The Effect of Integrating Light Emitting Diode (LED) on Different Fabrics Properties Used for Fashion Design

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Abstract:
Humans are usually attracted to light, as they have always been amused with the effects that light could cause when it falls on a substance, changing its physical appearance and creating a whole new range of aesthetic values, designers began to think of not only using elements to catch light on their garments such as mirrors, beads and sequins, but also using ones to emit light from clothes, from the most convenient technologies was the Light Emitting Diode (LED) as it has a long life time, high brightness, small in size, can be operated by batteries, etc. By the rise of futuristic fashion trends, LED clothes were accepted and worn by artists in live performances as they add surprising, entertaining impacts on the audiences. Also they were present powerfully in popular fashion events. Although this technology offers the designers with new innovative artistic ideas, it has effects on different synthetic fabrics' mechanical properties and color strength (bursting strength, maximum force and elongation, K/Sand color reflectance) that must be recognized, as when we exposed several samples of fabrics (20*20) cm² to warm white LED light (2700 Kelvin) for different interval of times (80, 110, 140) hours we found that the values of the previous properties have changed compared to the standard samples' values (samples that weren't exposed to light).

Keywords:
Light Emitting Diode (LED)
Fabrics Properties
Fashion Design

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Introduction
From the beginning of history there was a cohesive relationship between fashion design, manufacture and industrial modifications. Fashion designers have always adopted new technologies to submit their novel collections; from these recent technologies is using light emitting diode or LED in clothes.(1)But before presenting this technology in any new collection designers should consider two important aspects while designing their garments the first consideration is the physical appearance, while the second is the durability of those garments, In addition, since we are using a lighting technology and light sources have always been known to affect fabrics' mechanical properties and color strength, further tests should be performed to know the impact of LEDs on different fabrics after close exposure for certain intervals of time. Those fabrics could be used externally as an outer layer of the garment or internally as lining.

Light is a sort of electromagnetic radiation that could be visible in wave lengths between (400-700) nm, ultra violet (shorter wave length) below this range or infra-red (higher wave length) above this range, In some cases when materials absorbs light, the molecules are excited and the bonds between atoms could break causing photochemical changes.(2)That could cause change in color strength and changing in the fabrics' strength.

Problem statement
It is originated from the problem that installing any electronic component in garments may have effects on the fabrics properties which must be recognized, so we can determine the research problem in:-

1- Studying the general characteristics of fabrics that could be used in clothes lighted by LEDs, the relationship between the used fabric and the way of installing light emitting diode into it.

2-Studying the effects that LEDs could cause on synthetic fabrics after close exposure for certain intervals of time, and what is the most convenient number of hours that the fabrics could be exposed to LEDs without changing much their properties.

Research objectives:
1- To study types of materials that could be combined with LEDs to produce clothes and

the effect that LED could cause on this materials. Also determining the most suitable number of hours that the fabrics could be exposed to LEDs without changing much their properties.

2- To clarify the relationship between used materials and the techniques used to combine LEDs into garments preserving the garments functionality.
3- Catching up with futuristic fashion trends by keeping updated to scientific and technological development and applying it in new fashion design and production techniques.

Research importance.

1- Mentioning the effect of LED installation on the fabrics used in fashion design.
2- Enlighten an important side of fashion design which is combining design with modern technological techniques by applying LEDs to evening gowns as a decorative ornament with beads, reflecting surfaces to create decorative shapes according to the LEDs arrangement.
3- Developing the experimental abilities of the designers by trying new techniques and skills.

Research methodology

1- 1-Analytical
2- 2-Practical

Research tools

1- Different fabrics.
2- Camera.
3- Wired LED strings with a battery.
4- ANOVA statistical analysis.

Research limits

1- Place limits: Women outwear specially evening gowns.
2- Technical limits: mixed materials chiffon (95%polyester 5% Lycra), satin (95% nylon and 5% Lycra), tulle (95% nylon and 5% Lycra).

Research hypotheses

1- There are statistically significant differences between bursting strength values of tulle samples exposed to LEDs for 80,110, 140 hours.
2- There are statistically significant differences between maximum force and elongation values of satin samples exposed to LEDs for 80,110, 140 hours, there are statistically significant differences between maximum force and elongation values of chiffon samples exposed to LEDs 80,110, 140 hours.
3- There are statistically significant differences between reflectance values of light grey tulle samples exposed to LEDs for 80,110, 140 hours, there are statistically significant differences between reflectance values of light grey satin samples exposed to LEDs for 80,110, 140 hours, there are statistically significant differences between reflectance values of light grey chiffon samples exposed to LEDs for 80,110, 140 hours.
4- There are statistically significant differences between K/Svalues of light grey tulle samples exposed to LEDs for 80,110, 140 hours, there are statistically significant differences between K/S values of light grey satin samples exposed to LEDs for 80,110, 140 hours, there are statistically significant differences between K/S values of light grey chiffon samples exposed to LEDs for 80,110, 140 hours.

Terms of research

1- Light emitting diode (LED): 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).[3]
2- Fashion: The long man dictionary (1995)defines fashion as the popular style of clothes, hair, behavior etc. at a particular time that is likely to change. [4]

1. Literature review

1.1. Light emitting diode

A light emitting diode (LED) 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, for example Aluminum Gallium Arsenide (AlGaAs) for red, Aluminum Gallium phosphide (AlGaP) for green and Zinc Selenide (ZnSe) for blue.[3]

1.2. LEDs advantages that made it suitable for applying to clothes

LEDs consume less energy than other types of bulbs so they can be powered with batteries[3] and installed easily into clothes offering the wearer free movement, they are shock resistant, difficult to be damaged and very small in size. [5] So the fabrics keep their flexibility after LED installation and the garments are durable, LEDs also radiate very little heat and get rids of it by mounting in a direction opposite to light emission.[5]For the same electric power LEDs are brighter compared to other types of bulbs so it is energy saving. [3] In addition, LEDs are perfect if the wearer want to switch off and on light frequently in the garment. [3] Unlike traditional methods of lighting without using any color filters LEDs can emit light of any desired color depending on the semiconductor type which is more efficient and can lower initial costs. [3]Also it has a characterized long lifetime between 35,000 to 50,000 hours of life. [6]

1.3. Fabrics used with LEDs to create LED garments

Clothes with reflecting surfaces such as mirrors, beads and sequins may have been existing since the beginning of civilization but the ability to produce light from and through clothes is relatively novel, light has always been an important element in fashion design as light reflection on materials causing shine and gloss (which were believed in old civilizations that they expresses wealth) changes there whole appearance and increase their aesthetic value.[1]There are certain aspects that should be considered while choosing the fabrics for the evening wear LED collection whether these fabrics are external representing the outer surface of the garment or internal as linings, the first aspect is choosing the fabrics according to the fashion trends of the season regarding colors and textures, the second one is choosing convenient fabrics that fits the techniques of LEDs installation, the researchers chose tulle, satin and chiffon as they are commonly used in evening wear and they can be nicely integrated with LEDs in clothes

1.3.1. Tulle fabric

It is a delicate fabric made of rayon, nylon or polyester, the tulle fabric lines are intersected in a hexagon shaped mesh. [7]The tulle used in this research is made of 95% nylon and 5% Lycra. The LEDs are fixed under the tulle fabric, by passing the LED heads through holes in the satin lining and then placing the tulle fabric above as shown in fig (1), (2), (3), we chose tulle for this technique as it is a light sheer fabric with high transmission so LED light can be beautifully transmitted through it.


Fig (1) LED fixed In the front of satin lining


Fig (2) LED wires at the back of satin lining

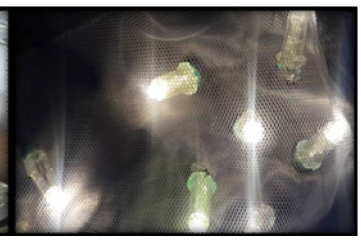
Fig (3) tulle fabric on LEDs

1.3.2. Satin fabric

This fabric has two faces one is glossy and the other is dull, this gloss is achieved by a certain weaving technique and other finishing processes. It is made of silk, rayon, acetate or polyester, satin is silky soft and drapable.[8] The satin type used in this research is made of 95% nylon and 5% Lycra. The technique of installing LEDs into satin is by putting metal grommets on the fabric's front side and passing the LEDs through them to the surface as shown in fig (4), (5), we chose satin specifically for this technique as fixing the metal grommets needs a strong fabric, In addition the gloss and low transmission of the satin fabric makes the LEDs look brighter and more glowy as the light is concentrated on the top of the fabric.


Fig (4) LEDs Passing through grommets


Fig (5) LEDs wires fixed at the back

1.3.3. Chiffon fabric

It is a light sheer fabric made of wool, silk, polyester or other synthetic materials.[9]The chiffon type used in research is made of 95% polyester and 5% Lycra. The LEDs are fixed under the chiffon fabric by passing the LED heads through holes in the satin lining and then placing the chiffon fabric above it as shown in fig (6), (7), (8) we chose chiffon for this technique as it is a light sheer fabric with high transmission so LED light can be beautifully transmitted through it. Showing a visual effect which is different from the previous effect when we installed LEDs on satin.

Fig (6) LED fixed In the front of satin lining

Fig (7) LED wires at the back of satin lining

Fig (8) chiffon fabric on LEDs

1.4. Fabrics general properties that should be considered when used with LEDs

1.4.1. Weight

The fabric's weight has a great effect on its drapery and thickness, as light weight fabrics with high drapery enhances the body curves and gives excellent drapes while heavy weight fabrics are stiff and undefine the body shape. (10) To determine the weight of a certain fabric a sample is measured with sensitive scale and then we calculate the weight in the meter square, fabrics could be divided to light, medium and heavy weight. (11)

1.4.2 Thickness

The fabric's thickness differs depending on the material's type whether it is natural or manmade, yarn number, the direction of twist in wrap and weft and weave's structure.(12) The thickness of fabrics is determined by precise measurement of the distance between two parallel, flat surfaces separated by a piece of fabric after applying certain pressure. (11)

1.4.3. Tensile strength and elongation

They are mechanical properties; tensile strength is the maximum stress that a material can bear before tearing while elongation is the increase in fabrics length until tearing under external influences. (13)Its value depends on the fibers properties.(14)Yarns structure and weaving structure.(15) The tensile strength and elongation test is important to determine the strength of fabrics to handle maximum stress this test is performed be exposing a piece of fabric with certain dimensions to a gradual stress until reaching the tearing point.(11)

1.4.4. Texture

It describes the distinguished outer appearance of a material which is a result of internal, external components and molecular arrangement.In addition, the weaving technique, weave structure,types of fibers and finishing techniques affect the fabrics texture.(16)We can recognize any fabric's texture through vision and touching.(17)

1.4.5.Color strength

Color strength of a dye or a pigment is the capability of transporting color to the materials It relies on the (K/S) which is the ratio between (k) absorption coefficient and (S) Scattering coefficient,also it is relatedto reflectance values (R), black has 0% reflection while white has 100% reflection, and it is measured by spectrophotometer.(18)

2. Experimental work

2.1. Tested fabrics specifications

Different types of fabrics were tested;detailed specifications are mentioned in table (1**)**

Table (1) specifications of tested fabrics

Sample number	Commercial name and color	Fiber type	Structure	Warp/c.m	Weft/c.m	Mass g.m/m²	Thickness (m.m)
1	Tulle	95% Nylon 5% lycra	Netting	-	-	34.89	0.016
2	satin	95% Nylon 5% lycra	Satin4	38	29	230	0.1
3	chiffon	95% polyester 5% lycra	Plain1/1	34	32	75	0.04

2.2. Experimental tests

All tests were done in conditioned atmosphere of 20 ºc and 60% RH the masses of different samples of fabrics were tested using digital sensitive scale according to ASTM D3776/D3776M-09a. (19)Thickness obtained using thickness tester according to ASTM D1777. (20)While Bursting Strength of textiles was measured by Ball Burst

Test ASTM D3787, 2001. [21]Maximum Force and Elongation were tested by maximum force and elongation tester strip method (QMat5.37/Q3214) model number H5KT/130 5000N –EN ISO13934-1.1999.[22] Load range 250N, extension range 150m.m, gauge length 200m.m, speed 100mm/min, preload 1.0N, color reflectance and K/S measurement test was done by spectrophotometer device, all the previous tests were done to determine the change in properties that happened to the fabrics after exposure to LED light for 80hours, 110hours, 140 hours the samples are of size 20*20 exposed closely to 12 LEDs, all fabrics are of light grey color.

3. Results and Discussion

3.1. Tulle fabric

3.1.1. Bursting strength

This test is performed on tulle to determine the effect of LEDs on its bursting strength after **exposure** to light for 80 hours, 110 hours, and 140 hours test results shown in table (2)

hypothesis there are statistically significant differences between tulle samples after exposure to LED lights for 80 hours, 110 hours, and 140 **hours** in bursting strength test and to investigate this hypothesis we calculated the analysis of variance for the mean bursting strength values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours)

Table (2) Mean bursting strength of tullebefore exposure to LED and after exposure to LED for (80h, 110h, 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Bursting strength value	174.7	179.1	195.4	173.4

Table (3) Analysis of variance for the mean bursting strength values of tulle samples exposed to (80h, 110h, and 140h) to LED light

Bursting strength	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	161.216	80.608	2	43.862	0.01
Within groups	11.027	1.838	6		
Total	172.243		8		

This table shows that the F value was (43.862) which is the statistically significant value on (0.01) level which refers to the difference in bursting strength values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (4)

Table (4) LSD test for multiple comparisons

Bursting strength test	80 hours of exposure to LED 179.1	110 hours of exposure to LED 195.4	140 hours of exposure to LED 173.4
80 hours of exposure to LED	-		
110 hours of exposure to LED	**16.3	-	
140 hours of exposure to LED	**5.7	**22	-

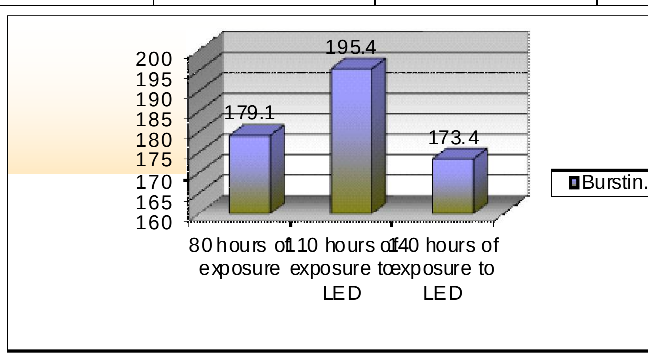

Fig (9)Mean bursting strength of tulle after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the tulle sample exposed 110 hours to LEDs and tulle samples exposed to 80 hours and 140 hours to LED in favor of 110 hours of exposure at significance level of 0.01.There are statistically significant differences between the tulle sample exposed for 80 hours and tulle sample exposed for 140 hour in favor of 80 hours exposure at significance level of 0.01. Comparing the three samples to the standard sample which is not exposed to light, the bursting strength increased after 80 hours to LED exposure and reached it's maximum after 110 hours exposure and then its bursting strength decreased after 140 hours exposure to a valueslightly smaller than the standard sample

3.1.2. Color reflectance value

The color reflectance values of light grey tulle before and **after** exposure to LED shown in table (5)

hypothesis there are a statistically significant difference between tulle samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in color reflectance test and to investigate this hypothesis we calculated the analysis of variance for the mean color reflectance values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours)

Table (5) color reflectance values of tulle fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Color reflectance	37.96	37.91	44.66	43.94

Table (6) Analysis of variance for the mean color reflectance values of tulle samples exposed to (80h, 110h, and 140h)

Color reflectance	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	262.957	131.479	2	30.249	0.01
Within groups	26.079	4.347	6		
Total	289.036		8		

This table shows that the F value was (30.249) which is the statistically significant value on (0.01) level which refers to the difference in color reflectance values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (7)

Table (7) LSD test for multiple comparisons

Color reflectance	80 hours of exposure to LED 37.91	110 hours of exposure to LED 44.66	140 hours of exposure to LED 43.94
80 hours of exposure to LED	-		
110 hours of exposure to LED	**6.75	-	
140 hours of exposure to LED	**6.03	*0.72	-

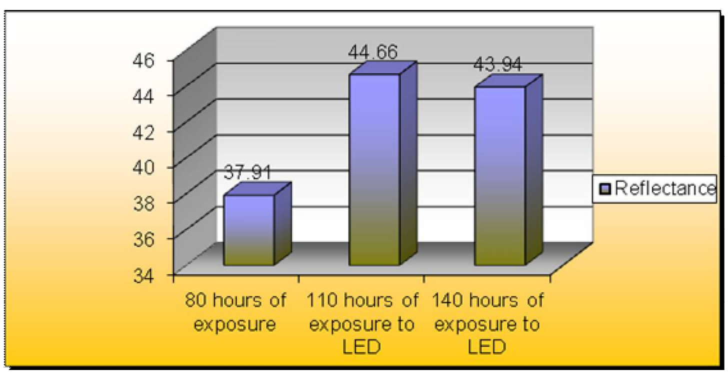

Fig (10) Color reflectance of light grey tulle after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the tulle sample exposed 110 hours to LEDs and tulle samples exposed to 140 hours to LEDin favor of 110 hour of exposure at significance level of 0.05, there are statistically significant differences between the tulle sample exposed 110 hours to LEDs and tulle samples exposed to 80 hours to LEDin favor of 110 hour of exposure at significance level 0.01.There are statistically significant differences between the tulle sample exposed for 140 hours and tulle sample exposed for 80 hour in favor of 140 hours exposure at significance level of 0.01.

Comparing the three samples to the standard sample the color reflectance of tulle samples decreased slightly after 80 hours of exposure then increased to a value more than the standard samples value after 110 hours then decreased slightly to a value more than the standard samples value after 140 hours.

3.1.3 K/S

The K/S values of light grey tulle before and after exposure to LED shown in table (8)

hypothesis there are a statistically significant difference between tulle samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in K/S and to investigate this hypothesis we calculated the analysis of variance for the mean K/S values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours)

Table (8) K/S values of light grey tulle before exposure to LED and after exposure to LED for (80h, 110h, 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
K/S value	0.5070	0.5085	0.3429	0.3576

Table (9) Analysis of variance for the mean K/S values of light grey tulle samples exposed to (80h, 110h, and 140h) to LED light

K/S	Sum of square	Mean of squares	Degrees of freedom	F	Significance
Between groups	153.060	76.530	2	15.502	0.01
Within groups	29.620	4.937	6		
Total	182.680		8		

This table shows that the F value was (15.502) which is the statistically significant value on (0.01) level which refers to the difference in K/S values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (10)

Table (10) LSD test for multiple comparisons

K/S	80 hours of exposure to LED 0.5085	110 hours of exposure to LED 0.3429	140 hours of exposure to LED 0.3576
80 hours of exposure to LED	-		
110 hours of exposure to LED	**0.165	-	
140 hours of exposure to LED	**0.151	*0.014	-

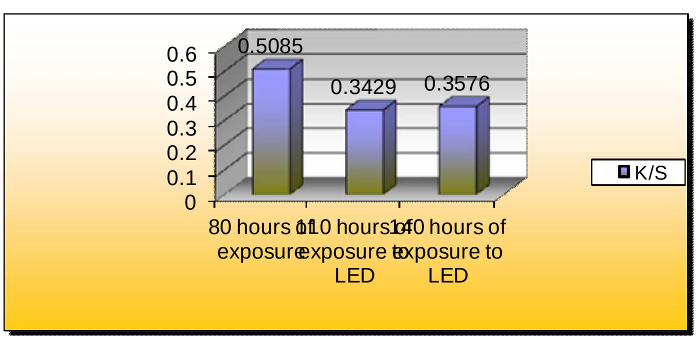

Fig (11) K/S of light grey tulle after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the tulle sample exposed 80 hours to LEDs and tulle samples exposed to 140 hours and 110 hours to LED in favor of 80 hours of exposure at significance level of 0.01.There are statistically significant differences between the tulle sample exposed for 140 hours and tulle sample exposed for 110 hour in favor of 140 hours exposure at significance level of 0.05

Comparing the three samples to the standard sample the K/S of tulle samples increased slightly after 80 hours of exposure then decreased to a value less than the standard samples value after 110 hours then increased slightly to a value less than the standard samples value after 140 hours.

3.2. Satin fabric

3.2.1. Maximum force and elongation

3.2.1.1. Maximum force

The mean maximum force values of satin fabric before and after exposure to LED shown in table (11).

Hypothesis there are statistically significant differences between satin samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in maximum force test and to investigate this hypothesis we calculated the analysis of variance for the mean maximum force values of the three samples.

Table (11) Mean Maximum force values of satin fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Maximum force	1237	1207	1175	1249

Table (12) Analysis of variance for the mean maximum force values of satin samples exposed to (80h, 110h, and 140h)

Maximum force	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	137.309	68.654	2	32.048	0.01
Within groups	12.853	2.142	6		
Total	150.162		8		

This table shows that the F value was (32.048) which is the statistically significant value on (0.01) level which refers to the difference in maximum force values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (13).

Table (13) LSD test for multiple comparisons

Maximum force	80 hours of exposure to LED 1207	110 hours of exposure to LED 1175	140 hours of exposure to LED 1249
80 hours of exposure to LED	-		
110 hours of exposure to LED	**32	-	
140 hours of exposure to LED	**42	**74	-

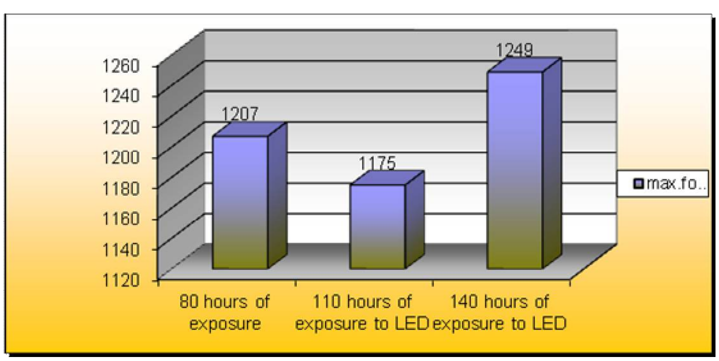

Fig (12) Mean maximum forcevalues of satin after exposure to LED for (80h, 110h, 140h).

Therefore, there are statistically significant differences between the satin sample exposed to 140 hours to LEDs and satin samples exposed to 80 hours and 110 hours to LED in favor of 140 hours of exposure at significance of 0.01.There are statistically significant differences between the satin sample exposed for 80 hours and satin sample exposed for 110 hour in favor of 80 hours exposure at significance of 0.01

Comparing the three samples to the standard sample which is not exposed to light, the maximum force decreased after 80 hours to LED exposure and decreased more after 110 hours exposure, and then the maximum force increased to a value higher than the standard sample after 140 hours of exposure.

3.2.1.2. Elongation

The mean elongation values of satin fabric before and after exposure to LED shown in table (14)

Hypothesis there are statistically significant differences between satin samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in elongation test and to investigate this hypothesis we calculated the analysis of variance for the mean elongation values of the three samples.

Table (14) Mean Elongation values of satin fabric before and after exposure to LED for(80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Elongation %	19.92%	19.07%	17.967%	20.88%

Table (15) Analysis of variance for the mean elongation values of satin samples exposed to (80h, 110h, and 140h)

elongation	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	81.776	40.888	2	20.581	0.01
Within groups	11.920	1.987	6		
Total	93.696		8		

This table shows that the F value was 20.581 which is the statistically significant value on (0.01) level which refers to the difference in elongation values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (16)

Table (16) LSD test for multiple comparisons

Elongation	80 hours of exposure to LED 19.07%	110 hours of exposure to LED 17.67%	140 hours of exposure to LED 20.88%
80 hours of exposure to LED	-		
110 hours of exposure to LED	**1.103	-	
140 hours of exposure to LED	**1.81	**2.913	-

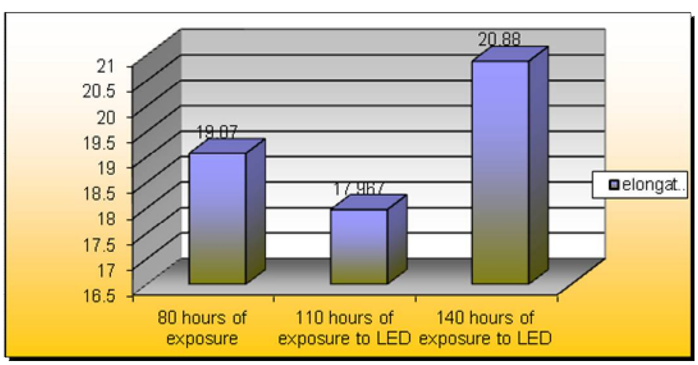

Fig (13) Mean elongation values of satin fabric after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the satin sample exposed 140 hours to LEDs and satin samples exposed to 80 hours and 110 hours to LED in favor of 140 hours of exposure at significance level of 0.01.There are statistically significant differences between the satin sample exposed for 80 hours and satin sample exposed for 110 hour in favor of 80 hours exposure at significance of 0.01. Comparing the three samples to the standard sample which is not exposed to light the elongation decreased after 80 hours to LED exposure and decreased more after

110 hours exposure, then the elongation increased to a value higher than the standard sample after 140 hours of exposure.

3.2.2. Color reflectance value

The color reflectance values of light grey satin before and after exposure to LED shown in table (17)

hypothesis there are a statistically significant difference between satin samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in color reflectance test and to investigate this hypothesis we calculated the analysis of variance for the mean color reflectance values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours)

Table (17) color reflectance of satin before exposure to LED and after exposure to LED for (80h, 110h, 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Color reflectance	29.69	29.42	30.28	30.59

Table (18) Analysis of variance for the mean color reflectance values of tulle samples exposed to (80h, 110h, and 140h) to LED light

Color reflectance	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	325.412	162.706	2	35.769	0.01
Within groups	27.293	4.549	6		
Total	352.705		8		

This table shows that the F value was (35.769) which is the statistically significant value on (0.01) level which refers to the difference in color reflectance values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (19).

Table (19) LSD test for multiple comparisons

Color reflectance	80 hours of exposure to LED 29.42	110 hours of exposure to LED 30.28	140 hours of exposure to LED 30.59
80 hours of exposure to LED	-		
110 hours of exposure to LED	**0.86	-	
140 hours of exposure to LED	**1.17	*0.31	-

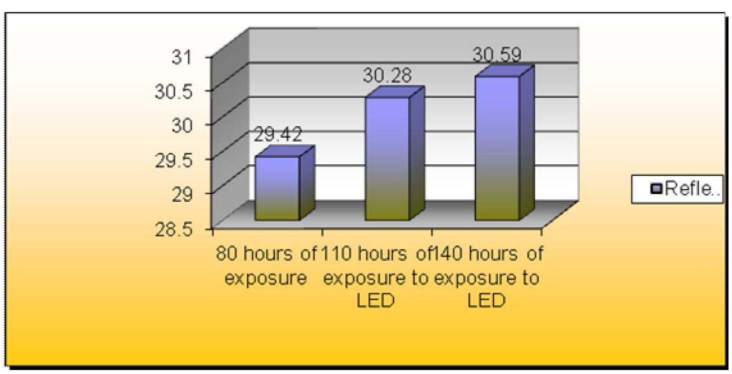

Fig (14) color reflectance of light grey satin after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the satin sample exposed 140 hours to LEDs and satin samples exposed to 110 hours to LEDin favor of 140 hour of exposure at significance level of 0.05, there are statistically significant differences between the satin sample exposed 140 hours to LEDs and satin sample exposed to 80 hours to LEDin favor of 140 hour of exposureat significance level of 0.01.There are statistically significant differences between the satin sample exposed for 110 hours and satin sample exposed for 80 hour in favor of 110 hours exposure at significance level of 0.01.Comparing the three samples to the standard sample the reflectance value decreased slightly after 80 hours then increased to a value more than the standard sample after 110 hours and then increased more to a value more than the standard value after 140 hours.

3.2.3. K/S

K/S values of light grey satin fabric before and after exposure to LED shown in table (20)

hypothesis there are statistically significant differences between satin samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in K/S and to investigate this hypothesis we calculated the analysis of variance for the mean K/S values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours).

Table (20) K/S values of satin fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
K/S	0.8325	0.8466	0.8027	0.7875

Table (21) Analysis of variance for the mean K/S values of satin samples exposed to (80h, 110h, and 140h)

K/S	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	359.452	179.726	2	28.718	0.01
Within groups	37.550	6.258	6		
Total	397.002		8		

This table shows that the F value was (28.718) which is the statistically significant value on (0.01) level which refers to the difference in K/S values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (22)

Table (22) LSD test for multiple comparisons

K/S	80 hours of exposure to LED 0.8466	110 hours of exposure to LED 0.8027	140 hours of exposure to LED 0.7875
80 hours of exposure to LED	-		
110 hours of exposure to LED	**0.043	-	
140 hours of exposure to LED	**0.059	**0.015	-

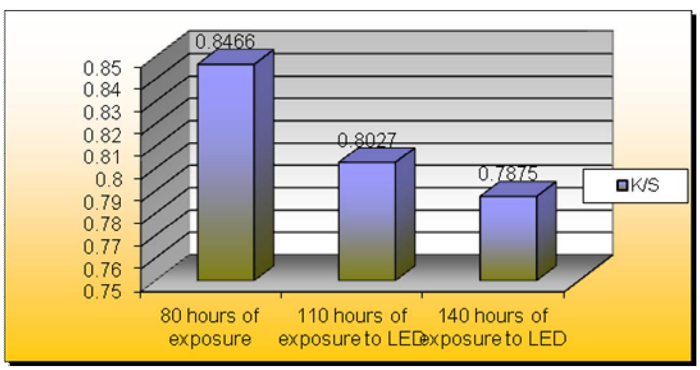

Fig (15) K/S values of light grey satin after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the satin sample exposed to 80 hours to LEDs and satin samples exposed to 110 hours and 140 hours to LED in favor of 80 hours of exposure at significance level of 0.01.There are statistically significant differences between the satin sample exposed for 110 hours and satin sample exposed for 140 hour in favor of 110 hours exposure at significance level of 0.01.Comparing the three samples to the standard sample the K/S of satin samples increased slightly after 80 hours of exposure then decreased to a value less than the standard samples value after 110 hours then decreased more to a value less than the standard samples value after 140 hours.

3.3. Chiffon fabric

3.3.1. Maximum force and elongation

3.3.1.1. Maximum force

Mean maximum force values of chiffon fabric before and after exposure to LED for (80h, 110h, and 140h) shown in Table (23)

hypothesis there are statistically significant differences between chiffon samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in maximum force test and to investigate this hypothesis we calculated the analysis of variance for the mean maximum force values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours).

Table (23) Mean maximum force values of chiffon fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Maximum force	223.3	228.1	228.15	236.0

Table (24) Analysis of variance for the mean maximum force values of chiffon samples exposed to (80h, 110h, and 140h) to LED light

Maximum force	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	210.976	105.488	2	13.050	0.01
Within groups	48.500	8.083	6		
Total	259.476		8		

This table shows that the F value was (13.050) which is the statistically significant value on (0.01) level which refers to the difference in maximum force values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (25)

Table (25) LSD test for multiple comparisons

Maximum force	80 hours of exposure to LED 228.1	110 hours of exposure to LED 228.15	140 hours of exposure to LED 236
80 hours of exposure to LED	-		
110 hours of exposure to LED	0.05	-	
140 hours of exposure to LED	**7.9	**7.85	-

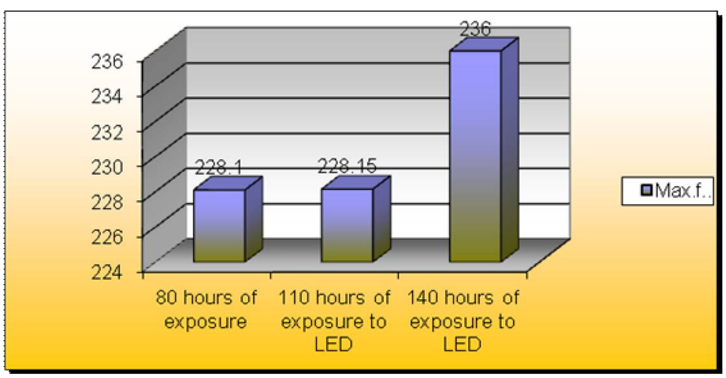

Fig (16) Mean maximum force values of chiffon after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the chiffon sample exposed 140 hours to LEDs and chiffon samples exposed to 110 hours and 80 hours to LED in favor of 140 hours of exposure at significance level of 0.01, there are no significant differences between the chiffon sample exposed for 110 hours and chiffon sample exposed for 80 hour to LED, Comparing the three samples to the standard sample after 80 hours the maximum force value increased then remained almost the same after 110 hours of exposure, after 140 hours maximum force value increased the most.

3.3.1.2. Elongation

The elongation values of chiffon fabric before and after exposure to LED shown in table (26)

Hypothesis there are statistically significant differences between chiffon samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in elongation test and to investigate this hypothesis we calculated the analysis of variance for the mean elongation values of the three samples.

Table (26) Elongation values of chiffon fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Elongation %	26.76%	27.00%	27.79%	30.02%

Table (27) Analysis of variance for the mean elongation values of chiffon samples exposed to (80h, 110h, and 140h)

Elongation	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	120.509	60.254	2	18.623	0.01
Within groups	19.413	3.236	6		
Total	139.922		8		

This table shows that the F value was 18.623 which is the statistically significant value on (0.01) level which refers to the difference in elongation values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (28)

Table (28) LSD test for multiple comparisons

Elongation	80 hours of exposure to LED 27%	110 hours of exposure to LED 27.79%	140 hours of exposure to LED 30.02%
80 hours of exposure to LED	-		
110 hours of exposure to LED	*0.79	-	
140 hours of exposure to LED	**3.02	**2.23	-

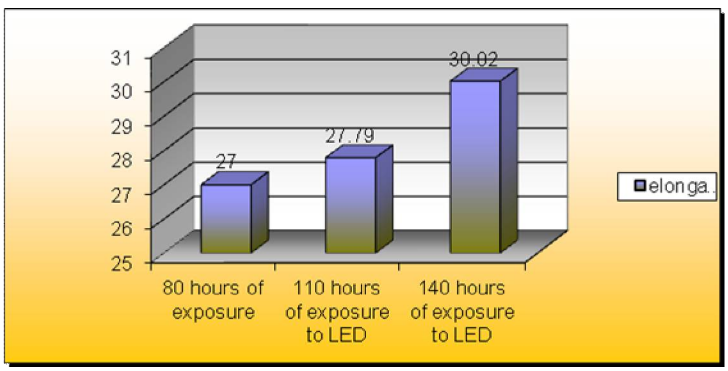

Fig (17) Mean elongation values of chiffon after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the chiffon sample exposed 140 hours to LEDs and chiffon samples exposed to 110 hours and 80 hours to LED in favor of 140 hours of exposure at significance level of 0.01, there are statistically significant differences between the chiffon sample exposed 110 hours to LEDs and chiffon samples exposed to 80 hours to LED in favor of 110 hours of exposure at significance level of 0.05.

Comparing the three samples to the standard sample after 80 hours the elongation percent value increased then increased slightly after 110 hours of exposure, after 140 hours elongation value increased the most.

3.3.2. Color reflectance value

The color reflectance values of light grey chiffon before and after exposure to LED shown in table (29)

hypothesis there are a statistically significant difference between light grey chiffon samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in color reflectance test and to investigate this hypothesis we calculated the analysis of variance for the mean color reflectance values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours)

Table (29) color reflectance of light grey chiffon before exposure to LED and after exposure to LED for (80h, 110h, 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
Color reflectance	28.39	28.81	28.85	28.71

Table (30) Analysis of variance for the mean color reflectance values of light grey chiffon samples exposed to (80h, 110h, and 140h) to LED light

Color reflectance	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	265.292	132.646	2	31.949	0.01
Within groups	25.271	4.212	6		
Total	290.563		8		

This table shows that the F value was (31.494) which is the statistically significant value on (0.01) level which refers to the difference in color reflectance values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (31)

Table (31) LSD test for multiple comparisons

Color reflectance	80 hours of exposure to LED 28.81	110 hours of exposure to LED 28.85	140 hours of exposure to LED 28.71
80 hours of exposure to LED	-		
110 hours of exposure to LED	*0.04	-	
140 hours of exposure to LED	**0.100	**0.140	-

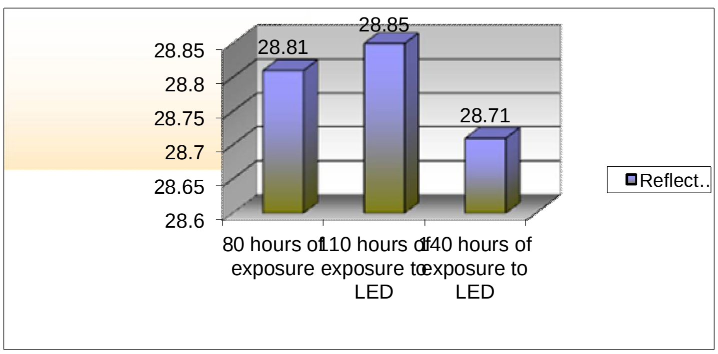

Fig (18) color reflectance of light grey chiffon after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the chiffon sample exposed 110 hours to LEDs and chiffon samples exposed to 80 hours in favor of 110 hours of exposure at significance level of 0.05, there are statistically significant differences between the chiffon sample exposed 110 hours to LEDs and chiffon samples exposed to 140 hours to LED in favor of 110 hours of exposure at significance level of 0.01, there are statistically significant differences between the chiffon sample exposed 80 hours to LEDs and chiffon samples exposed to 140 hours to LED in favor of 80 hours of exposure at significance level of 0.01.

Comparing the three samples to the standard sample the color reflectance of chiffon samples increased after 80 hours of exposure then increased more after 110 hours then decreased after 140 hours to a value bigger than the standard sample.

3.3.3. K/S

K/S values of light grey chiffon fabric before and after exposure to LED shown in table (32)

hypothesis there are statistically significant differences between chiffon samples after exposure to LED lights for 80 hours, 110 hours, and 140 hours in K/S and to investigate this hypothesis we calculated the analysis of variance for the mean K/S values of the three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours).

Table (32) K/S values of chiffon fabric before and after exposure to LED for (80h, 110h, and 140h)

Time of exposure to LED light	Not exposed to LED light	80 hours of exposure to LED	110 hours of exposure to LED	140 hours of exposure to LED
K/S	0.9031	0.8796	0.8774	0.8851

Table (33) Analysis of variance for the mean K/S values of chiffon samples exposed to (80h, 110h, and 140h)

K/S	Sum of squares	Mean of squares	Degrees of freedom	F	Significance
Between groups	229.749	114.874	2	18.598	0.01
Within groups	37.060	6.177	6		
Total	266.809		8		

This table shows that the F value was (18.598) which is the statistically significant value on (0.01) level which refers to the difference in K/S values between three sample (the first exposed to LED for 80 hours, the second 110 hours and the third 140 hours), to determine significance direction we performed the LSD test for multiple comparisons as shown in table (34).

Table (34) LSD test for multiple comparisons

K/S	80 hours of exposure to LED 0.8796	110 hours of exposure to LED 0.8774	140 hours of exposure to LED 0.8851
80 hours of exposure to LED	-		
110 hours of exposure to LED	**0.002	-	
140 hours of exposure to LED	**0.005	**0.007	-

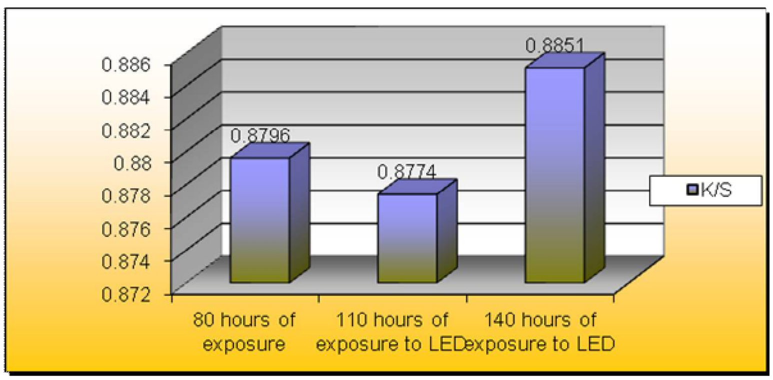

Fig (19) K/S of light grey chiffon after exposure to LED for (80h, 110h, 140h)

Therefore, there are statistically significant differences between the chiffon sample exposed 140 hours to LEDs and chiffon samples exposed to 80 hours and 110 hours to LED in favor of 140 hours of exposure at significance of 0.01, there are statistically significant differences between the chiffon sample exposed 80 hours to LEDs and chiffon samples exposed to 110 hours to LED in favor of 80 hours of exposure at significance of 0.01.

Comparing the three samples to the standard sample the K/S of chiffon samples decreased after 80 hours of exposure then decreased more after 110 hours then increased after 140 hours but to a value less than the standard value.

Conclusion

It can be concluded that:-

1- Using light emitting diode in fashion design as a decorative item is an innovative way to introduce new collections with new ideas and concepts.
2- There are several techniques of how we could add LEDs into clothes and we chose the suitabletechnique according to the fabrics type and properties.
3- By this paper we recognized the effects that LED could cause on mechanical properties and color strength of fabrics at certain number of hours, the exposure to LEDs have changed the maximum force and elongation of satin and

chiffon fabrics, the bursting strength of tulle fabric was changed too also LEDs changed the K/S and reflectance values of light grey chiffon, satin, and tulle.

4- In the bursting strength test the best interval of time that tulle was exposed to LED without changing much its value is 140 hours.

5- In maximum force and elongation test the best interval of time that satin was exposed to LED without changing much its elongation value is 80 hours and the best interval of time that satin was exposed to LED without changing much its maximum force value is 140 hours, while in chiffon fabric the best interval of time to LED exposure without changing much its maximum force and elongation value is 80 hours.

6- In K/S the best interval of time that tulle was exposed to LED without changing much its K/S value is 80 hours, while in satin the best interval of time to LED exposure without changing much its value is 80 hours, for chiffon the best interval of time to LED exposure without changing much its value is 140 hours.

7- In reflectance test the best interval of time that tulle was exposed to LED without changing much its value is 80 hours, while in satin the best interval of time to LED exposure without changing much its value is 80 hours, for chiffon best interval of time to LED exposure without changing much its value is 140 hours.

References

1- Lee, Suzan, Du Preez,Warren: "Fashioning the future: tomorrow's wardrobe",Thames & Hudson, London.p.97, 2005.
2- Schaeffer,Terry T.: "Effect of light on materials in collections", The Getty conservation institute, p.6, 2001.
3- Lam, Chi Hin: "Creation of illuminative smart fashion", PH.D thesis, The Hong Kong Polytechnic University, China, p.20, 21, 2013.Retrieved from https://webapp.lib.polyu.edu.
4- "Longman dictionary of contemporary english", third edition, Addison Wesley Longman limited, England, 1995.
5- Thorseth,Anderes: "Characterization, modeling, and optimization of light-emitting diode System." PH.D thesis, University of Copenhagen, Denmark, P.4, 2011.Retrieved from http://orbit.dtu.dk.
6- U.S.departement of energy, energy efficiency and renewable energy: "Life time of white LEDs"retrieved from http://www.betterbuildingssolutioncenter.energy.gov, Sep.2009.
7- Sabry,Abdelmonem, Saleh, Reda: "Textile terms dictionary", Democratic Germany, p.62, 1975.
8- Elmahdy, Enayat: "Learn sewing basics", Ibn Sina, Egypt, p.98, 1995.
9- Callan Georgina: "The Thames & Hudson dictionary of fashion and fashion designers" fourth edition, Thames & Hudson, London, p.68, 2008.
10- Winifred, Aldrich: "Fabric form and flat pattern cutting", Blackwell science Ltd, London, p.23, 2007.
11- "Textile tests", Nubair printing, Cairo, p.115, 2006.
12- Abd Allah, Ola: "The Effect of some fabric's structural construction difference on draping", unpublished master's thesis, Faculty of Home Economics, p.10, 1997.
13- Sabry Mohamed: "Textile materials", Nubair printings, Cairo, p.8, 2006.
14- Ibrahim, Saadya: "The Effect of changing materials type on fabrics strength",Science and Arts magazine, Volume 15, Issue1, p.47, jan.2003.
15- Mahmoud, KhaledEzzeldin: "Determining the most convenient standards to measure the quality of some textiles used in readymade garments industry", unpublished PH.Dthesis, Faculty of Applied Arts, p.117, 1999.
16- Shawky, Ismael: "Design principles and elements in fine art", Omraniyah offset printings, p.101, 2000.
17- Gouda, AbdElaziz, Shehata, Ahmad: "Readings in art taste and history", Helwan University printings, Cairo, p.29, 1993.
18- Shimo S, Sultana, Smriti A, Shamima: "Color co-ordinates and relative K/S of reactive dye influenced by fabric GSM and dye concentration", International journal of research in engineering and technology, Vol 4, Issue 2, p.193, Feb.2015.
19- ASTM D3776 / D3776M-09a: Method for determination of mass.
20- ASTM D1777: Method for determination of thickness.
21- ASTM D 3787, 2001: Method for determination of bursting strength of textile.
22- EN ISO13934-1.1999: Method for determination maximum force and elongation of textile.