INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY ISSN: 2456-6683 Volume - 4, Issue - 1, Jan – 2020
Monthly, Peer-Reviewed, Refereed, Indexed Journal Scientific Journal Impact Factor: 5.245
Received on : 27/12/2019 Accepted on : 09/01/2020 Publication Date: 31/01/2020

An Overview on Multifunctional Smart Textiles and Future Perspective for Mankind Development with Nano-technology.

[1] Sourav Kumar Das, [2]Injamam Ul Huq, [3] Sabbir Ahamed , [4] Sudipta Das
[1, 2, 3, 4] Wuhan Textile University, Hubei , China
Email: sourav.biomedical@outlook.com

Abstract: *Now at present, modern Textiles reflects on smart textiles which covers every incidents of mankind with proper technology and take this advantages on human development that is mentioned functional textiles. Technical textiles with its Nano- technology is becoming a part of every portion of life from human brain to space ship. An attempt has been taken by this paper to accumulate some smart multi-functional textiles like-PCM(Phase Change Materials) process with thermo regulatory system for electronically wearable textiles and medical textiles for human body. Wearable textiles can sense, react and adapt themselves accordingly to external conditions or stimuli and wearable textiles can be divided into active and passive smart wearable textiles which can be work with human brain with cognition, reasoning, activating capacity.*

Key Words: *Phase change materials, thermo regulations, wearable electronic textiles, crystal elastomer, artificial muscles.*

1. INTRODUCTION:

A phase change material (PCM) is a substance which releases or absorbs sufficient energy at phase transition to provide useful heat or cooling. By melting and solidifying at the phase change temperature (PCT), a PCM is capable of storing and releasing large amounts of energy compared to sensible heat storage. Fiber and textile which have automatic acclimatizing properties have recently attracting more and more attention[1].Many People working in extremely cold or hot environment which is necessarily needed for extremely one technical textiles through electrical signals and wearable. To integrate safety signals into smart textiles, long afterglow phosphors material is a rational choice, which can store excitation energy and emits luminescence with different colors after ceasing excitation[2]. These materials can acts under external stimuli like radiation, changing in temperature, chemical reaction, mechanical force, electric or magnetic field which acts on the outer layer of these materials. Human has always trying to build those smart materials which can sense the external stimuli and also can acts as per the external stimuli. These materials can adapt the outer environmental condition very quickly and can sense into it as human brain, with cognition, reasoning and activating capacities.[3]

Electronic Textiles (e-textiles) are fabrics that feature electronics and interconnections woven into them, presenting physical flexibility and typical size that cannot be achieved with other existing electronic manufacturing techniques. A study about intelligent textiles is at his first stage reduced to a study on smart materials. In a second phase, it is to be considered in which way these smart materials can be processed into a textile material. Both conventional and technical textiles are indispensible products for human daily life with various functions. Research and development activities in the field of textiles are running parallel to the advances in smart materials, which sense all relevant environmental stimuli (electrical, chemical, mechanical, magnetic, optical, etc.) and evaluate, react, or sometimes adapt to those conditions.[4] In this context the vision of smart clothes promises greater user-friendliness, user-empowerment, and more efficient services support. Wearable electronics recognizes and responds to the presence of individuals in a more or less invisible way.[5] This PCM will be implemented through thermodynamic treatment method for fabricating long, soft, and reversibly actuatable liquid crystal elastomer (LCE) fibers by using direct ink write (DIW) printing was developed artificial muscle. According to Tao, fibers that are able to withstand a minimum of 100% strain and are under 750 μm in diameter can be easily integrated into textiles using existing manufacturing strategies, such as loom knitting, weaving, and sewing. This indicates opportunities for the incorporation of stretchable, mechanically robust, smart fibers into textiles.[6] The mechanical power output from actuator materials per mass or volume tends to increase at smaller dimensions, due to faster mass and heat transport or higher surface area to volume ratios.[7] Increasingly, there is interest in the development of highly flexible and sensitive pressure sensors that can detect a wide range of pressures. These sensors have a vast potential to be used for applications where surface complexity, thickness limitations and sensitivity are critical, such as electronic skin. These sensors could potentially stimulate applications in the fields of soft robotics, human-machine interfacing, electronic gloves, touch detection, biomedical devices and prostheses, and human motion analysis.[8]

Received on : 27/12/2019 Accepted on : 09/01/2020 Publication Date: 31/01/2020

2. PHASE CHANGE FOR MATERIALS:

Latent heat storage is one of the most efficient way of storing thermal energy. Unlike the sensible heat storage method, the latent heat storage method provides much higher storage density, with a smaller temperature difference between storing and releasing heat. Every material absorbs heat during a heating process while its temperature is rising constantly. The heat stored in the material is released into the environment through a reverse cooling process. for an example, absorbs approximately 200 kJ/kg of heat if it undergoes a melting process .[1] High amount of heat absorbed by the paraffin in the melting process is released into the surrounding area in a cooling process starts at the PCM's crystallization temperature. After comparing the heat storage capacities of textiles and PCM, it is obvious that by applying paraffin-PCM to textiles their heat storage capacities can substantially enhanced.

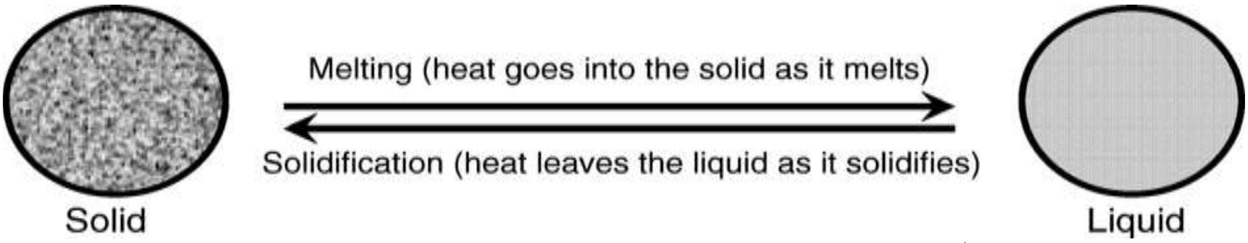

Fig. 1. Schematic representation of phase change process.[1]

A phase change material (PCM) is capable of absorbing or releasing great amount of energy in a form of latent heat (_H) during phase transitions between solid–solid or solid–liquid phases over a narrow temperature range. This action is typically transient, i.e.it will occur until a latent heat of the PCM is absorbed or released.[9] To produce the required microcapsules, shell materials and some auxiliaries were chosen in relation to the applied in situ polymerization technique. SEM view(figure-2) after done PCM process. The chosen types of reaction initiator and anionic polyelectrolyte are able to serve for improving the polymerization of urea and formaldehyde whereby microcapsules having high strength and low permeability are obtainable 1,3-Benzenediol (Resorcinol) reacts with formaldehyde as a cross-linking agent and produces resorcinol/formaldehyde resin, which enhances the shell formation and prevents bond breaking in polymerization chains.[10]

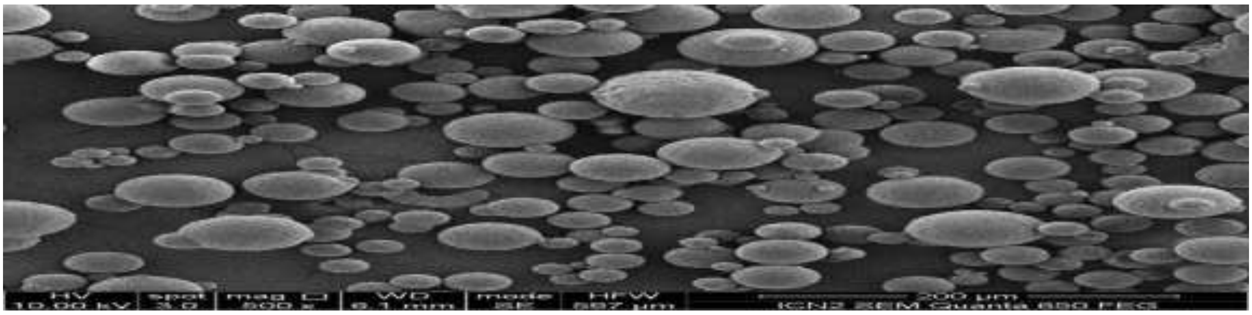

Fig 2: SEM view at 200µm after PCM of Materials

3. After PCM done/ Surface treatment of Electrical smart Textiles:

Conductive coatings are applied on the surface of the yarns without sufficient changing of density, flexibility and handle. There are various processes as- sputtering, gravure printing, flexographic printing, screen printing, ink jet printing (by DoD, continuous ink jet, pulsed ink jet heads), evaporative deposition (CVD) and elctroless plating generally used for manufacturing of vacant electronic state (band).

4. End uses of electrical smart textiles:

There are various usages wearable e-textiles as- sensors, data transferring, USB connection, textile Bluetooth antenna, system integration on P-FCB capacitive sensor (LED off/light-on water drop on the sensor), kids and pets, medical, hearables, sports and fitness, smart watches, augmented reality, fashion shoe, smart undergarments, flexion handrest, Numetex sports bra (Textronics).[3]

Fig 3 : Classification of Smart Textiles

5. Electricity measurement of materials after PCM:

The electrical resistivity of conductive materials can be measured as per the following formula:

$P = V.t.w/ I.L.(\Omega m)$

Where, V is the measured voltage, t is the sample thickness in meters, w is the sample width in meters, L is the sample length in meters and I is the imputed current in amp.

Shielding effectiveness can be measured in ASTM 4935 standard where the spectrum analyzer and shielding effectiveness test fixture used to measure the EMSE under an frequency range of 30 MHz-1.5 GHz.[3]Figure -4 shows from PCM to smart Textiles.

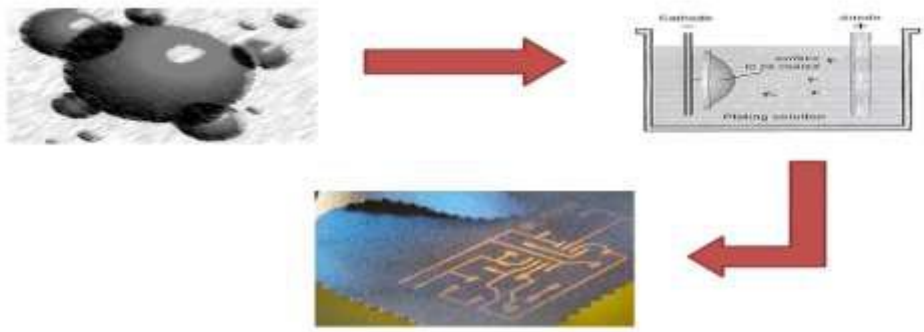

Fig 4 : PCM process to Electro treatment of surface to Smart Textiles

6. Performance measure of Conductive materials as sensor

Conductive textiles that change their electrical properties as a result of the environmental impact can be used as sensors. Typical examples are textiles that react to deformations such as pressure sensors, stretch sensors and breathing sensors. On the other hand, with smart textiles we have the further possibility to make bio-potential sensors.

7. Medical Textiles

Investigation of the capabilities of optical fiber sensors for healthcare monitoring in MRI environment has been largely reported in the past, due to the well-known immunity of fiber optics against electromagnetic radiations. Monitoring of respiratory motions and/or detection of heart beats were demonstrated using pure optical methods, in particular the bending loss technique using either a coil.[11]

Medical Textiles are the products and constructions used for medical and biological applications and are used primarily for first aid, clinical and -hygienic purposes. It consists of all those textile materials used in health and hygienic applications in both consumer and medical markets.As such it comprises a group of products with considerable variations in terms of product performance and unite value.Because of the nature of their application many medical products are disposable items.The increased use of textiles in composite applications will provide major growth fiber consumption in terms of volume.

8. Artificial Muscle through crystal elastomer fiber :

A method for fabricating long, soft, and reversibly actuatable liquid crystal elastomer (LCE) fibers by using direct ink write (DIW) printing was developed. Here, the LCE was produced based on a two-stage thermal-photo curing reaction between a difunctional acrylate monomer and thiol. The LCE ink, mixed with nanoclay to increase the viscosity, was extruded through a nozzle onto a rotating mandrel to obtain a long fiber.[6] The knitted textile provides the combination of strain sensing and the ability to control dimensions required for smart clothing that simultaneously monitors the wearer's movements and adjusts the garment fit or exerts forces or pressures on the wearer, according to needs. The developed processing method is scalablefor the fabrication of industrial quantities of strain sensing and actuating smart textiles.[7]

Figure -5 shows schematic movement of the anatomy of artificial muscle.

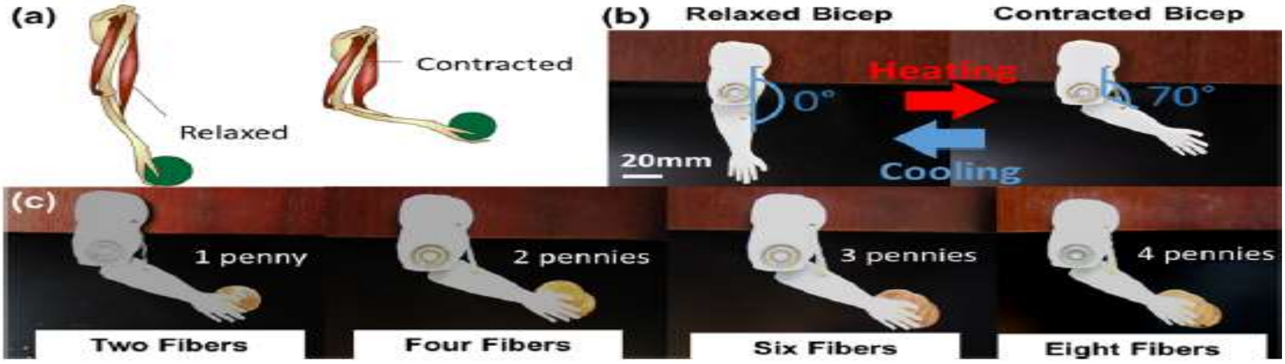

Fig 5: Schematic movement of the anatomy of an artificial Muscle [6]

9. CONCLUSION:

In upcoming future this world all perspective will depend on nano-technology. As being a part Textile Nano Technology further research need to do for future mankind development. Medical science are relying more day by day on smart textile with its effected nanotechnology. There is a vast field for doing research on this medical textile and need to be effectively implemented on human development. Electronic textiles, or smart textiles, describe the convergence of electronics and textiles into fabrics which are able to sense, compute, communicate and actuate. As many different electronic systems can be connected to any clothing, a wearable system becomes more versatile, and the user can change its look depending on environmental changes and individual preference. Finally, we consider relevant that the development of smart textiles requires a multidisciplinary approach in which knowledge of circuit design, smart materials, micro-electronics and chemistry are fundamentally integrated with a deep understanding of textile fabrication.

REFERENCES:

1. Mondal, S., Phase change materials for smart textiles – An overview. *Applied Thermal Engineering* 2008, *28* (11), 1536-1550.
2. Lu, Y.; Xiao, X.; Liu, Y.; Wang, J.; Qi, S.; Huan, C.; Liu, H.; Zhu, Y.; Xu, G., Achieving multifunctional smart textile with long afterglow and thermo-regulation via coaxial electrospinning. *Journal of Alloys and Compounds* 2020, *812*, 152144.
3. Singha, K.; Kumar, J.; Pandit, P., Recent Advancements in Wearable & Smart Textiles: An Overview. *Materials Today: Proceedings* 2019, *16*, 1518-1523.
4. Bedeloglu, A.; Demir, A.; Bozkurt, Y.; Sariciftci, N. S., A Photovoltaic Fiber Design for Smart Textiles. *Textile Research Journal* 2009, *80* (11), 1065-1074.

5. Jung, S.; Lauterbach, C.; Strasser, M.; Weber, W. In *Enabling technologies for disappearing electronics in smart textiles*, 2003 IEEE International Solid-State Circuits Conference, 2003. Digest of Technical Papers. ISSCC., 13-13 Feb. 2003; 2003; pp 386-387 vol.1.
6. Roach, D. J.; Yuan, C.; Kuang, X.; Li, V. C.-F.; Blake, P.; Romero, M. L.; Hammel, I.; Yu, K.; Qi, H. J., Long Liquid Crystal Elastomer Fibers with Large Reversible Actuation Strains for Smart Textiles and Artificial Muscles. *ACS Applied Materials & Interfaces* 2019, *11* (21), 19514-19521.
7. Foroughi, J.; Spinks, G. M.; Aziz, S.; Mirabedini, A.; Jeiranikhameneh, A.; Wallace, G. G.; Kozlov, M. E.; Baughman, R. H., Knitted Carbon-Nanotube-Sheath/Spandex-Core Elastomeric Yarns for Artificial Muscles and Strain Sensing. *ACS Nano* 2016, *10* (10), 9129-9135.
8. Doshi, S. M.; Thostenson, E. T., Thin and Flexible Carbon Nanotube-Based Pressure Sensors with Ultrawide Sensing Range. *ACS Sensors* 2018, *3* (7), 1276-1282.
9. Sarier, N.; Onder, E., Organic phase change materials and their textile applications: An overview. *Thermochimica Acta* 2012, *540*, 7-60.
10. Sarier, N.; Onder, E., The manufacture of microencapsulated phase change materials suitable for the design of thermally enhanced fabrics. *Thermochimica Acta* 2007, *452* (2), 149-160.
11. Grillet, A.; Kinet, D.; Witt, J.; Schukar, M.; Krebber, K.; Pirotte, F.; Depre, A., Optical Fiber Sensors Embedded Into Medical Textiles for Healthcare Monitoring. *IEEE Sensors Journal* 2008, *8* (7), 1215-1222.