4.4 Fabrication Techniques

Different fabrication techniques like knitting, weaving, and embroidery are used to convert raw materials like conductive fibers, yarns, polymers, and polymer composites into smart textiles. Smart electronic textiles are applied in every field of life due to their novel and unique properties.

The term 'smart textiles' is used to describe materials that are advanced in their structure, composition and 'behaviour' in special conditions. Their 'intelligence' is classified into three subgroups:

•Passive smart textiles, which are sensors and can only sense the environment;

•Active smart textiles, which can sense stimuli from the environment and also react to them; simultaneously with the sensor function, they also play an actuator role;

•Very smart textiles, which are able to adapt their behaviour to the circumstances.

4.5 Conductive Fibres

Conductive polymer-based electrochromic fabrics show promising applications in new intelligent displays, flexible smart wearables, and military camouflage, thanks to their flexibility, light weight, high degree of controllability, and wide range of color change.

The textile structures which can conduct electricity are called conductive textiles. It may be either made using conductive fibres or by depositing conductive layers onto non-conductive textiles.

A conductive fabric can conduct electricity and made with metal strands woven into the construction of the textile. It can be inhibited the static charge generated on fabric, to avoid uncomfortable feelings and electrical shocks also.

Methods of producing conductive textiles are summarized as follows:

- Adding carbon or metals in different forms such as wires, fibres or particles.
- Using inherently conductive polymers.
- Coating with conductive substances.

Types of Conductive Textiles:

Generally, four kinds of conductive textile as follow:

1. Anti-static textiles
2. EM shielding textiles
3. E-textiles
4. Functional coatings

1. Anti-static textiles:

Static electricity can the build-up of electric charge on the surface of objects. Which can be caused many problems for textile materials, manufacturing and handling the product. In dry textile process, fibres and fabrics can tend to generate electro-static charges from friction. When fibres and fabrics are moving at high speeds on different surfaces, (like: conveyer belts, transport bands, driving cords, etc) causing fibres and yarns to repel each other. These static charges can be produced electrical shocks and caused the ignition of flammable substances. Two techniques are known to prevent static electricity in textiles. One is to create a conducting surface and another is to produce a hydrophilic surface. In these ways antistatic textiles are produced to avoid the potential hazards caused by static charge or, electricity.

2. EM shielding:

Electro Magnetic shielding (EMs) is the process of restricting the diffusion of electromagnetic fields into a space. In this process, electrically or magnetically conductive barrier is used. Shielding is common technique for protecting electrical equipment and human beings from the radiating electro-magnetic fields. This barrier can be rigid or flexible. When an EM beam passes through an object, the electro-magnetic beam interacts with molecules of the object and this interaction may take place as absorption, reflection, polarization, refraction, diffraction through the object. EM Shielding textiles materials can be found in the form of woven, knitted, and nonwoven fabric also. The major components of these fabrics are fibres and yarns. To achieve an effective shielding behaviour, these fibres should be electrically conductive. Conductive yarns can be made by blending conductive fibres with conventional staple fibres, twisting conductive or insulator filaments together. For example, conductive metallic yarn (such as: silver, copper, etc.) can be wrapped with insulating textile materials to create hybrid yarns. Which could be integrated into woven or knitted structures. Hybrid yarns or metallic fibre can be integrated into these designs as warp. Electromagnetic shielding effectiveness of the fabric decreased with the increase in fabric openness.

3. E-textiles:

Electrically conductive fibres and yarns have attracted great interest because of their distinguished features including reasonable electrical conductivity, flexibility, electrostatic discharge, and EM interference protection. Conductive textile fibres are the primary component for wearable smart textiles introduced particularly for different applications such as sensors, electromagnetic interference shielding, electrostatic discharge, and data transfer in clothing. Therefore, the demand for electrically conductive fibres and yarns is ever-growing. The development of novel conductive fibres becomes crucial with technological improvement in wearable electronics such as wearable displays, solar cells, actuators, data managing devices, and biomedical sensors. E-textiles play a critical role in selecting the conductivity of smart textile electronics. Textile applications such as lighting, considerable current is necessary and low ohmic fibres are preferred. On another hand, for certain sensing or heating applications lower conductivity would work better. So, it requires fibres exhibiting lower electrical conductivity. E-textiles need flexible and mechanically stable conducting materials to ensure electronic capabilities in apparel.

4. Functional coatings:

For many applications, functional coating is the material interfaces and surfaces that provide beneficial functionality over their intrinsic bulk characteristics. Hence, coatings provide a versatile method of modifying textiles with conductive properties. Subsequently, the textile fabric acts as a supporting structure or carrier material for the conductive finish. Conventional methods such as dip coating or roll coating are typically used to apply bulk coatings in the form of a saturation or lamination that covers the entire “surface” of the textile. However, as will be presented herein, the advent of nano-technology in textile research, the development of novel process techniques, and the advancement of inks and coating formulations affords the opportunity to apply coatings to increasingly finer structures.

Properties of Conductive Textiles:

Physical properties:

- Low weight,
- High strength,
- Flexibility,
- Durability,
- Elasticity,
- Heat insulation,
- Water absorbency,
- Dyeability,
- Drape,
- Soft handling,