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Fabric Conductivity in Textile Field and Emerging Trends - Review

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Abstract -The article critically reviews some of the significant advances in conductive textile materials. Because conductive fabrics can be well integrated with the garment, they are ideal as a sensing element of wearable human motion monitoring systems. [6] Coating a layer of electrically conducting material onto the textile can impart electronic capabilities to the base material in a facile manner. Such a coating can be done at any of the hierarchical levels of the textile structure, i.e., at the fiber, yarn, or fabric level[7]. Electroconductive textiles can not be considered as homogenous structures, because fabrics consist of conductive and nonconductive yarns, interlaced to each other. [10] This review focuses on various electrically conducting materials and methods used for coating e-textile devices, as well as the different configurations that can be obtained from such coatings, hybrid conductive threads , various uses of conductive fabrics creating a smart textile-based system.

***Key Words*:**Conductive Textiles, Conductive fabrics, Wearable electronic, Smart Textiles, flexible electronics

1. INTRODUCTION

A conductive textile is a fabric which can conduct electricity. Conductive textiles can be made with metal strands woven into the construction of the textile or by conductive yarns which are conductive thanks to a metal-coating. There is also an interest in semiconducting textiles, made by impregnating normal textiles with carbon- or metal-based powders. Conductive fibers consist of a non-conductive or less conductive substrate, which is then either coated or embedded with electrically conductive elements, often carbon, nickel, copper, gold, silver, titanium or PEDOT. Metals may be deposited chemically with autocatalytic chemistry, printed with conductive nanoparticle inks or applied with physical vapor deposition methods. Substratestypically include cotton, polyester, nylon, and stainless steel to high performance fibers such as aramids and PBO.[2]Electro-conductive fabrics were prepared via in situ oxidative polymerization of pyrrole (Py) in the presence of unmodified and chemically modified cotton fabrics. Chemical modification of cotton fabric was achieved by covalent attachment of a bifunctional linker molecule to the surface of the fabric, followed by incorporation of a monomer unit onto the linker.[5]

The field of e-textiles combines the worlds of textiles and electronics resulting in to novel product such as wearable computers which can electrically function as electronics and physically behave as textiles. It involves the use of conductive yarns and fibres for power delivery, communication, and networking, as well as new materials for display that use electronic ink and thermo chromic pigments.[11]

The combination of electronics and textiles can be classified as: wearable electronics,textronics and fibertronics, based on degree of integration. This paper discussed about development of conductive fabrics and emerging innovative treands. This work provides the platform for the methodology of developing conductive yarns and fabric for the wearable electronics product development to progress on the issue of user acceptability[9]

The application fields of conductive textiles have been spread out very widely in last few decades. Such fabrics can be used for medical and military applications, protective clothing, can be attributed to smart- or e-textiles The conductive threads act as carriers of electrical signals in this network, transmitting signals from one point in the network to another and are designed to follow a given electrical circuit. The nonconducting threads in such a fabric provide appropriate separation between the conductive threads. Metal, carbon, and optical fibers are the most well-known textile conductive yarns. Conductive yarns that have lower linear resistance values are used to transmit electrical signals in an e-textile configuration. They can be directly woven, knitted, embroidered, or sewn into the fabrics for designing e-textile transmission lines. [10]

Nowadays, development of electronic systems is focused on flexible electronics that are easily integrated into smart systems such as smart textiles, RFID, smart cities, internet of things, etc. An important part of these systems is passive electronic components, sensors, buses and interconnection structures that have to meet requirements such as low price, simple, smaller size, lighter, flexible, planar and robust for the harsh environment. These requirements have led to the development of planar electronic devices created by the embroidery/knitting/weaving technology. These technologies can use electrical conductive threads that allow creating conductive patterns on the textile substrates [15]

2.CONDUCTIVE FABRICS

Conductive fabrics are materials that are made from, coated or blended with conductive metals including but not limited to gold, carbon, titanium, nickel, silver, or copper. Base fabric materials include cotton, wool, polyester, and nylon. There are two main categories of conductive fibers according to the Conductive Fiber Manufacturers Council. The first category are "intrinsically conductive fibers and conductive polymers which constitute the largest portion of the industry, with carbon fiber being the biggest portion." While "the second group includes non-conductive or less conductive substrates, which are then either coated or embedded with an electrically conductive element, often carbon, nickel, copper, gold, silver, or titanium."[4]

Electrically conductive textiles make it possible to produce interactive electronic textiles. They can be used for communication, entertainment, health care, safety, homeland security, computation, thermal purposes, protective clothing, wearable electronics and fashion.

A conductive textile is a fabric which can conduct electricity. Conductive textiles can be made with metal strands woven into the construction of the textile or by conductive yarns which are conductive thanks to a metal-coating. There is also an interest in semiconducting textiles, made by impregnating normal textiles with carbon- or metal-based powders.[1]

In day to day life, textile materials are being used. In one instance they are used as garment to protect human body from heat or cold. As fabrics they are used for covering the surfaces of floors, or the upholstery of car seats. On the other hand electronic devices are spreading - but still some people do not have the knowledge to use them. So the next step to spread these electronics is to improve the user interfaces. Wearable Electronics could offer improved interfaces and make it easier for the user to accept electronic devices in everyday life. When textile materials are integrated with electronic sensors and actuators, they can prove useful in many end uses. Unfortunately, it is difficult to identify the needs without knowledge on the application in these fields. There is little interaction between the electronics-in-textiles community and respective industries. These threads need to be improved regarding conductance, process ability, reliability and signal transmission capability. Also isolation of textile integrated conductors has been neglected although it is required by most applications. Existing garments are primarily designed for protective functions, including protection from extreme cold, physiological monitoring for emergency conditions, and wearer GPS information for emergency intervention. Smaller electrical devices that can be worn and carried have been made possible through the process of continuous miniaturization.

Measuring human movements is beneficial to rehabilitation, training, or exercises. A motion capture system, which consists of cameras, accelerometers, and flexible electro gonio meters, has been used to monitor human motion . Despite the motion capture system being able to make accurate measurements, conventional sensors fixed on the cloth by strap or other techniques render them incapable for use owing to discomfort and inconvenience. During the flexion of a limb, the skin around the joint stretches, as does the surrounding clothing. In order to achieve general comfort from the fabric, it needs 25-30% stretchability, since the skin around the knee stretches lengthwise about 40% of its normal length [4]. Textile solutions are well suited for constructing a sensing system that is comfortable for the wearer, because it can integrate well with clothing.

Owing to the quick advances and large market prospectus relating to wearable electronics and smart textiles, conductive fabrics have been the focus of researchers . Conductive fabrics can be applied to many fields, such as textile electrode , electromagnetic shielding , and heating fabrics. A number of techniques are available for producing conductive fabrics which include coating metals, metallic salts films, and conducting polymers on the fabric surfaces. The term -Smart Textiles‖ refers to a broad field of studies and products that extend the functionality and usefulness of common fabrics. Textile materials like fibers and filaments, yarns together with woven, knitted or non-woven structures that can interact with the surroundings/user are termed as smart textiles. The convergence of textiles and electronics (e-textiles) can be relevant for the development of smart materials that are capable of accomplishing a wide spectrum of functions, found in rigid and non-flexible electronic products nowadays.[6]

To achieve this goal of unobtrusive integration of electronics with textiles, it is important to use materials and methods that can impart the necessary electrical conductivity to a textile fiber. Electrical conductivity at the fiber level can be achieved by using either intrinsically conducting polymers (ICPs) in forming the fiber or by coating conventional insulating fibers with conducting materials . Various materials such as ICPs, conducting polymer composites , metals , and carbon based materials, such as carbon nanotubes, carbon nanopowders and graphene, have been used to achieve this. These materials have been applied using coating methods such as electro- and electrolessdeposition , dip-coating, and chemical vapor deposition (CVD)to achieve such electrically conductive e-textile coatings. The electrically conductive coated fibers can be used in a variety of applications in e-textiles. [7]

Electrically Conductive Textiles

Electrically conductive textiles are already used for years in various industrial application fields for the purpose of controlling static and electromagnetic interference shielding. Nowadays, textiles are modified to offer a good electrical conductivity to be applied in smart textiles. Here electrically conductive textiles are used as electrodes or as interconnection between the different components. In general, they can be classified into two categories, yarns and textiles being intrinsically conductive, such as stainless steel, and yarns and textiles that are specially treated or produced to gain conductivity, e.g. by metallization.[2]

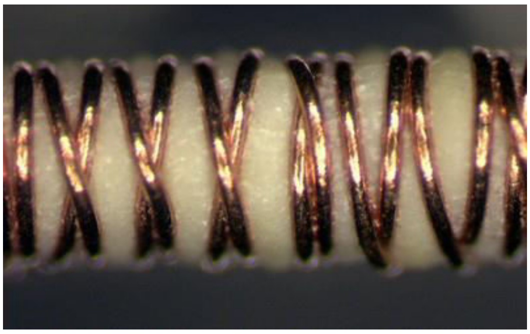

Fig 1. Elastic electroconductive yarn

3.ELECTRICAL PROPERTIES AND METHODS OF PRODUCING CONDUCTIVE FABRICS

There are two ways to produce textile-based deformation sensors for wearable devices. One is by coating a thin layer of piezo resistive material on conventional fabrics, and the other is by knitting and weaving conductive yarns with nonconductive yarns. The technique permits continuous, long-term monitoring of a human joint, based on the stretch of the skin and the elastic fabric, where a conductive fiber [26] or conductive elastomer is attached to the fabric. There is an increase in resistance of the conductive fibre due to increase in the length of wire between two terminals when bending of fibre occurs. If the conductive fabric is attached to clothes worn next to the skin, its resistance also increases during the bending process. Besides, in order to monitor the flexion angle of elbow and knee movements, elastic conductive webbing by conductive yarns and elastic yarns has been designed and the elastic conductive webbing exhibits a linear response of resistance to the flexion angle. Conductive elastomer sensors have been directly integrated into lycra fabrics. This has been made possible by a combination of silicon rubber and graphite. These test devices can be worn for a long period and be used for monitoring without discomfort.

Recently, a great deal of investigation has been carried out relating to the technology for conductive fabric sensing elements from conductive polymers. These materials offer several advantages with respect to other sensors: lightness, large elasticity and resilience, resistance to corrosion, flexibility, and so on. Polypyrrole (PPy), polyaniline, and polythiophene are some of typical types of conductive polymers that offer certain merits like high conductivity, good environmental stability, ease of synthesis, adhesion, nontoxicity, etc. Furthermore, polypyrole conductive fabric is generally used for wearable fabric sensors.

A high sensitivity in elongation has been observed in the case of the surface resistance of PPy conductive fabric. The relation of strain-resistance relationship in the case of PPy coated lycra fabric and its strain sensitivity coefficient is up to. Thus, the sensor made from PPy conductive fabric can be used to detect knee joint movements.

Body joint motion was detected by monitoring the resistance change of the conductive fabric. The movement of the human joint is normally multidirectional, like the torsional flexion of an elbow joint. In this case, the fabric sensor around the joint is not only stretched along the axial direction of extremities, the sensor can also deform in the other direction, which is usually neglected in previous studies. The resistance in all directions has to be monitored in order to characterize the joint movement. Hence, there is a need to understand the directional resistance distribution of the conductive fabric. Due to more or less anisotropic structure of the fabric, the PPy coated fabric will show to some extent anisotropic electrical resistance. In such a regard, the dependence of the anisotropic resistance on fabric structure can be considered for study. The electrical conductivity of PPy woven fabric has been studied with respect to the surface resistance and its directional distribution, as well as the elongation-resistance relationship. Subsequently, the extension angle of the knee and elbow has been monitored by the PPy-coated conductive fabric. The relation between angle and resistance has been explained.

The conductive resistance of PPy coated woven fabric has been found to be anisotropic, and the anisotropy feature of PPy conductive fabric resistance is dependent on the structure of the fabric itself . And the trend of PPy conductive woven fabric resistance distribution in each direction depends only on the orthogonality of the fabric sample structure, and the extremes occur in the direction that parallels the direction of the warp or the weft yarn. There is an upper limit for the change in the electrical resistance of PPy conductive fabric which is based on the structure of the fabric. Moreover, PPy conductive woven fabrics can be used to monitor the movement of human joints.

Innovative Method of Designing Silver Plated Cotton Fabrics

Many techniques like vacuum deposition, chemical plating, and composite plating by in situ polymerization have been applied to development of conductive fabrics. The chemical plating method has better industrial application prospect for fabricating conductive textiles due to operation simplification and high efficiency. Recently, owing to better electrochemical properties and good electrical conductivity of silver nano particles, the surface electro less silver plating has been utilized for surface metalizing of many of electrical insulating materials due to superior electrochemical properties and good electric conductivity of silver nano particles. However, silver plating fabrics have low washing fastness when silver plating is coated on surface of fabrics by electro less plating method. Hence, surface modification of substrate is of great importance for improvement of the adhesive force between the metal and the substrate. Silver plating fabrics can be applied in these fields such as antibacterial, intelligent textiles, smart garments, electromagnetic shielding, and flexible sensors.[6]

Methods of producing conductive yarns can be summarized as follows:

- Adding carbon or metals in different forms such as wires, fibres or particles (eg. core spun, blends)
- Using inherently conductive polymers
- Coating with conductive substances

Adding carbon or metals in different forms such as wires, fibres or particles:

It is possible to obtain textiles with conductive property by inserting carbon or metals such as silver, steel, nickel to the structure, in the form of wires, fibres, and micro or nano particles. Carbon fibres and carbon filled fibres exhibit good conductive properties, but on the other hand, they have some aesthetic problems.

Metal fibres can be produced by using bundle-drawing process or shaving process. Metal fibres and wires which can be incorporated into textile structures have high conductivity, but they have also some disadvantages like their weight, cost and the damage which they can give to the textile machinery.

Using Inherently Conductive Polymers:

Inherently conductive polymers are polyanyline, polyvinyl alcohol, polypyrrole and polyamide 11 etc. Conductive polymers are still a developing area. Amongst these polymers polyanyline has attracted a lot of attention due to its good environmental, thermal and chemical stability. Although it was discovered over 150 years ago, only recently has polyaniline captured the attention of the scientific community due to the discovery of its high electrical conductivity. Actually conductive polymers are gaining more and more importance due to their advantages, but these polymers are still rather costly. They can be used in applications where flexibility, low weight and conductivity are required.

Coating with Conductive Substances:

Another important aspect is using coated conductive fibres. Coating can be applied through various techniques. Conductive polyester yarns and filaments of this kind are used in many application areas. Highly conductive fibres can be produced by metallic or galvanic coating, but these methods have some limitations with adhesion and corrosion resistance and suitability of the substrate. Metallic salt coatings have some limitations in conductivity.

By utilizing the conductive yarns in the fabric structures, various functionalities may be attributed to the fabrics. Enhancing both the properties of textile structures and the function of conductivity, conductive textiles have important applications not only in medical and military fields, but also in the fields of fashion, architecture and design for their aesthetic appeal. Therefore textiles with conductivity function are used in many technical applications such as protection of people and electronic devices from electromagnetic interference (EMI) and electrostatic discharge, heating, wearable electronics, data storage and transmission, sensors and actuators.[8]

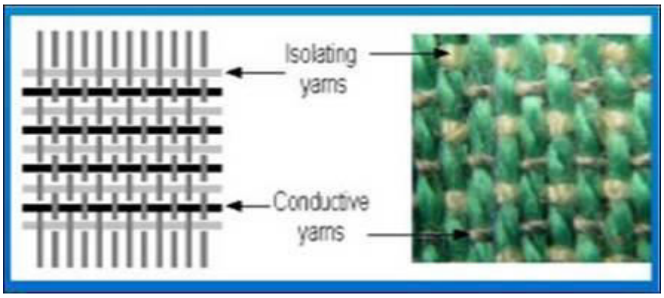

Fig.2 Conductive yarns in the fabric structures

The purpose of this innovation is to produce new LCVG components with improved thermal conductivity. This was addressed using nanocomposite engineering incorporating high-thermalconductivitynanoscale fillers in the fabric and tubing components. Specifically, carbon nanotubes were added using normal processing methods such as thermoplastic melt mixing (compounding twin screw extruder) and downstream processing (fiber spinning, tubing extrusion). Fibers were produced as yarns and woven into fabric cloths.
The novel feature is that fabrics do not inherently possess good thermal conductivity. In fact, fabrics are used for thermal insulation, not heat removal. The technology represents the first material that is a wearable fabric, based on company textiles and materials that will significantly conduct heat.[13]

4. CONDUCTIVE MATERIALS ANDFABRICATION METHODS

One important consideration for wearable electronics is the choice of materials used in the fabrication and the possibility to provide good electrical performance with desirable mechanical properties, and stability into the flexible devices. The development of conductive and (semi)conductive materials, which are flexible, are necessary for wearable electronics. These smart materials are incorporated into the textile structure by different technologies such as weaving, embroidering, knitting, printing, chemical treatments and coating (coating the fibers with metals, galvanic substances or metallic salts by electroless plating and with a conductive polymers). The different materials like conductive polymers (e.gpolypyrrole, polyaniline), metals and metal oxide nanoparticles/nanowires/nanorod (such as silver and zinc oxide), carbon-based micro/nanomaterials (such as graphene, carbon particles, and carbon nanotubes), have been used and investigated as textile modifier. Generally, in addition to metallic yarn and strain, smart materials can be grouped into three categories: conductive organic polymers, carbon-based micro/nanomaterials, and conductive metallic nanostructures. The following section discusses some of the materials and the fabrication technology frequently used to accomplish these goals.

a. Conducting polymers

Conductive polymers are organic polymers exhibiting electrical properties similar to those of metals. Polypyrrole, polyaniline, and polythiophenefibers are good examples in practical flexible and stretchable electronic devices, and they can be produced with different sizes and even in nanometer dimensions, with high conductivity (120–130 S cm−1) at room temperature. To provide the necessary biocompatibility and increased resistance to mechanical stress these polymers can be modified and produced in different shapes such as fiber or nanofiber. Nanofiber is a class of nanomaterials having a diameter in the submicron range (50–500 nm), small pore size, sometimes with high porosity and high surface area with length is in the micron or millimeter range such as polyanilinenanofibers. Another significant advantage of this method is that they facilitate the use of low-cost patterning techniques at room conditions. Generally, the most promising materials are organic polymers because they are intrinsically flexible or can be easily used for making desired composite materials with special chemical, physical, and electronic properties.

b. Carbon-based micro/nano materials

Zero, one and two dimensional carbon-based micro/nanomaterials such as graphene (nanonanosheets), carbon nanotube, carbon nanoparticles and its derivatives are promising materials for flexible and wearable electronics, due to their unique properties such as their high electron transfer rate and mechanical properties, large surface area, environmental stability and the potential for production at low cost.
Among the various carbon materials, carbon nanotubes and graphene are two of the most intensively explored carbon allotropes in electrochemical sensors that have been evaluated as the electrode materials with great potential in wearable electronics. A stretchable, porous, and conductive textile has recently been developed by a simple 'dipping and drying" process using a carbon nanotubes ink
Much attention has been paid towards the preparation and applications of nanostructured coatings onto textile substrate due to their promising applications. Low dimensional nanostructures of metals, e.g., nanowires, nanorods (ZnO, Ag) or nanoparticles (such as Au, Ag, or Pt), are particularly attractive for fiber-based flexible and wearable electronics because some of these like gold and silver have very high conductivities.
Wearable electronic Introduction Textiles are used in everyday life, for example as garment to protect ourselves from heat or cold, fabrics covering the surfaces of floors, or the upholstery of car seats. On the other hand electronic devices are spreading – but still some people do not have the knowledge to use them. So the next step to spread these electronics is to improve the user interfaces. Wearable Electronics could offer improved interfaces and make it easier for the user to accept electronic devices in everyday life.

Integrating electronic sensors and actuators into such textiles could be useful for a wide range of applications. [9]

c. Conductive fabrics as wearable electronics

Different kinds of yarn and methods of fabric production, modifications conducted in the conventional textile machines, problems encountered during the production processes and the solutions have been dealt with. The specialty yarns and fabrics can be utilized for developing wearable electronic products.

Today, the interaction of individual humans with electronic devices demands specific user skills. Wearable Electronics are an emerging Tran's disciplinary field, bringing together concepts and expertise from a variety of disciplines, ranging from materials science, through computer engineering to textile design. An emerging area of research which combines the strengths and capabilities of electronics and textiles in wearable electronics is highlighted. In order to develop a heating garment, the cotton yarn wrapped by nichrome is integrated into knitted fabric. Copper core conductive yarn and Optical core conductive yarn were developed for the production of Communication Garment and POF integrated tele intimation fabric has been developed for Teleintimation Garment.[6]

In recent years, electronic textiles (e-textiles) as a class of soft or flexible electronics have generated a growing interest due to their many potential applications in healthcare, security, entertainment, and others. E-textile systems are produced through the integration of various electrical devices, such as sensors, transistors , communication devices, energy harvesting and storage devices, and actuators , with textiles[7] With the development of flexible electronics, conductive textiles are becoming important building blocks for the design of wearable electronics for a broad range of applications.

Wearable computing:

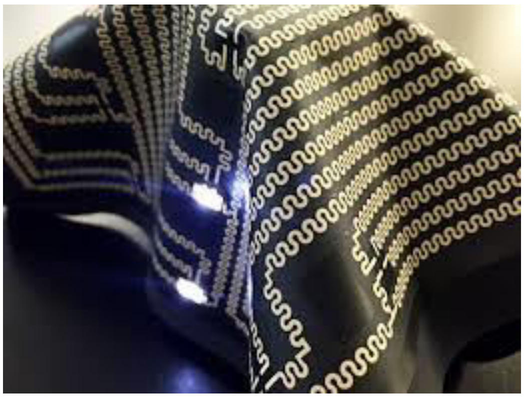

Fig. 3 Patterned Conductive Fabrics

The first conductive fabric tried was silk organza which contains two types of fibers. On the warp is a plain silk thread while running in the other direction on the weft is a silk thread wrapped in thin copper foil. This metallic yarn is prepared just like cloth-core telephone wire, and is highly conductive. The silk fiber core has a high tensile strength and can withstand high temperatures. This allows the yarn to be sewn orembroidered with industrial machinery. The spacing between these fibers also permits them to be taken care ofindividually, so a strip of this fabric can function like a ribbon cable.

Circuits fabricated on organza only need to be protected from folding contact with themselves, which can be accomplished by coating, supporting or backing the fabric with an insulating layer which can also be cloth. There are also conductive yarns manufactured specifically for producing filters for the processing of fine powders.[15]

Protective clothing

Smart textiles are divided according to the degree of integration of electronic elements into textile substrates. The aim is to integrate these electronic components as much as possible into textile substrates. For this purpose, it is necessary to implement new elements on a textile basis with electrical properties. Between this basis elements, we can include conductive hybrid threads that can be used to implement some electronic components as part of textile materials.[15]

Fig. 4: Embroidered conductive pattern on the textile substrate

Hybrid Conductive Threads

Passive electronic elements, sensors, bus, and interconnecting structures can be realized by a suitable construction of hybrid conductive or resistive threads by means of common technological processes known in the textile industry. The construction of hybrid conductive threads is based on ultrafine metallic wires combined with synthetic filaments like polyester or polyamide (Fig. 4). These threads have excellent electrical properties, esp. low linear electrical resistance that are given by used conductive material, diameter and number of conductive wires in threads. The particular metallic wire can be non-insulated or insulated based on used application. Developed hybrid conductive threads are fully compatible with standard textile manufacturing processes such as weaving, knitting and embroidering for creating of completely functional conductive tracks, circuits, textrodes, heating elements.

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No.	Mass density of fibers	Metal wires from	Tension cN/tex	Elongation %	Linear R Ω/m
25A	72 tex	Brass	21,82	10,16	8,90
53	50 tex	Cu/Ag	31,59	14,08	6,50
74	76 tex	Cu/Ag	16,89	13,39	2,90
7A	39 tex	Chrome-nickel steel	53,11	14,39	2420,2

Tab. 1: Type of conductive threads and their parameters

Conductive threads, which are based on silver-coated non-conductive polyamide fibers, have been available on the market for several years. These threads have better electrical parameters than hybrid conductive threads but their mechanical resistance is poor – about 20 washing cycles. The advantages of hybrid conductive threads are high mechanical resistance and resistance to washing/ drying process.The performed tests show that these developed threads are resistant to washing process for more than 80 cycles. During the washing process, the resistance of the hybrid conductive threads are changed but in comparison with threads that are silver-coated, these changes are negligible[15]

Wearable electronics industry is growing exponentially as well as the demand for conductive textile materials. Ideally, conductive textile materials should be washable, breathable, and easily convertible into textile product using conventional textile machinery. These requirements are critical for creating comfortable wearable electronics products in a facile way. In this study we have developed conductive knitted and nonwoven textile materials using AgNWs. AgNWs were synthesized according to the polyol method and coated on aforementioned textile materials. Both synthesized AgNWs and coated samples were characterized with SEM. Moreover, samples' electrical conductivity was investigated under stretching conditions. Results show that knitted samples perform higher stretchability than nonwoven samples. Nonwoven sample was employed as a touched based sensor which can be converted into wearable electronics products in the future. [17]

Applications of Hybrid Conductive Threads

Hybrid conductive threads that consist of different metallic wires with different numbers and diameters can be used for different electronic elements that are integrated directly into textile. Hybrid conductive threads allow to create simple but also more complicated electronic elements. The hybrid conductive threads can be used to implement textile bus and interconnect systems that can be both stretchable and flexible.

Passive electronic components and antennas

Using conductive threads, embroidered planar passive components such as resistors, inductors and capacitors or antennas can be easily implemented directly on textile substrates . These components are flexible, stretchable and washing resistance. By assembling these embroidered electronic elements, more complex electronic modules can be formed.

Conductive stretchable textile ribbons

Conductive stretchable textile ribbons mean that hybrid conductive threads are integrated into stretchable woven ribbons contain elastomer fibers. The stretchability of these ribbons is up to 70 % of the length. The ribbons can contain a different number of the conductive line with different number of conductive threads. In this way, the electrical parameters can be influenced.

The advantage of these ribbons is that the electrical resistance is stable during stretching. The ribbons can be in a version with insulated or non-insulated hybrid conductive threads. The textile ribbons withstand with conductive threads is more than 25 000 cycles for 30% stretching, more than 10 000 cycles for 50 % stretching and more than 9 000 cycles for 70% stretching.Washing resistance is more than 50 cycles @ 400 rpm, 40 °C. If the conductive threads are on the surface of textile ribbons, the electronic components can be contacted and integrated by different technologies such as soldering, welding, and crimping on stretchable textile ribbons. These textile ribbons can be used for interconnection of electronic elements in/on textiles with conventional electronics elements or batteries.

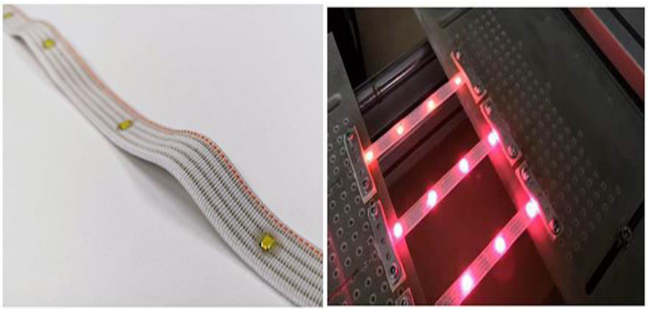

Fig. 5 Conductive stretchable textile ribbons with integrated LED and these ribbons after 4500 stretching cycles[16]

Copper is the most widely used electrical conductor. Like most metals, though, it has several drawbacks: it is heavy, expensive, and can break. Fibers that conduct electricity could be the solutions to these problems, and they are of great interest to NASA.

Conductive fibers provide lightweight alternatives to heavy copper wiring in a variety of settings, including aerospace, where weight is always a chief concern. This is an area where NASA is always seeking improved materials. The fibers are also more cost-effective than metals. Expenditure is another area where NASA is always looking to make improvements.

In the case of electronics that are confined to small spaces and subject to severe stress, copper is prone to breaking and losing connection over time. Flexible conductive fibers eliminatethat problem. They are more supple and stronger than brittle copper and, thus, find good use in these and similar situations.

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While clearly a much-needed material, electrically conductive fibers are not readily available. The cost of new technology development, with all the pitfalls of troubleshooting production and the years of testing, and without the guarantee of an immediate market, is often too much of a financial hazard for companies to risk.[18]

5. CONDUCTIVE FABRIC USES

Major Application Areas Of Conductive Textiles Can Be Grouped As Follows:

Smart clothing
Transport of electrical signals
Heating
Protection from electromagnetic interference and electrostatic discharge

Use Of Conductive Textiles In Electromagnetic Shielding:

Electromagnetic shielding effectiveness (EMSE) is defined as the degree of shielding against electromagnetic interference at a specific frequency. Electromagnetic energy is absorbed, reflected or transmitted by the materials.

An important factor for all electromagnetic shielding textiles is including the suitable amount of conductive yarns or other conductive components since conductive materials weaken the electromagnetic weaves by reflection.

Therefore, materials which are intended to be utilized in electromagnetic shielding applications must have the property of being electrically conductive. Smoother surfaces are preferred for better shielding effectiveness.It is known that best materials used for electromagnetic shielding are based on metals. Metals are known to reduce the effects of radio waves, electromagnetic and electrostatic fields. The effectiveness of these materials depends on the type of the material used, connections of the conductive net and the frequency of the electromagnetic weave. However, since the materials based on metals have some disadvantages such as rigidity, heavy weight and weak comfort properties in end use, they are increasingly being replaced by thermoplastics especially for commercial applications due to high flexibility, light weight, low cost and etc.[8]

Conductive fibers are used in products ranging from metal mesh, aerospace textiles, taser or stun gun vests, conductive threads or yarns, fabric sheets used for thermal heating, etc. Conductive fabrics can also be used to conduct electricity in small spaces, for static dissipation, EMI shielding, signal and power transfer in low resistance versions, and in heating elements in higher resistance versions, in medical equipment like electrodes, and so much more. One major conductive fabric product is ARACON, a brand metal clad fiber by Micro-Coax. ARACON fibers are built on a modified KEVLAR® base and provide good thermal and dimensional stability with very high yarn strength.Conductivefibers can be woven, knit, sewn, cut or braided. This is a great benefit formanufacturers who can use conductive fibers for their flexibility, low weight, and versatility.[4]

Major application areas of conductive textiles:

- Military & defence
- Healthcare
- Consumer electronics
- Sports & fitness
- Smart clothing
- Transport of electrical signals
- Heating
- Protection from electromagnetic interference and electrostatic discharge
- Others[2]

The Future of Conductive Fabrics

Conductive fabrics are relatively new to the specialty fabrics industry even though Thomas Edison used a carbonized sewing thread in his light bulb. With today's technological advances, the possibilities for conductive fiber uses have grown tremendously. Engineers and manufacturers are developing products that can be worn for sports activity and even used in a new type of neuroprosthesis - precision mapping of responses from different areas/regions of the brain or spinal cord.Also, conductive fabrics are being utilized in the electronics industries to help make products that are smaller – E-fabrics are much more flexible than standard metal wire making it easier to create smaller electronics.

Conductive fabrics have a variety of uses in the specialty fabrics industry. Manufacturers like Herculite Inc. custom engineer specialty products like conductive fabrics. Visit Herculite at www.herculite.com for more information. [3]

As a hierarchical structure, textiles offer unique opportunities to integrate electrical functionalities at various levels—from fibers, yarns, to the finished product. While electronic capabilities can be integrated into any of these hierarchical levels, the integration of electrically conductive materials at the fiber level arguably enables the most seamlessly-integrated e-textile products. Fiber level integration of electrical capabilities is more likely to help retain the intrinsic textile characteristics of strength, flexibility, durability, comfort, etc., enhance the functionality by enabling communication, as well as sense and respond to the external environment .

Textiles are used in everyday life, for example as garment to protect ourselves from heat or cold, fabrics covering the surfaces of floors, or the upholstery of car seats. On the other hand electronic devices are spreading – but still some people do not have the knowledge to use them. So the next step to spread these electronics is to improve the user interfaces. Wearable Electronics could offer improved interfaces and make it easier for the user to accept electronic devices in everyday life. Integrating electronic sensors and actuators into such textiles could be useful for a wide range of applications.. Continuous miniaturization of electronic components has made it possible to create smaller and smaller electrical devices which can be worn and carried all the time. Researchers have developed user friendly techniques to develop methods that will make e-textile technology available to crafters, students, and hobbyists. Also possible to develop transmission lines structures screen-printed on fabrics as well as photonic textile displays woven on a Jacquard loom. Wireless communication and wearable computers coupled with clothing forms a new approach to wearable computing[9]

6. CONCLUSIONS

Conductive textiles are widely used in smart textile applications such as sensors, communication, heating textiles, electrostatic discharge clothing and so on. It became popular during the last decade. So, we should have to more and more research on conductive textiles and also smart textile product development.[2] Nowadays, smart textiles are rapidly developing and allow the direct integration of various electronic elements directly into textile substrates. [16] This review demonstrates the versatility of materials and processes for conductive coatings for textiles. Also gives application of conductive fabrics in various fields. And emerging trends in conductive textile. While there is a variety of coating types and application techniques that can be used to make such fiber and yarn based sensors, it is important that this is done without sacrificing the inherent qualities that textiles possess[7]

REFERENCES

1. https://www.sciencedirect.com/topics/engineering/conductive-fabric
2. https://www.textileblog.com/conductive-textiles-types-properties-and-applications/
3. https://www.herculite.com/blog/how-are-conductive-fabrics-used
4. https://www.sciencedirect.com/topics/engineering/conductive-textile
5. https://iopscience.iop.org/article/10.1088/1757-899X/254/3/032002/pdf
6. https://lupinepublishers.com/fashion-technology-textile-engineering/fulltext/some-significant-trends-in-conductive-textiles.ID.000136.php
7. https://www.mdpi.com/2079-6439/7/6/51
8. https://www.technicaltextile.net/articles/conductive-yarns-and-their-use-in-technical-textiles-3739
9. https://www.hilarispublisher.com/open-access/study-on-different-techniques-of-fabricating-conductive-fabrics-fordeveloping-wearable-electronics-garments-2165-8064-1000212.pdf
10. http://article.sciencepublishinggroup.com/html/10.11648.j.ajmie.20160103.12.html
11. Applications of Electrically Conductive Yams in Technical Textiles P. C. Patel, Head, Associate Professor, MSU, D. A. Vasavada, and H. R. Mankodi, Associate Professor, MSU
12. https://www.ugent.be/ea/match/textiles/en/research/researchtopics/smart-textiles/conductive-textiles.htm#ContactandBibliography
13. https://www.techbriefs.com/component/content/article/tb/techbriefs/materials/14234
14. https://iopscience.iop.org/article/10.1149/1945-7111/ab6827
15. https://epci.eu/conductive-hybrid-threads-and-their-applications/
16. https://www.google.com/search?q=conductive%20textiles&tbm=isch&rlz=1C1CHBD_enIN905IN905&hl=en&sa=X&ved=0CJQBEKzcAigAahcKEwi42Nid1czrAhUAAAAAHQAAAAAQDw&biw=1349&bih=657
17. file:///C:/Users/ADMIN/Downloads/11523-Article%20Text-26728-1-10-20190731.pdf
18. http://www.tetex.com/textiles-electrical-conductivity/