TECHNICAL TEXTILES

Technical Textiles

- Technical textile are textile products manufactured for non-aesthetic purposes.
- Technical textiles are ‘advanced materials’ for which the technical performance and physical properties are more important than features such as colour, pattern and price. This industry encompasses a vast array of materials, manufacturing processes and end use markets.
- Its growth and evolution is driven by the combination of sector lead by R&D and collaboration with other industries.
- They are used for automotive applications, medical usages, crop protection, protective clothing etc.
- Textile technical means “Textile materials and products manufactured primarily for their technical and performance properties rather than their aesthetic or decorative characteristics”.
- Textile that is primarily used for its performance or functional properties and not for its appearance or aesthetics is known as technical textiles.
- The industrial fabrics that are used for various industrial applications are also classified as technical textiles.
- Some textile academicians also include finished products such as ropes or tarpaulins, and parts of other products, such as tyre cord for tyres or cover stock for diapers, in the definition of technical textile.

- Technical textiles are used individually or as a component/part of another product.
- They can be used individually to satisfy specific functions, as a component or part of another product, to enhance the strength, performance or other functional properties of that product.
- They are also used as accessories in processes to manufacture other products.
- Other terms used for technical textiles are Industrial textiles, Functional textiles, Performance textiles, Engineering textiles, Hi-tech textiles etc.
- Their wide range of applications, lack of competition and growing consumer and industrial demands make it a big opportunity area and an attractive option to invest in.
- Though India is the 2nd largest textile economy in the world after China; its contribution in the global technical textile industry is only 9% to the total consumption.

Major Segments of Technical Textiles

The technical textile is broadly grouped under the following 12 segments based on the functional applicability.

1. Agrotech (Agriculture, horticulture and forestry)
2. Buildtech (building and construction)
3. Cloth tech (technical components of shoes and clothing)
4. Geotech (geotextiles, civil engineering)
5. Hometech (components of furniture, household textiles and floor coverings)
6. Indutech (filtration, cleaning and other industrial)
7. Medtech (hygiene and medical)
8. Mobiltech (automobiles, shipping, railways and aerospace)
9. Oekotech(environmental protection)
10. Pactech(packaging)
11. Protech (personal and property protection)
12. Sportech (sport and leisure)

Agro Textiles (Agrotech):

- These are the Agro-textiles, also known as Agrotex, that are used in agricultural applications related to growing and harvesting of crops and animals.
- Not only crop production, they are also used in forestry, horticulture, as well as animal and poultry rearing including animal clothing.
- Agro-textiles have to be strong, elongated, stiff, bio-degradable, resistant to sunlight and toxic environment.

Agro Textiles

- Agriculture, horticulture, forestry and aquaculture textiles
- Polypropylene, polyester, polyethylene etc.....

Construction Textiles

- Building and construction textiles
- Kevlar, nomex, carbon fibers.....

Clothing Textiles

- Technical components of shoes and clothing

  e.g. linings
- All the natural, man made and Synthetic Fibers

Geo Textiles (Geotech):

- These are the Geotextiles, also known as Geotex.
- These are woven, nonwoven and knit fabric used for many functions such as support, drainage and separation at or below ground level.
- Their application areas include civil and coastal engineering, earth and road construction, dam engineering, soil sealing and in drainage systems.
- Geotech have good strength, durability, low moisture absorption and thickness.
- Synthetic fibers such as glass fiber, polypropylene and acrylic fibers are used to prevent cracking of the concrete, plastic and other building materials.

Geo textiles

- Geotexiles and civil engineering materials
- Jute, coir, Polypropylene, Polyester, Polyethylene, polyvinyl chloride, Polyamide, Aramids

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Home Textiles

- Technical components of furniture, household textiles & floorcoverings
- Acetates, acrylics, polyester, natural fibers.....

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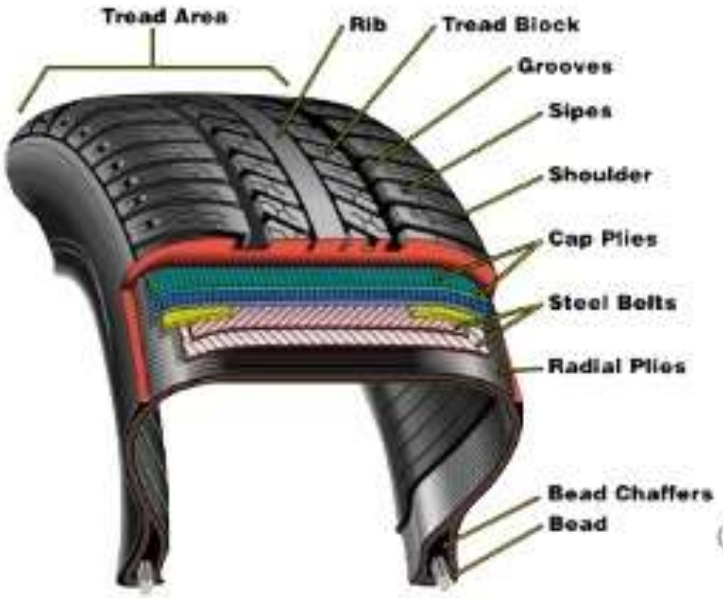
Industrial Textiles(Indutech):

- These are the Industrial Textiles, also known as Indutex.
- These are used in different ways by many industries for activities such as separating and purifying industrial products,
- cleaning gases and effluents,
- transporting materials between processes and
- acting as substrates for abrasive sheets and other coated products.
- They range from lightweight nonwoven filters, knitted nets and brushes to heavyweight coated conveyor belts.

Industrial textiles

- Filtration, conveying, cleaning etc
- Nylon, polyester, polypropylene, glass fibers....



Medical Textiles (Medtech):

- These are the Medical Textiles, also known as Medtex.
- They include all the medical fabrics that are used in health and hygiene applications in both consumer and medical markets.
- They are generally used in bandages and sutures that are used for stitching the wounds.
- Sutures and wound dressing uses fibers like silk fibers and other synthetic fibers.
- Hollow synthetic fibers are used with nano particles (very small particles) for delivery of drugs to any specific part of the body.
- Cotton, silk, polyester, polyamide fabrics are also used in medical applications

Medical Textiles

- Hygiene and medical products
- Polyester, Cotton, polypropylene, silk etc...

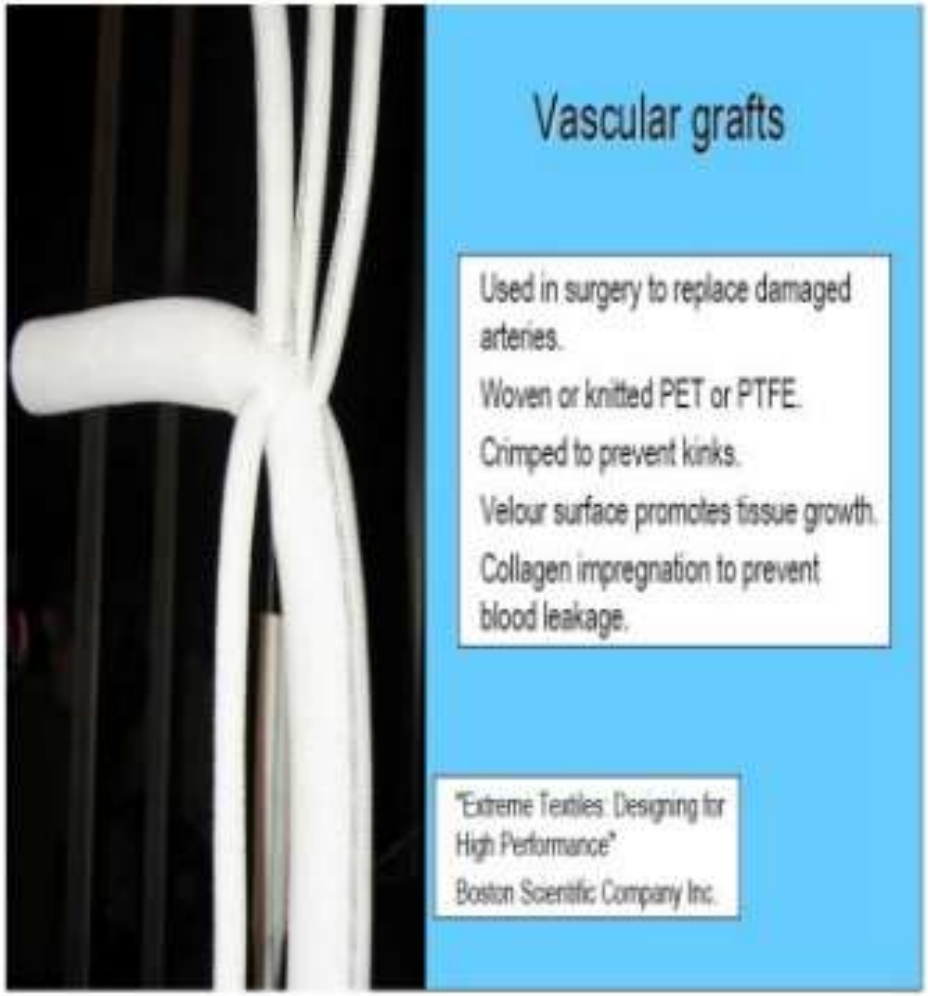
Alloplastic cruciate ligament

Extracorporeal devices- artificial kidney, liver, heart pacer and lung




Type Fibre	Application	Function
Hollow polyester fibre, hollow viscose	Artificial kidney	Remove waste products from patients' blood
Hollow viscose	Artificial liver	Separate and dispose of patients' plasma and supply fresh plasma
Hollow polypropylene fibre, hollow silicone membrane	Mechanical lung	Remove carbon dioxide from patients' blood and supply fresh oxygen

Implantable materials- sutures, vascular grafts, artificial ligaments, cartilages, artificial joints, heart valves etc



Sutures

Monofilament or multifilament threads.
Biodegradable – internal wound closures.
Non biodegradable – external.
Biocompatible.

Packaging Textiles (Packtech):

- These are the Packaging Textiles, also known as Packtex.
- Textiles have been used for packaging since ages.
- It ranges from heavyweight woven fabrics used for bags,
- packaging sacks,
- Flexible Intermediate Bulk Carriers (FIBCs) and
- wrappings for textile bales and carpets to the light weight nonwovens used as durable papers, tea bags and other food and industrial product wrappings.

Packaging Textiles

- Packaging materials
- Polyethylene, polypropylene, glass fibers.....

Protective Textiles

- Personal and property protection
- Nomex, kevlar fibers...

Sports Textiles (Sporttech):

- These are the Sports Textiles, also known as Sporttex.
- These are used mainly for making sports wear including sports shoes and other sports accessories.
- Increasing interest in active sports and outdoor leisure activities such as flying and sailing sports, climbing, cycling, etc. has led to immense growth in the consumption of textile materials in manufacturing sporting and related goods and equipment.
- Synthetic fibers and coatings have largely replaced traditional cotton fabrics and other natural fibers in the making of sporttech.

Sport Textiles

- Sport and leisure
  E.g Yatcht, Hot air balloons...
- Polyester, nylon, spandex, glass fibers.....

Transportation Textiles

- Automobiles, shipping, railways and aerospace
- Polyester, nylon, glass, UHMWPE, aramids compsites, carbon fibers...

- The market trends for traditional textiles is heavily inclined towards countries with cheap labor. In such an environment, technical textiles give an opportunity to the companies in the industrialized countries to survive the competition and to achieve sustainable growth due to their specialized skills, materials, processes and equipments.

Basic differences between technical textiles and traditional textiles industries:

- Technical textiles are preferred for their highly specific performance quality and as such they are more expensive than the traditional textiles.
- Technical textile manufacturers have to use accepted testing methods in order to gain customers' faith regarding standard specifications.

- Technical textiles are for a distinct segment of a market as opposed to mass market. This target market needs more flexible and smaller production spells. Thus the technical textile manufacturers too have to be flexible in their production schedules.

- Technical Textiles survive on innovations. Thus, technical textile manufacturers must be ready to invest in research and development and newer equipments too.

- In certain categories of technical textiles, the legal necessities have to be followed by the manufacturers.

SMART AND INTELLIGENT TEXTILES

SMART AND INTELLIGENT TEXTILES

- Our textile industry is distinctly moving towards an new era, an era of “smart and intelligent textiles”.
- There is a substantive difference between smart and intelligent textiles.
- Smart textiles or materials can be defined as the materials and structures which have sense or can sense the environmental conditions or stimuli,
- whereas intelligent textiles can be defined as textile structures which not only sense but also react and respond to environmental conditions or stimuli.
- These stimuli as well as response, could be thermal, chemical, mechanical, electrical, magnetic or from other source.

TYPES OF SMART TEXTILES:

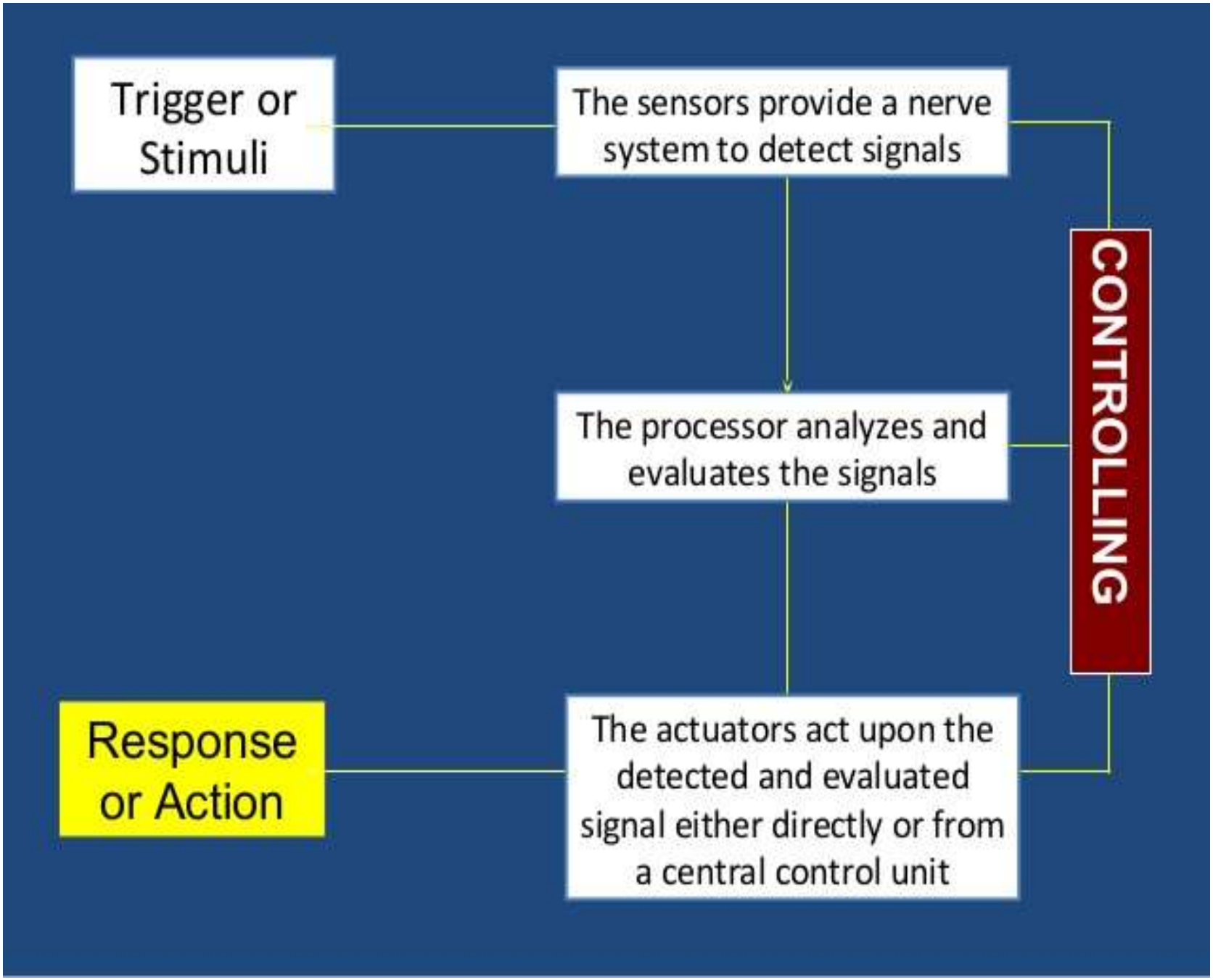
According to the manner of reaction, they can be divided into passive smart, active smart and very smart materials:

1. Passive smart materials: It can only sense the environmental conditions or stimuli; they are sensors;

2. Active smart materials: It will sense and react to the conditions or stimuli, besides the sensor function, they also have actuation characteristics;

3. Very smart materials: It can sense, react and adapt themselves accordingly;

4. Intelligent Textiles: An even higher level of intelligence can be achieved from those intelligent materials and structures capable of responding or activated to perform a function in a manual or pre-programmed manner.


Trigger or Stimuli
The sensors provide a nerve system to detect signals
The processor analyzes and evaluates the signals
The actuators act upon the detected and evaluated signal either directly or from a central control unit
Response or Action
CONTROLLING

COMPONENTS OF SMART TEXTILES:

- Three components may be present in such materials:
- Sensors
- Actuators
- Controlling units
- **Sensors:** Provide a nerve system to detect signals, thus in a passive smart material, the existence of sensors is essential.

  Actuators: Act upon the detected signal either directly or from a central control unit; together with the sensors, they are the essential element for active smart materials.

  Controlling Unit: At even higher levels, like very smart or intelligent materials, controlling unit is essential, which works like the brain, with cognition, reasoning and activating capacities.

2. Types of smart textiles

Smart textiles can be divided in to **four** types based on their functions.

1. ***Passive smart materials*** are materials or systems which **only sense** the environmental conditions or stimuli.

- They are just sensors. They show up what happened on them, Such as changing color, shape, thermal and electrical resistivity.
- e.g. a shirt with in-built thermistors to log body temperature over time.

2. Active smart materials: that can both **sense and respond** to the external conditions or stimuli.

- If actuators are integrated in the passive smart textile, it becomes an active smart textile as it may respond to a particular stimulus,
- e.g. the temperature aware shirt may automatically rolls up the sleeves when body temperature becomes elevated.

3. *Very smart materials:* are materials and systems which can execute triple functions; First, they are **sensors** which can receive stimuli from the environment; Secondly they are able to give reaction based on the stimuli; Thirdly they can adapt and reshape themselves accordingly to the environmental condition.

4. *Materials with even higher level of intelligence* develop artificial intelligence to the computers.

- These kinds of materials and systems are not fully achieved in the current investigation of human beings.
- This may be achieved from the coordination of those Very smart (intelligent) materials and structures with advanced computer interface.

3. Materials for smart textiles

- Metal fibers
- Conductive inks
- Quantum tunneling composites-change from insulator to conductor
- Inherently conductive polymers
- Optical fibers
- Nano particles
- Organic semi-conductors
- Shape memory fabrics

smart materials have appropriate responses

- photochromic glass
  - darkens in bright light
- low melting point wax in a fire sprinkler
  - blocks the nozzle until it gets hot
- acoustic emission
  - sounds emitted under high stress
- embedded optical fibres
  - broken ends reflect light back
- microporous breathable fabrics

4. Relation and difference with technical textiles

- Before the existence of smart and interactive textiles, technical and functional textiles served the human race in all aspects of application areas.
- Tents, ropes, ship guiding fabrics, military garments, curtains, bandages and others were used in the past many centuries. Still these and other technical and casual clothing's are on use many folds times.
- It is undeniable before the development of smart textile; the functional textiles were the advanced textiles.
- However whatever they perform they are not active. They are passive. They are not designed to regulate themselves. No smart material is applied to them.
- They can be protective cloth but cannot be as the smart protective clothing.

- All smart materials involve an energy transfer from the stimuli to response given out by the material. They are integrated and complex materials.
- They have the ability do some sort of processing, analyzing and responding. Even they can adapt to the environment. They can be described as textile materials that think for themselves.
- They got full ability to change themselves depending on — temperature, pressure, density, or internal energy—will change. The amount of energy transferred to make this change is determined by the properties of the material. This relationship between the amount of energy required and the degree of the specific change governs the behavior of all materials, including smart ones.
- In technical, high performance and conventional textiles materials, the properties scale the relationship between state change and energy transfer is not a complicated. It is straight forward.
- If they get energy or any stimuli from the outer environment they do not do any change on it .They just resist it. Or absorb it.

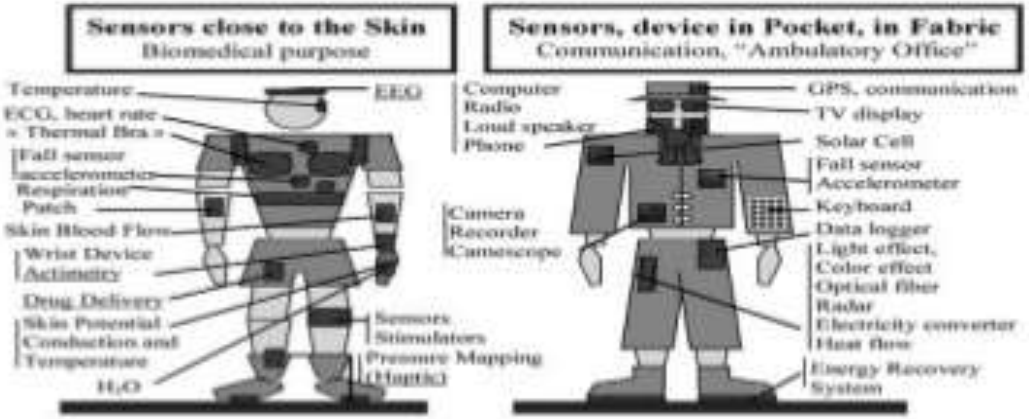
5. Some applications of smart textiles

Sports and Human Performance

- The sports sector, through seeking to improve athletic performance, personal comfort and protection from the elements
- e.g. breathable waterproof fabrics such as Goretex® and moisture management textiles like Coolmax®.
- It is even possible to maintain constant body temperature using phase-change technology

Personalized Healthcare

- The concept of personalized healthcare empowers the individual with the management and assessment of their own healthcare needs.
- Wearable devices allow physiological signals to be continuously monitored during normal daily activities. This can overcome the problem of infrequent clinical visits that can only provide a brief window into the physiological status of the patient.
- Smart clothing serves an important role in remote monitoring of chronically ill patients or those undergoing rehabilitation.
- It also promotes the concept of preventative healthcare.



Military/security

- In extreme environmental conditions and hazardous situations there is a need for real time information technology to increase the protection and survivability of the people working in those conditions
- The requirements for such situations are to monitor vital signs and ease injuries while also monitoring environment hazards such as toxic gases.
- Wireless communication to a central unit allows medics to conduct remote triage of casualties to help them respond more rapidly and safely.

Fashion/lifestyle

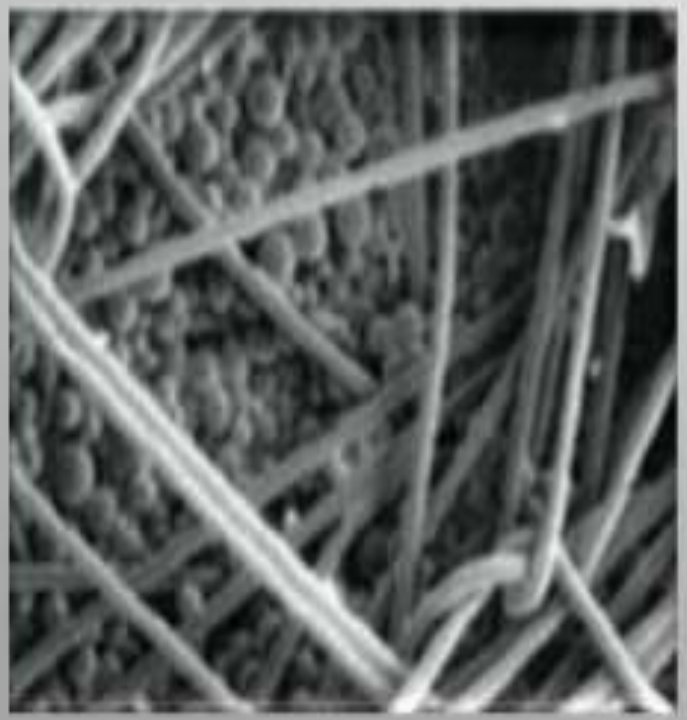
- The development of high-tech advanced textiles for initial high-value applications such as extreme sports will eventually find its way into street fashion

PHASE CHANGING MATERIALS USED---

- Thermo regulating materials
- Shape memory materials
- **Chromic materials**
- Luminescent materials
- Conductive materials
- Membranes
- Voltaic materials

THERMO REGULATING MATERIALS

- Paraffin PCM mostly use smart textiles absorbs heat and store it and change state to retain heat.



- Provide a thermal balance between the heat generated by body while engaging in sports and the heat released into the enviorment

Phase changing Materials for thermoregulation:

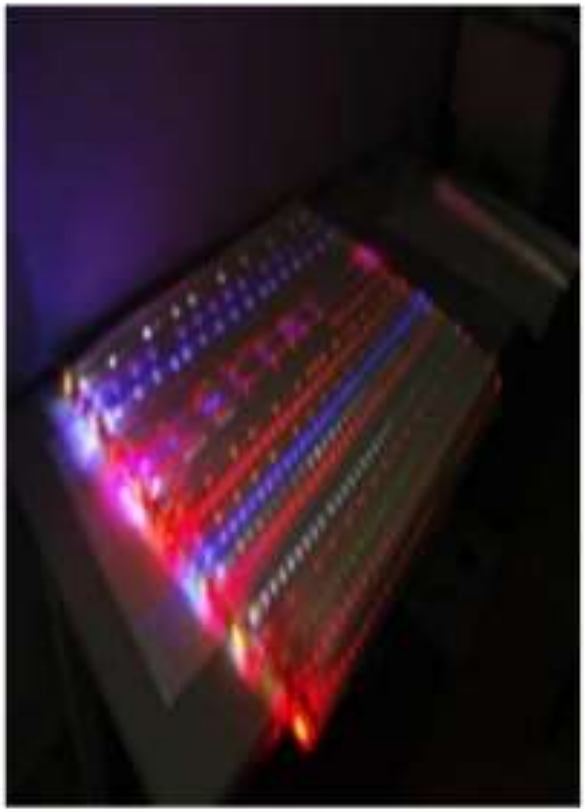
- PCM possesses the ability to change their state with a certain temperature range.
- it is developed under NASA
- Textiles containing phase change materials react immediately with changes in environmental temperatures, and the temperatures in different areas of the body.
- When a rise in temperature occurs, the PCM microcapsules react by absorbing heat and storing this energy in the liquefied phase change materials.
- When the temperature falls again, the microcapsules release this stored heat energy and the phase change materials solidify again

Chromic Materials

- Are those which change their colour reversibly according to external environmental conditions, for this reason they are also called **chameleon fibres**
- Chromic materials are the general term referring to materials which radiate the colour, erase the colour or just change it because its induction caused by the external stimulus,
- **Photochromic**: external stimulus is light.
- **Thermochromic**: external stimulus is heat.
- **Electrochromic:** external stimulus is electricity.
- **Piezorochromic:** external stimulus is pressure.
- **Solvatechromic**: external stimulus is liquid or gas.

❖Luminescent Materials

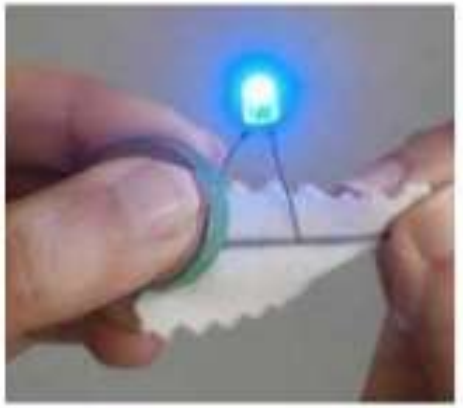
- Emits lights according to external environmental conditions
- **Photoluminescence**: external stimulus is light
- **Electroluminescence**: external stimulus is electricity
- **Chemioluminescence**: external stimulus is a chemical reaction
- **Triboluminescence**: external stimulus is friction



Glow in the Dark textile

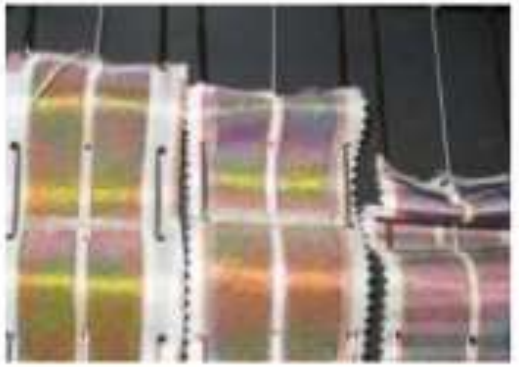
❖Conductive materials

- **Function:** It conducts electricity.
- **Properties:** Light weight, flexible, cost competitive with ability to be crimped, soldered and subjected to textile processing.
- **Preparation:** It can be made by filling synthetic fibres with carbon,nickel,gold ,silver or metal particles, coating fibres with conductive polymers or using conductive short fibres.



❖Voltaic materials

- Photovoltaic materials possess the property to generate electric current by means of a light excitation.
- Solar cell fabric is embedded with photo voltaic cells (PV)
- Capable of collecting more of sun's energy from different angles than a flat stationery panel.
- Solar fibres can not only charge our smartphones and gadgets but become wearable power sources for soldiers



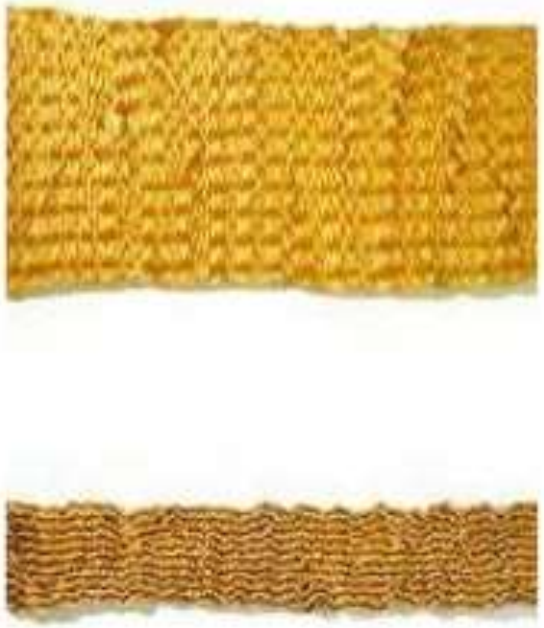
VOLTAIC MATERIALS

- Storage of energy for electronic parts and use of solar cells in textiles.

- Research underway to produce and store electricity from body movments and wrist rotation.

❖Shape memory material

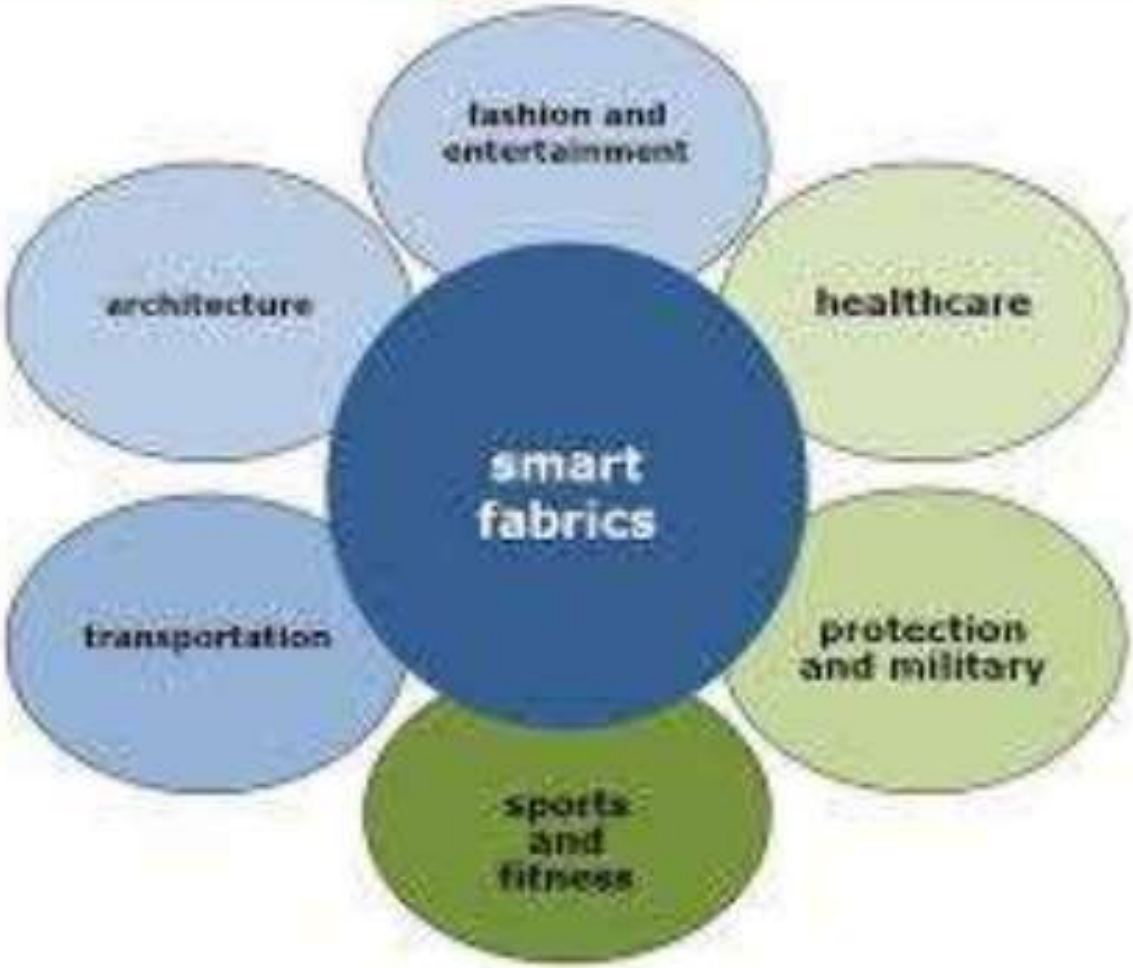
- Are polymeric smart materials that have the ability to return from a deformed state (temporary)to their original(permanent)shape induced by an external stimulus(trigger)such as temperature change.



MEMBRANES

- Mambranes are constituted of polymers and their structure could be made of one or more layers.
- Used in sportswear for the manufacture of breathable and impermeable clothes.

Smart Fabric End Use



MUSICAL JACKET

- The musical jacket was first developed in the fall of 1997.
- It has a touch sensitive MIDI keyboard embroidered directly into the fabric using conductive thread.
- It contains stainless steel filaments, which makes it conductive.

- lyphonic, thus several keys can be ly. Sound is generated by a single-chip General MIDI wavetable synthesizer, and sequences are generated in a microcontroller.
- The jacket is entirely battery operated, with powered speakers in the pockets

WI-FI DETECTOR T-SHIRT

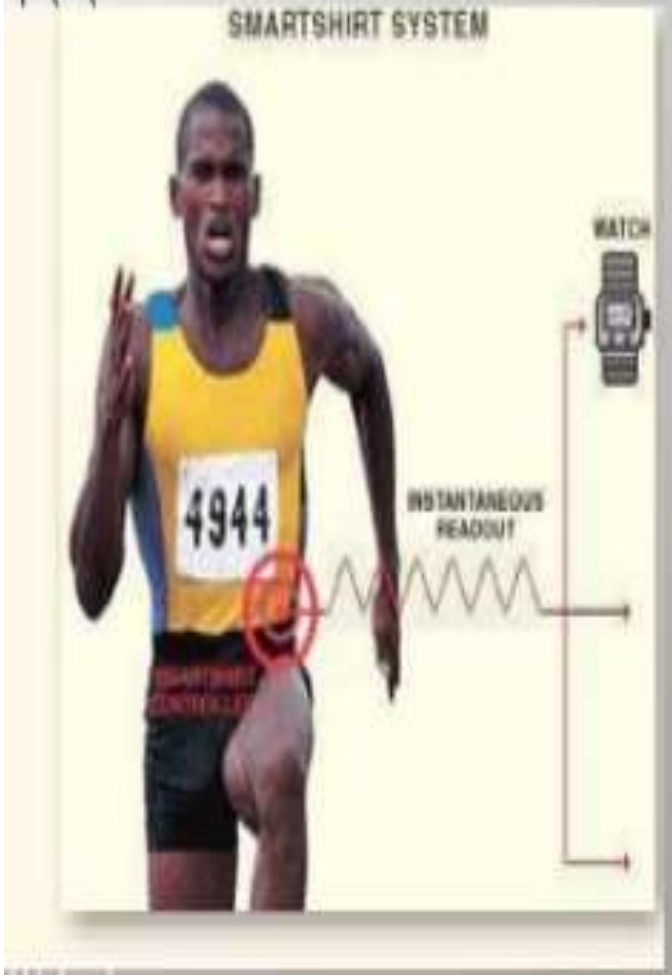
- A shirt with a built-in Wi-Fi signal detector
- Glowing animated shirt dynamically displays the current Wi-Fi signal strength

- Animated Decal is Removable (with hook and loop fasteners) for Easy Washing
- Battery Pack is Concealed in a Small Pocket Sewn Inside the Shirt

SPACE SUIT

- Aspace suitis a garment worn to keep a human alive in the harsh environment of outer space,vacuumand temperature extremes
- The innermost layer is made up of a Nylon tricot material
- Another layer is composed of spandex, an elastic wearable polymer
- Dacron—a type of polyester—is used for a pressure-restraining layer

JOGGING SUIT



- The Brussels, Belgium based research , which monitors the heart beat, and then plays certain type of music, adopting the rhythm to push the wearer faster or slower.

- A mobile phone in clothing can send the data by email to wearer's club.

Advantages

- Light weight
- Durable
- Washable
- Integratable with human body
- Pierce resistant
- Water resistant yet breathable
- Tracking/communication systems
- Monitoring systems
- Usable in security authentication

Drawbacks

- Needs to be charged
- Bulky
- Expensive
- Yet to be commercially recognized

Photo chromic dyes

Photo chromic dyes react to UV light & change colour. They can be useful for monitoring the amount of time children spend in the sun, to prevent sun-burn.

Interactive or Electronic Textiles

An interactive fabric incorporates electronics that are activated by a power source. They are still Smart fabrics, they just require a power source.

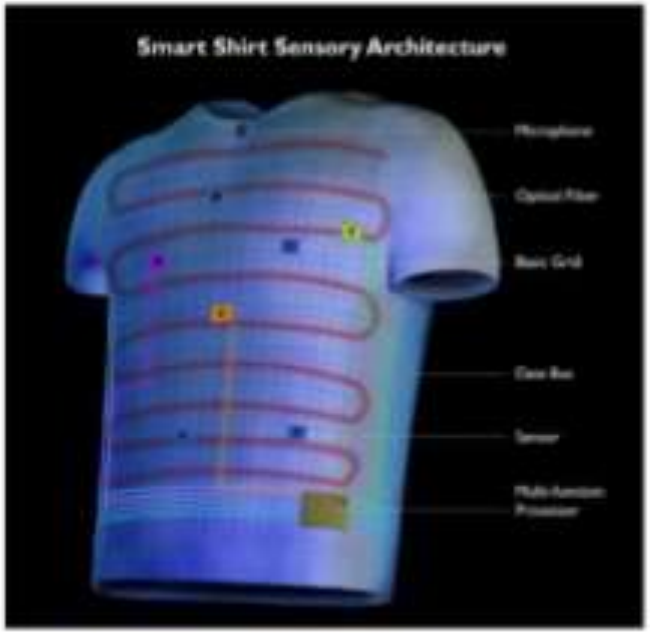
Introduction

- Electronic Textiles: electronic textiles, are fabrics that can function electrically as electronics and behave physically as textiles which enable computing ,digital components and electronics to be embedded in them. Part of the development of wearable technology, they are referred to as intelligent clothing or smart clothing that allow for the incorporation of built-in technological elements in everyday textiles and clothes.

WEARABLE ELECTRONICS

- They can be used in wearable textiles to dial telephones, pager messages and control music from MP3 players.
- Examples include a business suit with a mobile phone incorporated, a child's anorak with a tracking device, sportswear to monitor heart rate, aerobic outfits with music players incorporated, and club wear which changes colour etc.

Detection of Vital Signals



Sensatex is developing a SmartShirt™ System specifically for the protection of public safety personnel, namely firefighters, police officers, and rescue teams. Used in conjunction with a wireless-enabled radio system, the SmartShirt™ can monitor the health and safety of public safety personnel/victims trapped in a building or underneath rubble with the ability to detect the exact location of victims through positioning capability. In addition to monitoring vital signs, the system can detect the extent of falls, and the presence of hazardous gases; it also offers two-way voice communication

Warning Signaling

A combination of sensors and small flexible light emitting displays (FLED) can receive and respond to stimuli from the body, enabling a warning signal to be displayed or sent. The sensors can monitor EKG, heart rate, respiration, temperature, and pulse oximetry readings. If vital signals were below critical values, a FLED would automatically display, for example, a flashing red light, and a wireless communication system could send a distress signal to a remote location.

Global Positioning System (GPS)

Textiles integrated with sensory devices driven by a GPS can detect a user's exact location anytime and in any weather. Interactive electronic textiles with integrated GPS enhance safety by quickly locating the wearer and allowing the suit to be heated. GPS can provide added safety for firefighters and emergency personnel by facilitating offsite monitoring of vitals

Wireless, hands-free communication

Fabric area networks (FANs) enable electronic devices to exchange digital information, power, and control signals within the user's personal space and remote locations. FANs use wireless RF communication links using currents measuring one nanoamp; these currents can transmit data at speed equivalent to a 2400-baud modem

FABRIC COMPOSITES

WHAT IS COMPOSITES?

- COMPOSITES:-- **Composite materials** (also called **composition materials** or shortened to **composites**) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure.

TYPES OF COMPOSITES:-

- There are several different types of composites used today. The most common are:

  1. Fibre reinforced composites
  2. Particulate reinforced composites

- These types of composites cover a range of different material combinations. The most common type is polymer matrix composites, however, metal matrix composites, and ceramic matrix composites are also common, as are natural composites such as wood.

- FIBRE REINFORCED COMPOSITES

PARTICULATE REINFORCED COMPOSITES

REINFORCEMENTS & ITS ROLE IN COMPOSITES

The primary function of fibers or reinforcements is to carry load along the length of the fiber to provide strength and stiffness in one direction. Reinforcements can be oriented to provide tailored properties in the direction of the loads imparted on the end product. Reinforcements can be both natural and man-made.

MATRIX & ITS ROLE IN COMPOSITES

To bind the fibers together so that the applied stress is distributed among the fibers .To protect the surface of the fibers from being damaged and to separate the fibers and inhibit crack propagation.

ROLE OF INTERFACE

Interface plays an important role on coupling between fibre & matrix. It also developes the strength of the composites.

TYPES OF FIBRES USED IN COMPOSITES

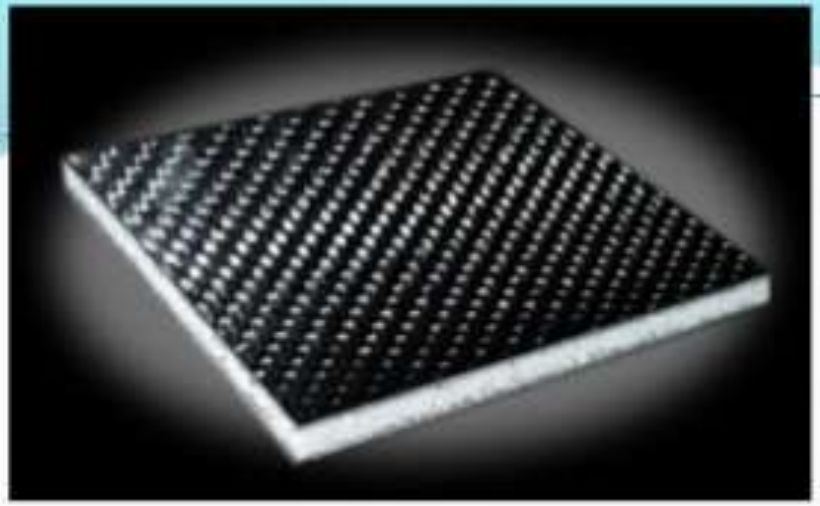
- There are mainly three types of fibre used in composites.
  They are: ***Glass Fibre***, ***Carbon Fibre*** & ***Aramid Fibre***.

- These fibres are used for having some important properties. They are as follows:

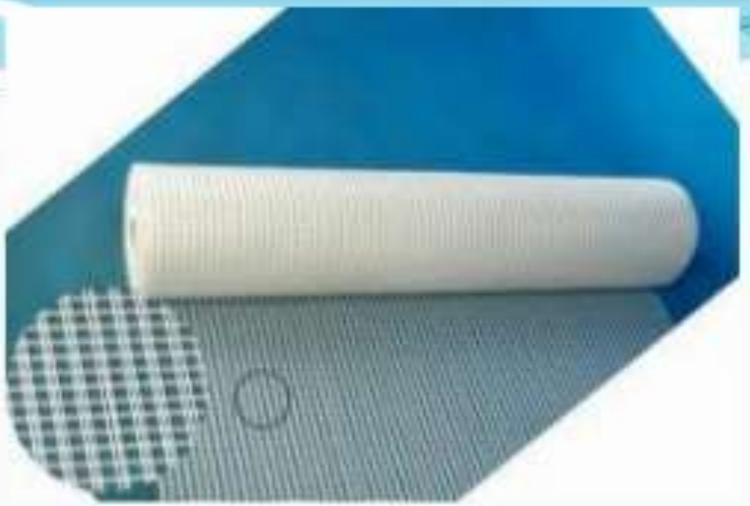
1. High tensile and compressive strength.
2. Low density.
3. High chemical stability.
4. High thermal stability .

- In case of fabric composites we mainly use the ***WOVEN FABRICS.***

  Woven fabrics are generally used in high-performance composites to reinforce them. A wide range of different types of woven fabrics are used, the most familiar being plain weave, twill weave and satin weave. The density of the fibre and the type of weave critically influence the forming properties and the characteristics of the finished product.



CARBON FIBRE COMPOSITE
COMPOSITE



GLASS FIBRE

ARAMID FIBRE COMPOSITE
COMPOSITE

WOVEN FABRIC

ADVANTAGES & DISADVANTAGES:-

ADVANTAGES:-

- A higher performance for a given weight leads to fuel savings. Excellent strength-to-weight and stiffness-to-weight ratios can be achieved by composite materials.
- Laminate patterns and ply buildup in a part can be tailored to give the required mechanical properties in various directions.
- Production cost is reduced. Composites may be made by a wide range of processes.
- Composites offer excellent resistance to corrosion, chemical attack, and outdoor weathering.

DISADVANTAGES:-

- Composites are more brittle than wrought metals and thus are more easily damaged.
- Hot curing is necessary in many cases, requiring special equipment.
- Repair at the original cure temperature requires tooling and pressure.

APPLICATION OF COMPOSITES

- The applications of composite materials continue to be of increasing importance due to the industry's need for modern analysis and improved performance

BULLET PROOF JACKET

Figure 2. Metal/fiber applications in A380 airplane from Airbus[9].

AIRCRAFTS

AUTOMOBILE PARTS

BOATS HULLS

SPORT'S KITS

BUILDING CONSTRUCTION