

## Using optical fibers in the design of new-born children Clothes for the treatment of jaundice

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### Abstract

This search specifies the requirements of clothing which are designed for new born children to offer comfortable and protection against bacteria growth and treatment of jaundice by phototherapy.

Due to the nature of phototherapy whenever areas increased it prone to light whenever the response are faster treatment. Nurseries for the treatment of jaundice require that the child be without clothes and the presence of a nurse to prone another area of the child to light every period and the child is far from his mother, breastfeeding is a main factor in the treatment of jaundice.

For the body of new born children to remain comfortable, we will use cotton. the growth of microbes on textiles during use and storage negatively affects the wearer especially children. the detrimental effects can be controlled by durable antimicrobial finishing of the textile by treated.

Though this study which is divided into three parts, first part, was found that Bafta %100cotton fabric plain weave,140gm/m<sup>2</sup>and Canvas (Etamean) %100cotton fabric warps rib 4,120/4gm/m<sup>2</sup>are particularly comfortable to wear for children . Bafta and canvas were treated against bacteria with natural materials and herbs.

Second part; took place on the best result from first part then attach optical fibers in bafta and Canvas (Etamean) fabric by different ways we found that the second method (optical fiber weaving in the threads of canvas fabric) is better to safety of optical fiber and easier in implement.We will use LED (Light- Emitting Diodes), Taking into account wavelength and spectral distribution.

Third Part, took place on the best result from second part then we design different designs of jump suit and blanket with side glowing optical fiber for new born children we found that Jump suit and blanket were suitable in implementation and both were selected.

### **Keywords**

Jaundice in new born children, phototherapy, optical fiber, antibacterial test

### **.1 Introduction**

Smart Clothing As a form of wearable technology, which refers to “many different forms of body mounted technology, including wearable computers, smart clothing, and functional clothing,” smart clothing distinguishes itself from other worn accessories like fitness bracelets and emphasizes the importance of clothing attributes ((1

Smart textiles for healthcare include textile sensors, actuators and wearable electronics systems embedded into textiles that enable registration and transmission of physiological data, and wireless communication between the wearer and the ‘operator’, for example, patient and medical personal. Such systems ensure patients’ mobility, thereby providing a higher level of psycho-physiological comfort, especially when a long-term bio-monitoring is required.( 2

Generally, applications of smart textiles for medicine and healthcare vary from the surgical applications of single yarns to complex wearable and axillary systems for personalized healthcare. There is no still classification smart textile for these applications, but initially those can be described referring to commonly distinguished groups in conventional medical textiles.((3

Fiber optic technology is particularly attractive for application in smart textiles because it allows both sensing and signal transmission. Moreover, polymer optical fibers (POFs) are cheap, lightweight, flexible and robust, and they are able to measure high strain values without damage.

During the last decade, several groups of research have focused their efforts on obtaining a substantial development in the integration of smart textiles and fiber optic technology.((4

#### **1.1 Problem statements**

The research problem is determined in the following:

- There is a deficiency in the ability of the current treatment to show the body of the whole child to light at the same time without flipping the child every period.
- Not available of phototherapy nurseries in all hospitals and high prices.

## 1.2 The aims of the research:

- In-depth study of clothing and smart fabrics and their application in newborn clothe.
- Study how to treatment newborns with jaundice.
- Identify the fabric used in children's clothing.
- The proposal for the design of jumb suit with optical fiber helps in the treatment of jaundice in neonates.

## 1.3 Research methodology:

### Experimental method by :

- conducting some measurement to measure the wavelength, light intensity, distribution consistency required in phototherapy that works to break down the excess bilirubin so that the liver can get rid of it.
- treatment the fabric from a bacteria.

## .2 Review of literature

Generally, applications of smart textiles for medicine and healthcare vary from the surgical applications of single yarns to complex wearable and axillary systems for personalized healthcare. There is no still classification smart textile for these applications, but initially those can be described referring to commonly distinguished groups in conventional medical textiles. Of course, due to new functions, several new categories must be highlighted. Those are textile drug-release systems, textiles with biometric performance and active textiles for therapy and wellness.((3

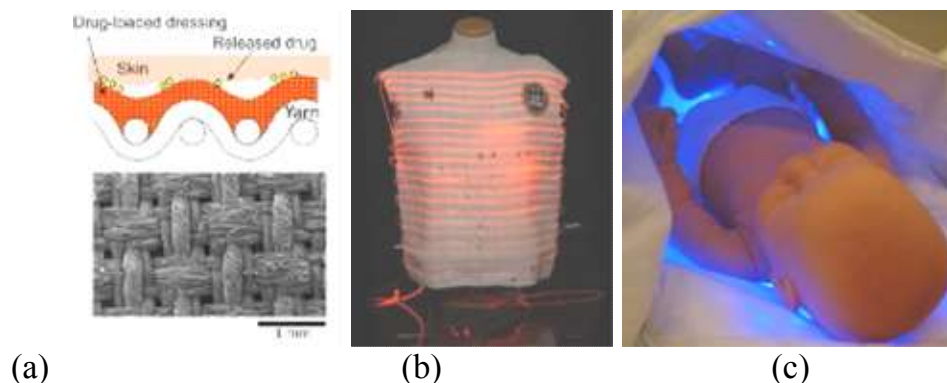


Figure (1) Wearable Motherboard™ and Philips phototherapy blanket

Figure (1)(a) Medical textile with a lubricating drug-delivery dress in  
Figure (5-1)(b) Wearable Motherboard™ for vital signs monitoring

Figure (1)(c) Philips phototherapy blanket for new-born' jaundice treatment (3)

During the first week of life all newborns have increased bilirubin levels by adult standards, with approximately %60of term babies and %85of preterm babies having visible jaundice. Most of these cases are benign but it is important to identify those babies at risk (although rare) of acute bilirubin encephalopathy and kernicterus/chronic encephalopathy. Jaundice may also be a sign of a serious underlying illness (6)

## 2.1 Treatment of jaundice

Hyperbilirubinaemia can be treated with :

- Phototherapy.
- Exchange transfusion.
- Pharmacological agents.

### 2.1.1 Phototherapy

Phototherapy is the first line treatment for neonatal jaundice and is effective in most babies in reducing TSB level. Its efficacy depends on wavelength and luminance of the light source and the skin surface area illuminated by the light.( 9)

The aim of phototherapy is to decrease the level of unconjugated bilirubin in order to prevent acute bilirubin encephalopathy, hearing loss and kernicterus. (7)

Lamps emitting light between the wavelengths of 400- 500 nanometers (peak at 460nm)

are specifically used for administering phototherapy as bilirubin absorbs this wavelength of light. The light is visible blue light and contains no ultraviolet light.(6)

Factors that influence the efficacy of phototherapy include: the light wavelength and irradiance, bilirubin level, birth weight, gestational age, postnatal age, surface area exposed, skin thickness and pigmentation and the etiology of the jaundice. (8)

The absorptions of light by bilirubin also results in the generation of excited-state bilirubin molecules that react with oxygen to produce colorless oxidation products, or photo oxidation products. This process occurs more slowly than configurationally or structural isomerization. Photo oxidation products are primarily excreted in the urine. Figure (2) provides a schematic of the conversion of normal bilirubin to

configurationally isomers, structural isomers, and photo oxidation products and the respective routes of excretion from the body.

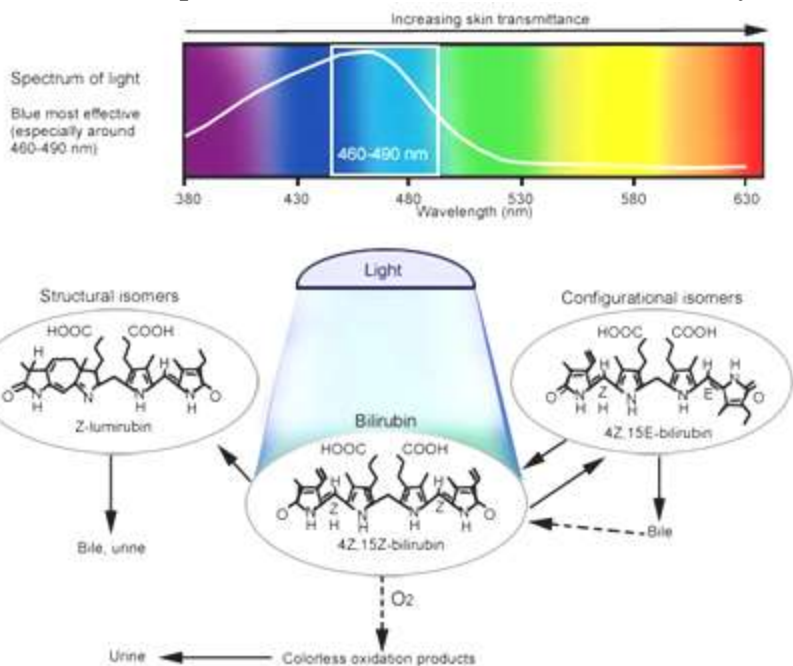
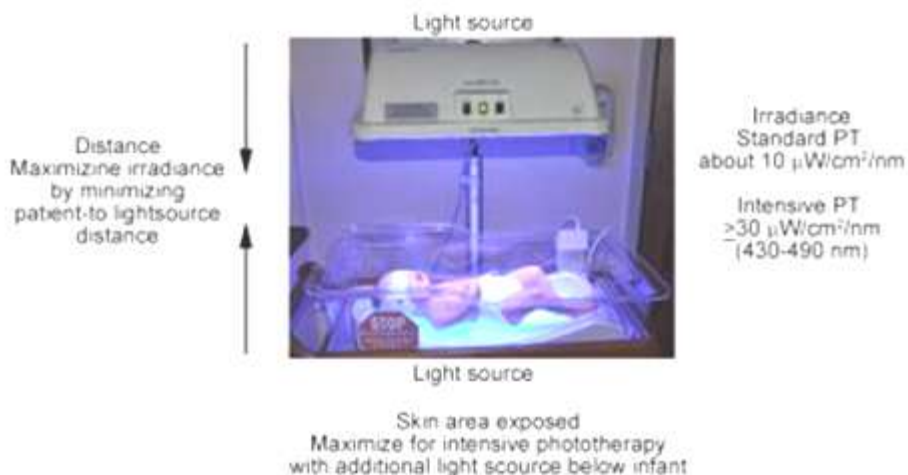


Figure (2) Illustration of how to convert bilirubin to liquid by light

### 2.1.2 Factors that affect phototherapy:

Third factors that affect the dose of phototherapy include the irradiance of light used, the distance from the light source, and the amount of skin exposed see figure(3)



Figure(3) Nursery of phototherapy

Standard phototherapy is provided at an irradiance of 10-8 microwatts per square centimeter per nanometer ( $\mu\text{W}/\text{cm}^2\text{per nm}$ ). Intensive phototherapy is provided at an irradiance of  $30\mu\text{W}/\text{cm}^2\text{per nm}$  or more (430– 490nm). (10)

### 3 Experimental work

#### 3.1 Materials:

##### 3.1.1 Fiber

There are two types of fiber end glowing and side glowing we will use side glowing type.

The side glowing optical fiber used in this search is 2mm solid core side light fiber cable) see figure( .4



Figure (4) side glowing optical fibers

##### 3.1.2 Light Sources

3.1.2.1 LASER Light Amplification by Stimulated Emission of Radiation.



Figure (5) blue leaser

##### 3.1.2.2 LED Light- Emitting Diodes

Different (White and blue) optical source collected from local market to Choose the most appropriate treatment for jaundice in children.



Figure (6) white LED and blue LED

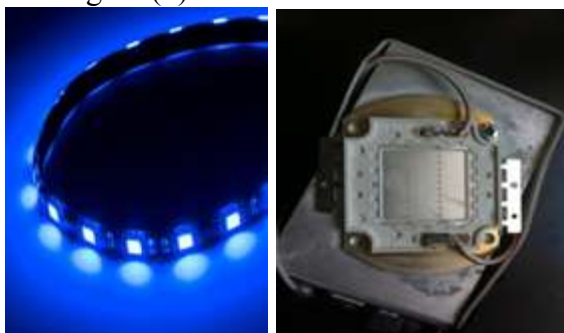


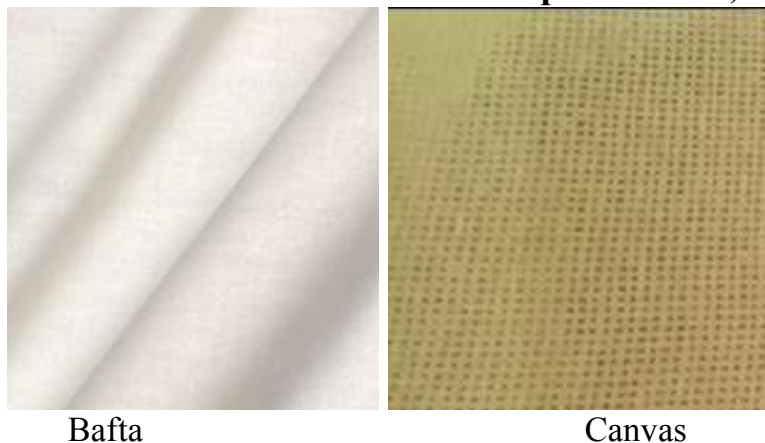
Figure (7) tape of LED

### 3.1.3 Fabrics:

Cotton and silk are both great fabrics for baby clothing as they allow the skin to breathe keeping baby cool and comfortable. Silk also has natural anti-bacterial properties which reduce the risk of infection.

Cotton is particularly comfortable to wear for children.

#### 3.1.3.1 Bafta %100 cotton fabric plain weave, 140gm/m.2



Bafta

Canvas

Figure (8) baft and canvas fabric

#### 3.1.3.2 Canvas (Etamean) %100 cotton fabric warp rib 4/4, 120gm/m.2

### 3.2 Measurement of the spectral power distribution

The spectral power distribution of different LED (Light- Emitting Diodes) sources collected from local market especially blue LED.

Using Mini Spectrometer, Model (C10082CAH), from HAMAMATSU company.

### 3.3 Methods of Attaching Fibers to fabric:

**3.3.1** Attach side optical fiber to the fabric in different ways to get the best design To obtain the best result of light passing within fiber optics (see figure( .(9

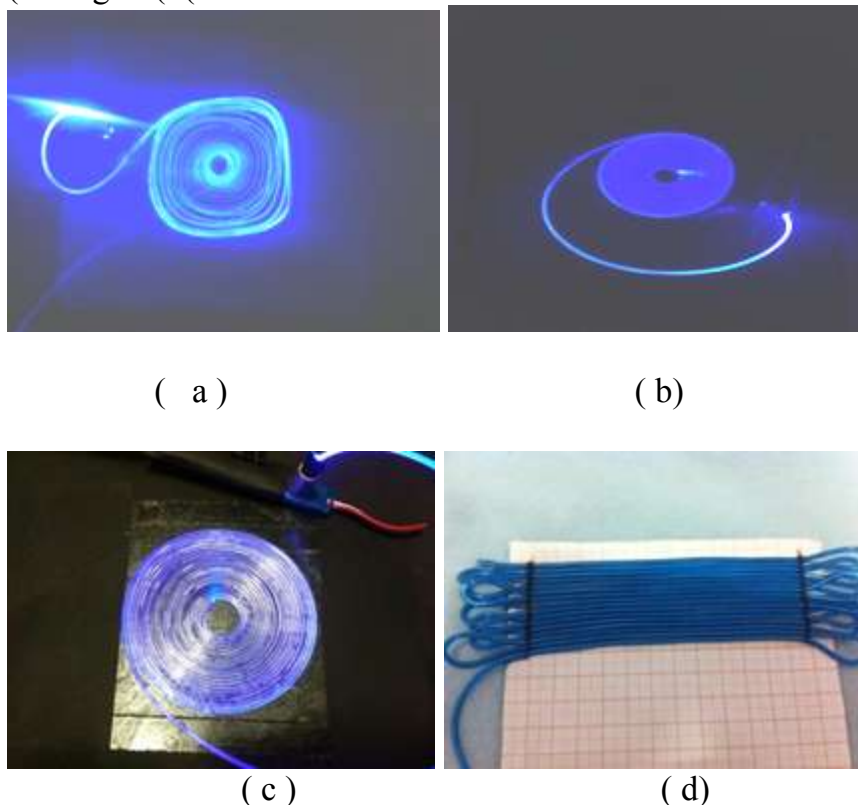


Figure (9) Attach side optical fiber to the fabric in different ways

Sample(1) Attach fibers to a Bafta fabric by hand sewing in straight lines see photo (d) figure (.10-2

Sample (2) Attach fibers to a Bafta fabric by double Face glutinous then hand sewing in a circle shape see photo (b , c ) figure (.9

Sample(3) Attach fibers to a Bafta fabric by double Face glutinous then hand sewing in square shape see photo (a) figure (.9



**3.3.2** Weaving optical fibers on Canvas fabric in different ways to get the best design to obtain the best result of light passing within fiber optics. Attach optical fiber with the fabric of canvas by weaving the optical fibers in the threads of the fabric of canvas (see figure (10).

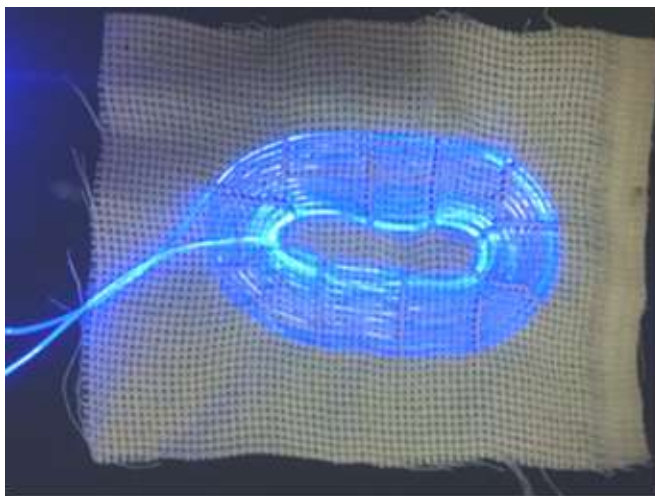


figure (10) Weaving optical fibers on Canvas fabric

### **3.4 Measuring the amount of energy (irradiance level $\mu\text{W}/\text{cm}^2$ )**

produced by the design Hyperbilirbinemia Irradiance Meter, Model (ILT 74) from International Light technology company.

measurement will be on different points of the design then device screen shows the amount of energy produced by the design.

### **3.5 Antibacterial Test**

The determination of percentage reduction is done according to (AATCC Test Method .(2011-147

Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method.

#### **3.5.1 Test Half a Bar**

#### **3.5.2 Test Vanilla.**

#### **3.5.3 Test Garlic and Vanilla**

### **3.6 Washing Test**

Home washing test was performed more than once on optical fiber by soaking the fibers in the water with soap and then rinse and dry it.

### **3.7 Designs**

**3.7.1 Design One:** Design of jump suit one piece with button of front for new born children see figure (11)



Figure (11) Jump suit

**3.7.2 Design Two:** Design (2) Design of blanket jump suit for new born children one piece with button of shoulder and sides see figure (.12)



figure (12) blanket Jump suit

**3.7.3 Design three:** Design of Cappuccino blanket one piece for new born children see figure (.13)



Figure (13) Blanket

**3.7.4 Design four :** Design of blanket with neck line and with button of shoulder and sides one piece for new born children see figure (.14

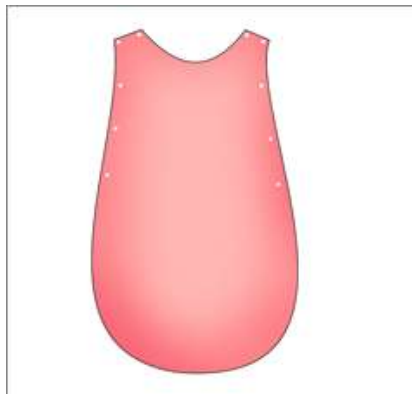


Figure (14) Blanket

#### 4Results

In this search we aim to design clothes of new born children for treatment of jaundice by using optical fiber and same time anti bacterial.

In part one test samples were bafta %100cotton fabric plain weave, 140gm/m<sup>2</sup>.and Canvas (Etamean) %100cotton fabric warp rib 4/4, 120 gm/m<sup>2</sup> treated with natural materials by using three different natural

materials, half a bar, vanilla, garlic and vanilla By comparing sample 1 and sample 2 (sample 2 washed after the test) it was found that :

- sample 1 was better than sample 2 in positive bacteria and the difference was 3mm.
- Sample 2 is better than 1 in negative bacteria and the difference is 3mm.

But both of them are better than two samples of half a bar and vanilla .

The test result of anti bacterial activity of garlic and vanilla for two samples (1,2) were very good and equal to the results of chemical treatment.

Part two, took place on the best result from part one then we attach optical fiber in Bafta and Canvas fabrics in different ways by hand sewing, double Face glutinous then hand sewing, and by weaving the optical fibers in the threads of the fabric, the probability of passing the light was very good in all of lines and points in last method.

and we attach optical fiber in Bafta and Canvas fabrics in different forms (Round, oval, square), The Circle and oval design were chosen to avoid bending the fiber and reaching the maximum amount of light.

then we measuring the spectral power distribution of different LED (Light- Emitting Diodes) by Using a device Mini Spectra meter, Model (C10082CAH) FROM HAMAMATSU company.

The result is suitable for Mechanism of phototherapy: Blue light in the range of 490-450nm is most effective for phototherapy.

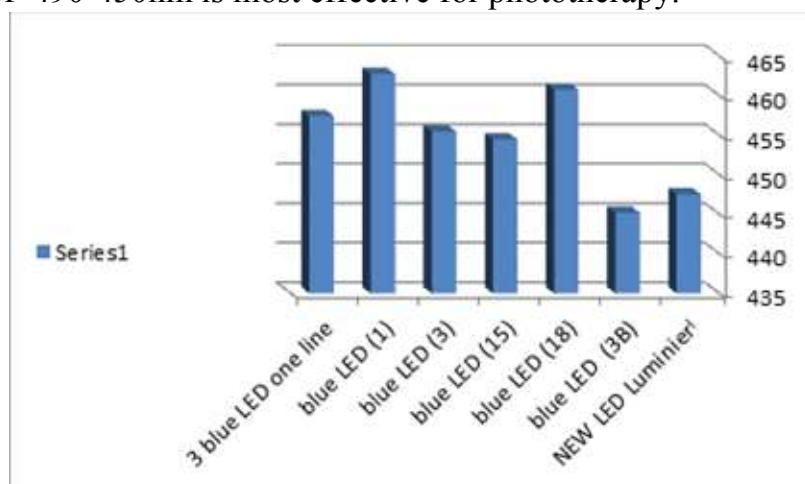


Figure (15) Graph Comparison of optical sources and their spectral distribution

A graph see Figure (15) showing that the optical light source blue LED (1) 462.739 obtained the highest wavelength and blue LED (3B)

obtained the least wavelength 445.2nm and both of them are suitable for treatment of jaundice where the required wavelength is from ( 450to 475) nm.

we measuring the amount of energy (irradiance level  $\mu\text{W}/\text{cm}^2$ ) to the design of samples by Using advice Hyperbilirbinemia Irradiance Meter, Model (ILT 74) from International Light Company.

Part three, took place on the best result from part two then we design different designs of jump suit and blanket for new born children to choose the best design and implement it with side glowing optical fiber

We shown design two of blanket jump suit for new born children one piece with button of shoulder and sides and its end is closed like a blanket and the idea in the oval shape from the bottom to fit with weaving optical fiber in the clothes .

### **Conclusion**

This study shows that, Cotton is particularly comfortable to wear for children. Jump suite and blanket were designed to select the most suitable in the extraction. and the suitable selection has been made .

Finally, we have optical fiber clothes for new born children treatment of jaundice and anti bacterial at a low cost that can be applied on an industrial range using materials available in the market .

## References

- 1- Dunne, L. E. (2004). The design of wearable technology: Addressing the human-device interface through functional apparel design (Master's thesis). Retrieved from <http://ecommons.cornell.edu/bitstream//2/150/1813/Lucy20%E20%Dunne-Masters20%Thesis.pdf>
- 2-Schwarz A., van Langenhove L., Guernonprez P., Deguillemont D. (2010) A Roadmap on Smart Textiles. Textile Progress, Vol., 42, pp.180-99
- 3-Rigby A.J., Anand S. (2000). Medical Textiles. In: Handbook of Technical Textiles, Cambridge, Woodhead Publishing, pp.424-407
- 4-Truman P. Jaundice in the preterm infant: effective management. Journal of Neonatal Nursing 2002;9(1): .26-22
- 5- Krebber, K.; Liehr, S.; Witt, J. Smart technical textiles based on fibre optic sensors. In Proceedings of the 22nd International Conference on Optical Fiber Sensors, Beijing, China, 14 October .2012
- 6- International Journal of Clothing - Science and Technology - Vol. 16 No. 2/1, 2004- pp. 72-63- q Emerald Group Publishing Limited 6222-0955 DOI 0955622041052036/10.1108
- 7-International Journal of Clothing - Science and Technology, - Vol. 14 No. 4/3, 2002, pp. 215-201. - q MCB UP Limited, 6222-0955 DOI .09556220210437167/10.1108
- 8-Smart textiles for healthcare: applications and technologies Viktorija Mečņika 1 Ms.sc.; Melanie Hoerr 2 Dipl.-Ing. Ivars Krieviņš 1 Assoc.prof. Dr.sc.ing.; Anne Schwarz 2 Dr.sc.ing. Institute of Textile Technology and Design of Riga Technical University, Latvia 1; Institut fuer Textiltechnik of RWTH Aachen University, Germany 2 viktorija.mecnika@rtu.lv, ivars.krievins@rtu.lv 1; melanie.hoerr@ita.rwth-aachen.de, anne.schwarz@ita.rwth-aachen.de 2
- 9-Canadian Paediatric Society. Position Statement (FN 02-2007). Guidelines for detection, management and prevention of hyperbilirubinaemia in term and late preterm newborn infants ( 35 or more weeks' gestation). Pediatr Child Health 2007;12:1B-12B.
- 10- Adapted from Maisel MJ, McDonagh AD. Phototherapy for Neonatal Jaundice. N Engl J Med. 2008; 928-358:920

## إستخدام الألياف الضوئية في تصميم ملابس الأطفال حديثي الولادة لعلاج مرض اليرقان

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### الملخص

يعتقد أن المنسوجات الذكية تكون فكرة جديدة عن المنتجات مع فرصة كبيرة على سوق الغزل والنسيج والملابس. وبشكل عام، فإن المنسوجات الذكية تذكر كمنتجات نسيجية ذات قيمة مضافة، أي أن لديها خصائص مشتركة من المنسوجات، للحصول على وظائف إضافية، وتوفير حلول جذابة لمجموعة واسعة من مجالات التطبيق، مثل الرعاية الصحية والملابس للحماية والرياضة. صناعة منتجات المنسوجات الذكية تحتاج إلى نهج تكنولوجي مبتكر، والمنسوجات الذكية لها خصائص المواد النسيجية التقليدية وتحمل القيم الوظيفية المضافة. ترتبط عادة مع أداء التفاعل الاستشعار. وتتماشى هذه المنتجات مع الالكترونيات القابلة للارتداء، والتي غالبا ما تكون جزءا رئيسيا من المنسوجات الذكية.

ويهدف هذا البحث إلي متطلبات تصميم ملابس للأطفال حديثي الولادة لعلاج اليرقان، باستخدام قماش منسوج 100% قطن (بافتا - إيتامين) وتمت معالجتهم ضد البكتيريا مع الحفاظ على خواص القماش المطلوبة (الخصائص الفيزيائية، الميكانيكية، الحرارية، الوظيفية، وخواص الراحة) المساحة الدافئة الموجودة بين جلد الطفل والملبس هي وسط مثالي لنمو البكتيريا والكائنات الدقيقة، لذا قد تمت معالجة الأقمشة بالمواد الطبيعية والأعشاب لتكون ملائمة وأكثر أماناً لجلد الطفل من المعالجات الكيميائية.

القسم العملي مقسم إلى ثلاثة أجزاء

الجزء الأول: اختبار مضاد للجراثيم

تم إجراء الاختبار على عينات أقمشة:

• قماش قطن منسوج سداء 1/1 (بافتا).

• قماش قطن منسوج سداء 4/4 (إيتامين).

بمواصفة قياسية AATCC 2011-147 قياس النشاط البكتيري للمنسوجات .

تتم مقارنة طرق المعالجة الثلاث:

- معالجة الأقمشة باستخدام نبات الحلفا بر، وكانت نتيجة الإختبار مقبولة.

- معالجة الأقمشة باستخدام نبات الفانيلا، وكانت النتيجة متوسطة.

- معالجة الأقمشة باستخدام الثوم والفانيلا، وكانت نتيجة الإختبار جيدة جدا مقارنة بالمعالجات

السابقة ، ومساوية لنتائج المعالجات الكيميائية للأقمشة ضد البكتريا.

### الجزء الثاني:

تم نسج الالياف الضوئية مع العينات تحت البحث بعدة طرق وكانت أفضلها الشكل

الدائري والبيضاوي.

عند مقارنة الشكل الدائري والشكل البيضاوي نجد أن:

الشكلين متساويين في انتقال الضوء في الألياف البصرية، ولكن الشكل البيضاوي سيكون

أفضل في تنفيذ التصميم النهائي للوصول إلى أكبر منطقة منسوجة بالألياف الضوئية.

عند مقارنة طريقة تثبيت الالياف الضوئية بالعينات تحت البحث:

كانت طريقة نسج الألياف الضوئية بقماش الإيتامين أفضل منها في قماش البافتا حيث

كانت أسهل في التنفيذ وأفضل للألياف الضوئية

قياس التوزيع الطيفي لأكثر من نوع من الديودات الباعثة للضوء "LED" لاختيار النوع

الأنسب في علاج اليرقان عند الأطفال. ووجدنا أن أكثرهم مناسب لعلاج اليرقان حيث الطول

الموجي المطلوب من (450 إلى 475) نانومتر.

قياس كمية الطاقة الناتجة من الألياف الضوئية المنسوجة في قماش العينات تحت البحث

كانت النتيجة متناسبة مع علاج اليرقان لحديثي الولادة.

### الجزء الثالث:

التصميمات

وجدنا أن السالوبيت والبطانية كلاهما مناسب في التنفيذ مع الألياف الضوئية ( side

glowing) لعلاج اليرقان في الأطفال حديثي الولادة.