In The name of God

Smart Textile

Silk yarn was the first material to be labeled as a smart textile.

Smart fabrics are materials that react to the environment. These fabrics can activate electronic and digital components and have the ability to do things that traditional fabrics are unable to do.

Like: conversion, connection, energy conduction, and even growth.

Smart textiles include battery or LED circuits, or advanced electrical textiles that have diodes and wires, conductive fibers, and solar cells embedded directly in their fibers, or they are a combination of the first two types.

Materials used to produce wearable smart textile, products can interact, communicate, and understand.

Metal fibers

Conductive ink

Chromic material

Coating with nanoparticles

Organic semiconductors

Materials that have the shape and ability to hold memory

Optical fibers

Quantum tunnel composites

Intrinsically conductive polymers

Stainless steel filaments, metal silk, organza special carbon fibers, etc. , are used to make fabric sensors, materials such as metal polymers, conductive polymers, optical fibers, electrical conductivity, measurable sensors and data transmission are also used. These materials are elastic, light weight, flexible, in expensive, an easy to process.

Smart textiles are divided into three general groups based on the type of behavior:

1.Passive smart textiles: textiles that have the ability to feel the environment around them.

2.Active smart textiles: textiles that have the ability to react to the environment or external stimulus.

3.Very smart textiles: textiles that can adapt their behavior to the environment or conditions.

Also, such textiles are divided into four groups based on the raw materials used:

1. chromic material

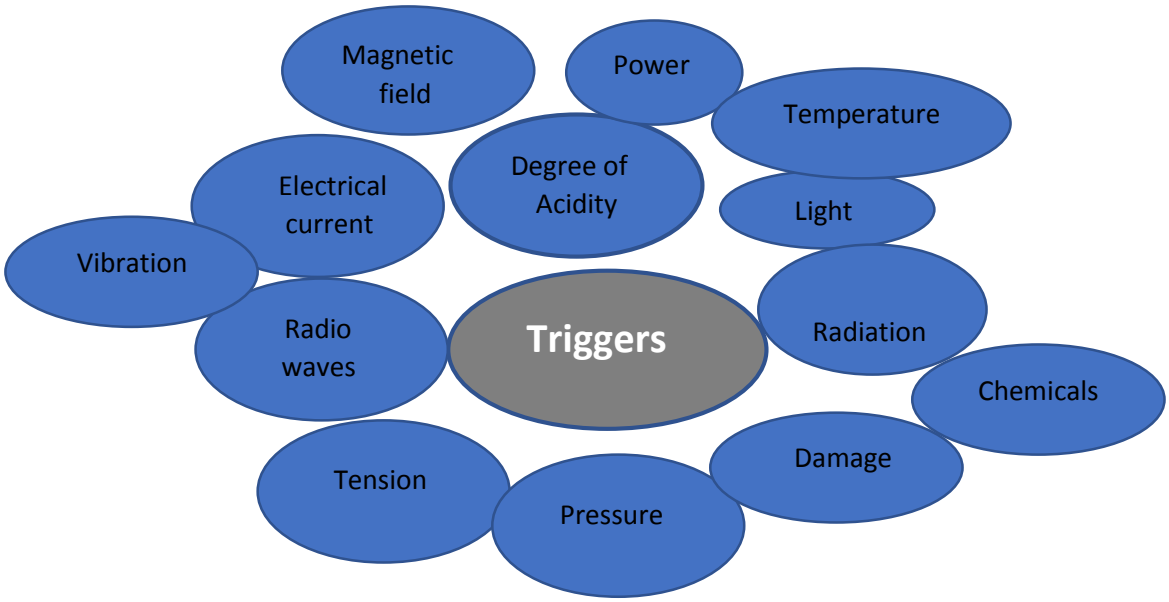
2.Martial with formal memory

3.Phase change material

4.Electronic textiles

Piezoelectric and pressure sensors are often used in smart clothes.

The most effective method in the production of sensors on textiles is the use of electrical conductive materials.



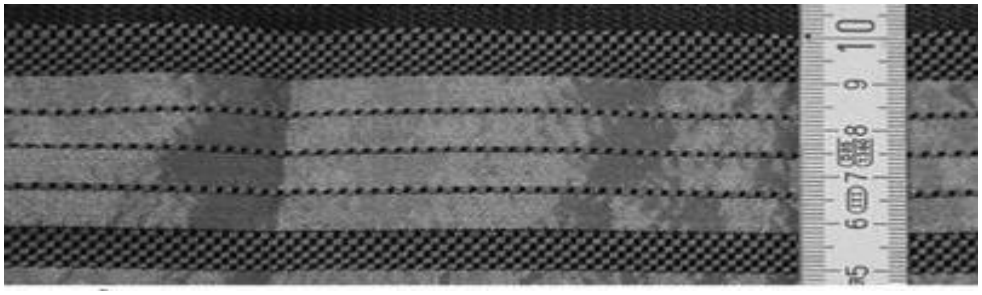
Various source of external stimulus

(NEC) Flexible battery designed for electronic paper that can be recharged and is suitable for power supply in electronic textiles.

Flexible optical fibers can be used to produce display screens in clothing or textiles.

Fabric microstrip Antenna

The connection between the various components of a smart textiles is often made possible by the use of conductive yarns that are woven into the fabric in the form a passage.



Bus structure based on textile

Conductive polymer materials are flexible, lightweight, strong and have low production costs which makes them a good choice for use in electronic textiles.

There are conductive fabrics that are made using conductive fibers or yarns that can be used in electronic textiles. In addition, it is possible to sew or embroider these threads using industrial machines.

Beams of this type of fabric act like strip cables. These fabrics have significant properties such as conductivity, strength, high thermal stability.

Metal fibers are heavier and more expensive than ordinary fibers, and not suitable for clothing comfort, strength and durability, especially in cases where the metal component increases, and using it, they are able to grind the parts of spinning machines, and these fibers are fragile.

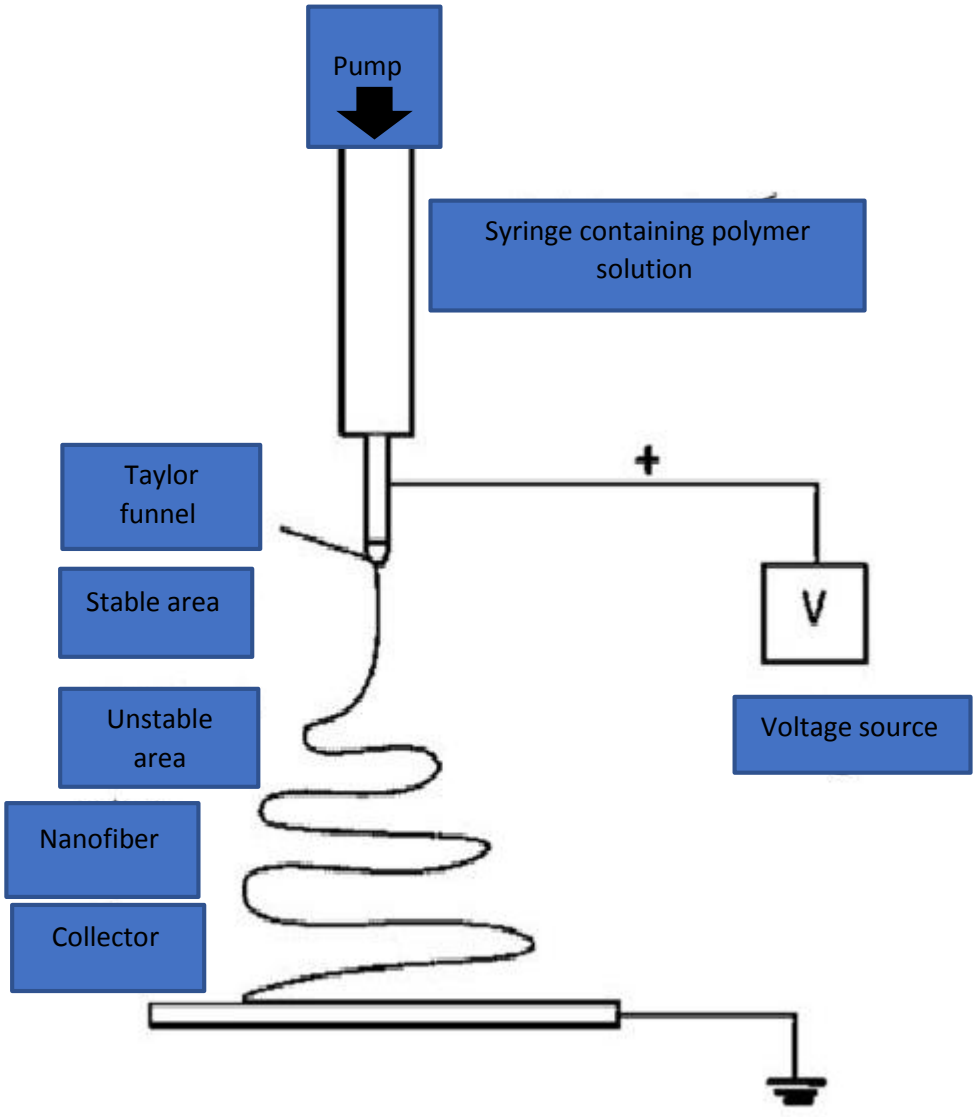
Carbon fiber: unfortunately, these fibers have low processability and due to the use of carbon in the production of fibers leads to the appearance of black color in the final product. Carbon is chemically resistant, but this property is not very significant in terms of the strength of the coating, which is used to make protective clothing.

Another way is to connect conductive yarns to the text of the fabric using the embroidery and loom weaving method to create a circuit pattern.

There are different methods for preparing nanofibers. These methods include: Template method and Island in the sea technology and electrostatic spinning process.

Among these, the electrospinning method is superior to other methods due to its simplicity and ability to produce fibers.

With this method, fibers with a dimeter of less than 100 nanometers can be produced. Another effective method for the production of conductive nanofibers are pyrolysis and polyacrylonitrile nano fibers in the carbon nanofibers.



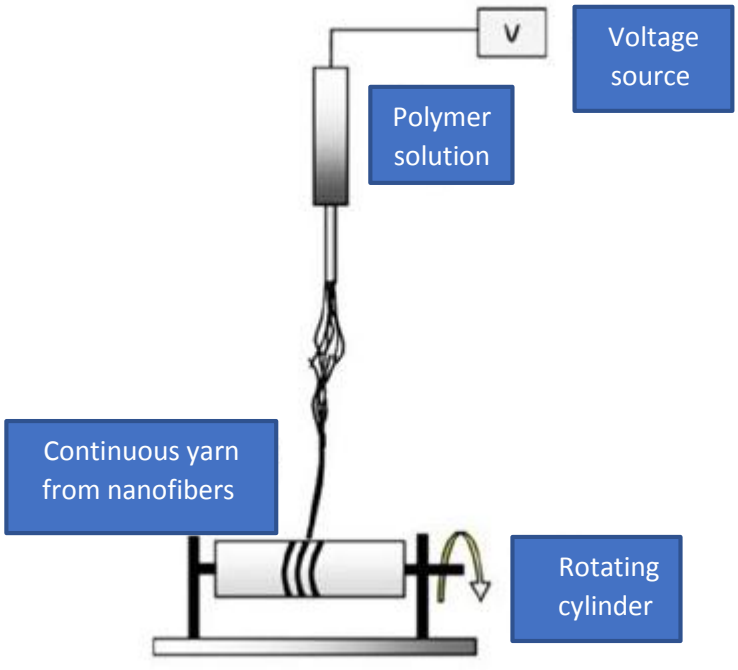
Symbolic image of electrospinning process

fiber diameter control; To produce fibers at the nanoscale, it is important to understand the factors that affect the fiber diameter, many factors of electrospinning process such as electric field strength , polymer solution concentration, spinning distance, polymer viscosity and the like affect the spinning ability and physical properties of nanofibers.

Empirical observation shows that nanofiber diameter affected by concentration of polymer solution and its molecular structure.

Fibers manufactured by Electrospinning could be collected as a nonwoven or smooth and parallel one. And by yarns manufactured from this method, warp, woof fabrics, braided and knitted fabrics could be produced.

The smooth and parallel types could be collected from nanofibers by mechanical force or electric field intensity control. Besides by optimal design of collector machine self- assembled yarn production in Electrospinning is possible.



Symbolic image of the electrospinning process of producing self assembled yarn

Producing conductive fiber from doped polyethylene with D-L Sulfonic acid in wide range of polymers such as: polyethylene oxide, polystyrene, polyacrylonitrile and some similar stuffs is relatively simple.

With increasing poly (ethylene deoxy thiophene) concentration, yarn conductivity also will increase. There are ceramic composites by which Piezoelectric and polymers performance optimization could be reached. These composites are totally flexible and could be used as sound detection sensor inside fabric or garment. Although using these sensors are used in medical industry but their application in smart and electronic textiles is still new. There are different methods to create piezoelectric features in textile. First one is to cover a fabric with thin layer of polypyrrole. Polypyrrole is an electric conductor which has elasticity, mechanical and heat transfer properties.
Another method is to cover the fabric and textile with carbon and rubber combination. This method by immersing material in rubber and carbon solution diffused in microphase is implemented.

There are two main problems in these fabric sensors efficiency. First problem lies in intense changes of electrical resistance of this sensor with time. Second one is having stable state few minutes after sudden mechanical stimulation force. This problem could limit the sensors application scope. however relative solution for these two problems is unilateral coding method.

Using conductor polymers for conductive textiles is one of the options.

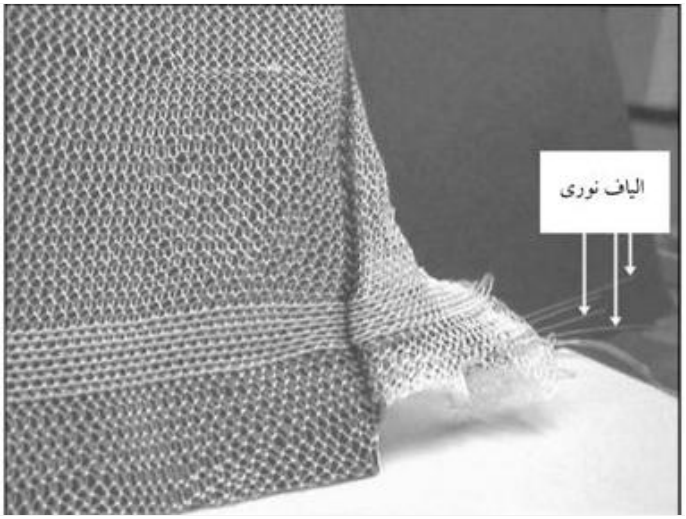
Optical fibers are cylindrical dielectric wave guide which are made of three layers: core, sheath, cover. core and sheath layers both are made of transparent dielectric substance.

There are diverse optical fibers in the market. single mode and multi-mode fibers, fully silica fibers to fully polymer fiber, with wide range of special substances combinations, core and sheath geometry.

Symbolic image of optical fiber

Optical fibers and electrical wires are applied in seven types of textile basic structures. Textures like knitted, weaving, warp fabrics, weft fabric, satin and twill waves. And nonwoven textiles manufactured by heating and adhesive methods, application process of fibers and electric wires is implementing industrial scale.

There are three main prerequisites for successful application: 1. This procedure is done in industrial scale 2. During procedure optical fibers and wires not getting damaged and no signal dropping happens 3. Application for final product shouldn’t change the signal propagation more than amount was taken to account in designing phase. This procedure is possible by using ordinary textile machinery.



Knitted fabric from optical fibers

Polyester and cotton are common materials to use. In addition, for the better comfort or data transfer, phase changing or color changing substances could be used. But using these types of stuffs maybe prohibited by standards.

Connection of two components on textile.

The electronic components in smart textiles could be connected in three stages

Stage one: freely use the available electronic equipment and place sit inside the fabric.

In deeper level specific reduced structured in form of a composite material (for instance between fabric layers) could be located inside textile. And finally, electronic equipment production in form of fiber structures could be overcome current restrictions which exist in two previous ones like low flexibility.

one of the prerequisites of smart garment development is the production of electric circuit in form of textile. Wearable optical sensors, are another smart system which are used in addition to common electronic sensors in textile.

Fiber Brag Grating and Near Infrared Spectrometry are two main technologies in this field. These technologies could use in form of static and dynamic sensors to provide different information such as heart beat rate and breathing.

The roll of nanotechnology in expanding the use of smart textiles by using nano,textures such as anti-stain can be given to textiles,which saves time and money to wash them.

Progress has been made in design and manufacturing smart textile based on nanotechnology could be divided in vast area of nano complementary process, nano- coating, nanocomposite coating, nano color, nano fiber and nano composite fiber.

Nanofibers and nanocomposite fibers also include wide range of different fibers which compare to average fibers have more features such as higher resistance, higher module, heat constant.

As mentioned;

the best type of material for a suitable and comfortable coating is polyester, cotton and viscose. Cotton alone cannot be used to produce a comfortable fabric because it has its own difficulties when ironing, and also, viscose is mostly used to make women's clothing. As a result, a combination of polyester and cotton can be used to prepare a textile, which is the best type of combination that can use a combination of 35 percent cotton and 65 percent polyester.