weave. It is water-resistant and washable (when not connected). Fiber optic fabric is as tough as standard man-made fabric. Luminous fabric can be folded in parallel to the optical fiber without any risk. Glowing fabric can be powered either by a 110/220 Volt mains adaptor for stationary applications or by batteries. [8]

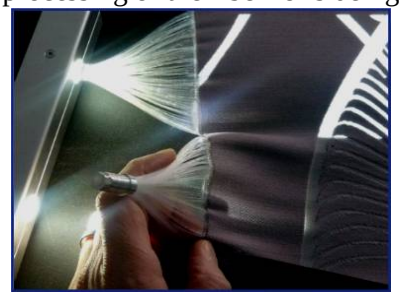
1.1.3.1 Manufacturing process

There are five steps to the manufacturing process of luminous fabrics: 1- Optical fiber weaving. 2- Surface processing of the fiber for side light emitting. 3- Optical surface processing and material assemblies. 4- Connection of fibers to light sources (LED) with lenses. 5- Electronic control and power supply, figure 1. [9]

1- Optical fiber weaving

2- Surface processing of the fiber for side light emitting

3- Optical surface processing and material assemblies



4- Connection of fibers to light sources with lenses

5- Electronic control and power supply

Figure 1 Manufacturing process of luminous fabrics

1.2 Illuminated fashion products

1.2.1 Hussein Chalayan laser dress

The laser dress was evolution based on Chalayan's Mechanical Dress and his LED dress. It used hundreds of servo motor driven tiny lasers diodes.

Figure 2 Hussein Chalayan Laser Dress

The laser diodes were integrated into the garment, illuminating Swarfvski crystals in the garment and extended to the dress visually into space. [10]

1.2.2 LED Tank Top

The LED recent tank-top was constructed with 140 LEDs, a 40-pin microcontroller, a battery, an IR receiver and several switches. The components were sewn into the handmade top with conductive thread. The top acts as a low-resolution display and has been programmed with cellular automaton and text animations. The IR receiver that is embedded in the shirt allows for wireless communication with a PDA. [4]

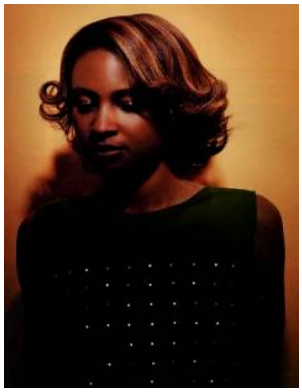


Figure 3 LED tank top

1.2.3 Elise Co – Puddle jumper

The puddle jumper coat, from 2001, is a raincoat/cape luminescent, nylon raincoat that turned the prospect of walking in the rain into an opportunity for play and performance, it was coated with PVC and had water sensors on its back and left sleeves. The sensors were wired via interior electronics to electroluminescent panels on the front of the jacket. When water hit one of the sensors, the corresponding lamp lighted up on the front panel of the raincoat and created a flickering of illumination that mirrored the rhythm of rainfall. [3]

Figure 4 Puddle Jumper

2 Materials and Methods

End emitting, fiber optics and luminous fabrics were used in this study, in addition to traditional fabrics (Satin & chiffon). Optical products are available to purchase on the internet from LumiGram Company.

2.1 Instructions for Luminous Fabric

The luminous fabric is a fabric that made out of ultra-thin optical fibers, directly woven with synthetic fibers. It is composed of 50% PL, 40% PMMA, and 10% PA6. The optical fibers are specially processed in order to allow the light to be emitted along the full length of the fibers (side emitting fibers). The optical fibers are then connected to ultra-bright LEDs (embedded in borders at the edge of the fabric). These LEDs, in conjunction with the woven fiber optics, are what inject light into the fabric making it luminous.

The light emitted by LumiGram luminous fabric is slightly visible in broad daylight, but is best viewed in dark or shadowed areas. It can be supplied directly by 110/220 Volt using a small transformer. Both rechargeable and replaceable batteries, which will light the item for roughly 8 to 12 hour. The lighting is controlled by on/off switch located on the battery box. The switch can be set directly through the fabric, without extracting the battery box from its pocket. The LEDs lifespan is more than 50000hrs. [11]

The luminous Fabric can be gently hand washed with water up to 50Â°C (120 degrees Fahrenheit) and natural soap. The batteries must be mandatory removed prior to washing. If possible, do not immerse the battery box, even if the batteries have been removed. The luminous Fabric must not be washed in washing machine, folded (pressed) or dried. Do not iron the luminous fabric. To dry and smooth the luminous fabric products, simply hang them on a clothing hanger.

The Luminous Fabric is as fast and flexible as any other synthetic fabric.

However, unlike other synthetic fabrics, you should not completely fold (like a sheet of paper) the fabric perpendicularly to the optical fibers; otherwise this may permanently damage or break the optical fibers. The Luminous Fabric can be folded parallel to the optical fibers.

The fabric is lit via bundles of optical fibers, connected to optical connectors, at the edge of the panel. These bundles & connectors are spaced every 46cm (18”) along the edges of the fabric. The pattern for cutting the fabric should be designed so it doesn’t cut the light path in the fabric, Figure5. Before cutting the fabric, make sure you understand the way the light feeds the fabric.

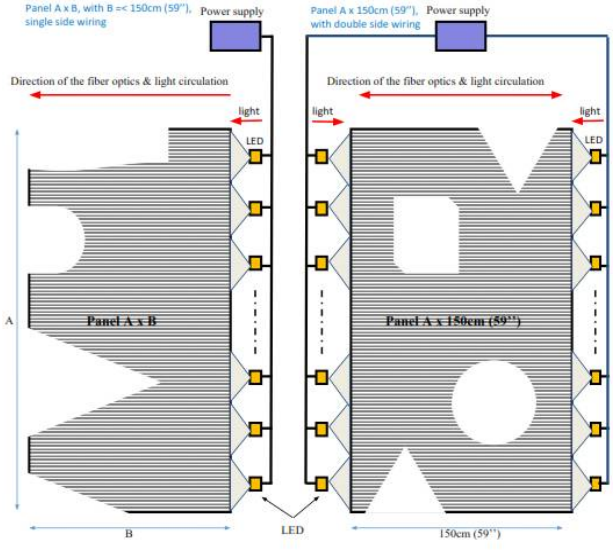


Figure 5 Different ways of cutting the panels, without affecting the lighting effect

The fabric can be sewn by a standard sewing machine (flatbed stitches).The space between the stitches should be as big as possible (at least 2mm / 0,1").Beware also not to scratch the fabric with the sewing machine. [12]

2.2 Measurement of Luminous Fabric Roughness

To evaluate the surface roughness of luminous fabric a reference is needed which fabric surfaces could be compared to it. In fact this reference are cotton and polyester T-shirts (Because of the transparency offered by optical fabrics when the switch turned off, cotton or polyester t-shirt has been worn). Surfcorder (SE1700α; Kosaka, Tokyo, Japan) instrument was used for the measurements of fabric roughness. The test is Compliant to ASTM D1894 international surface roughness standard. The considered value was the arithmetic mean (Ra) of the highest peak and the deepest valley in a 2.4 mm measuring path, a 0.8 mm wavelength and a 0.5 mm/s speed. Three measurements were made in each sample and the arithmetic mean was considered the roughness value (Ra-µm).

2.2 Measurement of Luminous Fabric Air Permeability

To investigate the air permeability properties of luminous fabric, three fabric samples comprising luminous, cotton and polyester fabrics were used. SDL ATLAS MO21A instrument was used for the measurements of fabric air permeability. It automatically measures the flow of air through a given area of a fabric at a given pressure drop over this test area during the time called out by ASTM D737 international air permeability standard. To calculate the air permeability of individual specimens, using values read directly from the test instrument in SI units as cm3 /s/cm2 and in inch-pound units as ft3 /min/ft2, rounded to three significant digits. Then calculate the average air permeability for each laboratory sampling unit and for the lot.

2.3 Proposed Fashion Designs

Proposed fashion designs were to create a high value fashion collection, which was inspired by the aesthetic forms of Greek's costumes. The technique draping on mannequin was used to create the designs, which is a great way to play with fabrics and create innovative designs. The main applications of designs are night fashion and stage costumes.

2.3.1 Inspiration

Proposed designs inspired by Greek's costumes. Greeks developed several different styles of clothes. In general, Greeks did not cut and sew their clothes until the fourth century B.C.E. Instead they draped finely woven cloth over and around their bodies to create distinct styles of dress and protective wraps. The most distinctive Greek garment is the chiton, or tunic. Two different styles of chiton were developed: the Ionic chiton and the Doric chiton. Over the chiton, Greeks kept themselves warm with a variety of wraps, including the himation, chlamys, chlaina, and diplax. Although these draped fashions continued to be popular, by the fourth century B.C.E. both women and men began wearing sewn tunics with a U or V neckline. The chlaina and the diplax were two forms of outer clothing primarily worn by women. They were both types of cloaks, which were wrapped around the body for warmth and protection. [13] Greek's costume enables many creations to be made in different design realms of new shapes, new constructions and new modes.

2.3.2 Fabrication

Satin and chiffon were chosen for the designs. In order to present the illuminated effect of LEDs, end emitting and side glowing optical fiber, and luminous fabrics were used as the outer layer.

3 Results and Discussion

3.1 Roughness of Luminous Fabrics

The surface properties of the fabric depend on several factors, such as the type of fiber, type of spinning system, stitch length etc. Table 1 shows the mean values of roughness of luminous, cotton, and polyester fabrics. When analyzing each type of fabrics, it was observed that the luminous fabrics, presented lower mean values in comparison with the other fabrics, which is because luminous fabric has a smoother surface compared with cotton and polyester fabrics. Smoothness and roughness of fabric materials are important fabric tactile properties which enhancing the performance of garments.

Table 1 Mean surface roughness values (in µm) of specimens

specimens	Mean values of roughness
Optical fabric	9.46
Cotton fabric	19.58
Polyester fabric	18.09

3.2 Air Permeability of Luminous fabrics

Air permeability is an important factor in the performance of such textile materials. The comfort of under and outer garments depends on some extent on the air permeability. It is influenced by several factors such as the type of fabric structure, the design fabric density, the amount of twist in yarns, the size of the yarns, the type of yarn structure, the size of the interstices in the fabric and etc. Table 2 shows the mean values of Air

permeability of luminous, cotton, and polyester fabrics. When analyzing each type of fabrics, it was observed that the luminous fabrics, presented higher mean values in comparison with the other fabrics, which is because luminous fabric has very high porosity. It can be assumed that it is permeable.

Table 2 Mean Air permeability values (in L/m2/S) of specimens

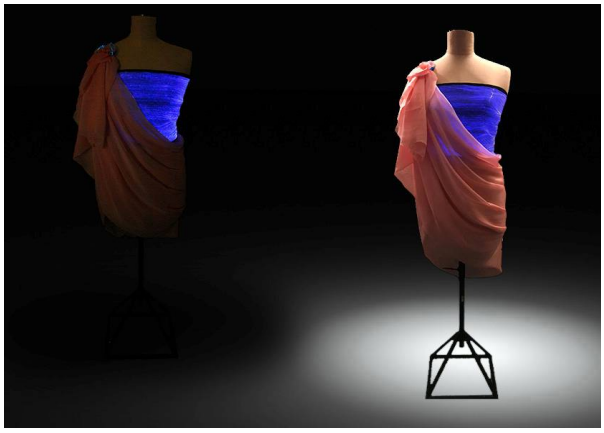
specimens	Mean values of air permeability
Optical fabric	3194
Cotton fabric	2150
Polyester fabric	271.8

3.3 Presentation of Proposed fashion Designs

Each design was presented in light and dark background to emphasize the appearance of Optical products (end emitting and side glowing optical fiber, and luminous fabrics) in light and dark areas.

Design 1

Silhouette	:	**Shapely- high bust- high waist- flared skirt.**
Material	:	**Satin- side glowing optical fiber**
Color	:	**Orange- orange and blue light.**
Inspiration	:	**Greek's costume- Ionic Chiton.**



Design 2

Silhouette	:	**Feminine- natural waist- flowing out.**
Material	:	**Satin- chiffon- luminous fabric.**
Color	:	**Orange- blue light.**
Inspiration	:	**Greek's costume- Chalmys.**

Design 3

Silhouette	:	**Slim- shapely- natural waist- feminine.**
Material	:	**Satin- side glowing optical fiber.**
Color	:	**Grey- blue light.**
Inspiration	:	**Greek's costume-TOGA**

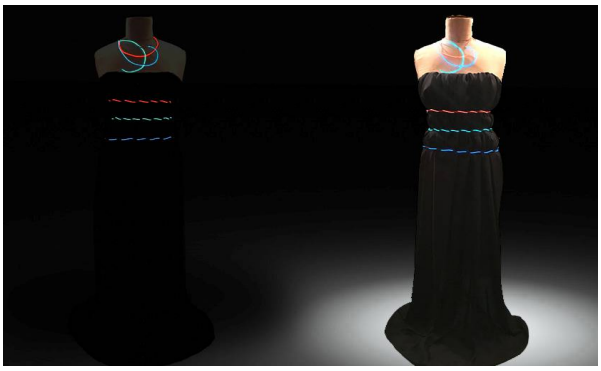
Design 4

Silhouette	:	**Curvaceous- natural waist- feminine- flared skirt.**
Material	:	**Satin- end emitting and side glowing optical fiber.**
Color	:	**Grey- blue light.**
Inspiration	:	**Greek's costume- Chiton.**

Design 5

Silhouette	:	**Shapely- high round bust- high waist - flared skirt.**
Material	:	**Satin- chiffon- side glowing optical fiber.**

Color	**:**	**Black- grey- blue and orange light.**
Inspiration	**:**	**Greek's costume- Chiton.**

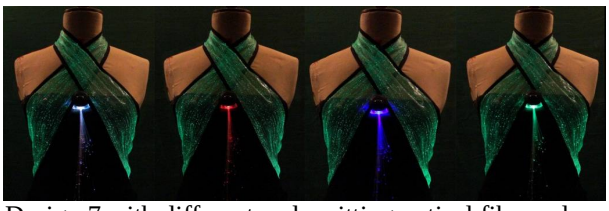


Design 6

Silhouette	**:**	**Shapely- high round bust- high waist - flared skirt.**
Material	**:**	**Satin- side glowing optical fiber.**
Color	**:**	**Black- orange, green, and blue light.**
Inspiration	**:**	**Greek's costume- Chiton.**

Design 7

Silhouette	**:**	**Elongated- natural waist- narrow skirt.**
Material	**:**	**Satin- Luminous fabric.**
Color	**:**	**Black- green light.**
Inspiration	**:**	**Greek's costume- Ionic Chiton.**



Design 7 with different end emitting optical fiber colors as accessories

Design 8

Silhouette	**:**	**Slim- natural waist- narrow skirt.**
Material	**:**	**Satin- side glowing optical fiber- Luminous fabric.**
Color	**:**	**Black- green, blue, and orange light.**
Inspiration	**:**	**Greek's costume- Chiton.**

Design 9

Silhouette	**:**	**Slim- high round bust- natural waist- glowing skirt.**
Material	**:**	**Satin- Luminous fabric.**
Color	**:**	**Grey- green light.**
Inspiration	**:**	**Greek's costume- Doric Chiton.**

Design 10

Silhouette	**:**	**Elongated- high round bust- natural waist- narrow skirt.**
Material	**:**	**Satin- Chiffon- Luminous fabric.**
Color	**:**	**Black- green- green light.**
Inspiration	**:**	**Greek's costume- Himation.**

Design 11

Silhouette	**:**	**Shapely- high round bust- high waist- narrow skirt.**
Material	**:**	**Chiffon- side glowing optical fiber-**

Luminous fabric.

Color	:	**Green- green, blue, and orange light.**
Inspiration	:	**Greek's costume- Himation.**

Design 12

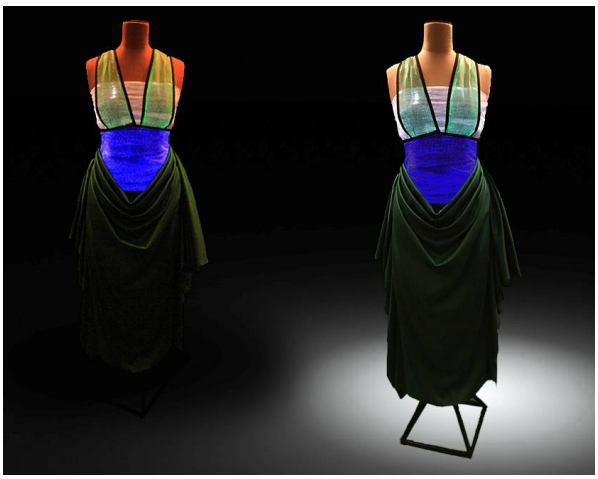
Silhouette	:	**Shapely-long- feminine.**
Material	:	**Satin- Chiffon- Luminous fabric.**
Color	:	**Green- blue light.**
Inspiration	:	**Greek's costume- Doric Chiton.**

Design 13

Silhouette	:	**Elongated- natural waist- narrow skirt.**
Material	:	**Satin- Luminous fabric.**
Color	:	**Black- blue and green light.**
Inspiration	:	**Greek's costume- Ionic Chiton.**

Design 14

Silhouette	:	**Shapely-long- feminine.**
Material	:	**Satin- Chiffon- Luminous fabric.**
Color	:	**Black- green- blue and green light.**
Inspiration	:	**Greek's costume- Ionic and Doric Chiton.**



Design 15

Silhouette	:	**Shapely-high round bust- high waist- mid-calf-length skirt.**
Material	:	**Satin- Luminous fabric.**
Color	:	**Green- blue, white, and green light.**
Inspiration	:	**Greek's costume- Himation.**

Design 16

Silhouette	:	**Feminine-high round bust- high waist- narrow skirt.**
Material	:	**Satin- Luminous fabric.**
Color	:	**Black- blue, and green light.**
Inspiration	:	**Greek's costume- Chlamys.**

Design 17

Silhouette	:	**Feminine-full bust- natural- glowing outfit.**
Material	:	**Chiffon- Luminous fabric.**
Color	:	**Black- blue, white, and green light.**

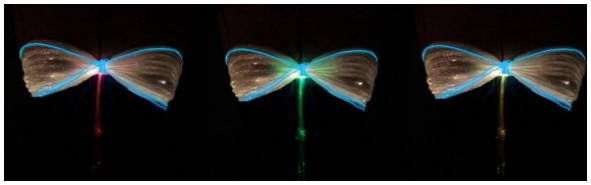
Inspiration : Greek's costume- Chlamys.

Design 18

Silhouette	**: Feminine- high round bust- high waist – mid-thigh- length skirt.**
Material	**: Satin- Luminous fabric.**
Color	**: Black- blue, white, and green light.**
Inspiration	**: Greek's costume- Ionic Chiton**

Design 19

Silhouette	**: Elongated- high round bust- flared skirt.**
Material	**: Satin- side glowing optical fiber- Luminous fabric.**
Color	**: Blue- white and blue light.**
Inspiration	**: Greek's costume- Himation.**



Design 19 with different end emitting optical fiber colors

Design 20

Silhouette	**: Feminine- natural waist- flared skirt.**
Material	**: Satin- Luminous fabric.**
Color	**: Blue- white light.**
Inspiration	**: Greek's costume- Himation.**

4 Conclusions

- Surface roughness is an important factor during touching and handling of fabrics. In this research, Surfcorder (SE1700α; Kosaka, Tokyo, Japan) instrument to evaluate the surface roughness of luminous fabric. The finding shows that luminous fabric has a smoother surface compared with cotton and polyester fabrics.
- The comfort of under and outer garments depends on some extent on the air permeability. In this research, SDL ATLAS MO21A instrument was used to evaluate the air permeability of luminous fabric. The finding shows that luminous fabric has very high porosity. It can be assumed that it is permeable.
- The design inspirations are triggered by technology along with the inner psyche of the fashion. Luminous fabric adds aesthetics to designs, which enhances the objective of technology/design.

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