

Technical Fabric as Health Care Material

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Abstract The objective of the study is to expose the achievements of advance application of textile material. Previously textiles are only used as normally wound care products, diapers, braces, prostheses and outhouses, wipes, breathing masks, bedding and covers, ropes and belts etc but the technology has been upgraded. Textile materials and products that have been engineered to meet particular needs are suitable for many applications as well as medical and surgical application in which a combination of strength, flexibility, and sometimes moisture- and air-permeability is required. Materials used include monofilament and multifilament yarns, woven, knitted, and nonwoven fabrics, and composite structures. The applications are many and diverse, ranging from a single-thread suture to the complex composite structures used for bone replacement, and from the simple cleaning wipe to the advanced barrier fabrics used in operating rooms. Although textile materials have been widely adopted in medical and surgical applications for many years, new uses are still being found. Research utilising new and existing fibres and fabric-forming techniques has led to the advancement of medical and surgical textiles. At the forefront of these developments is absorbency, tenacity, flexibility, softness, or biodegradability.

Keywords: artificial, bandage, cotton, polyester fibre, knitted, woven

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1. Introduction

It is one of the most rapidly expanding sectors in the technical textile market. Medical Textiles are the products and constructions used for medical and biological applications and are used primarily for first aid, clinical and hygienic purposes. It consists of all those textile materials used in health and hygienic applications in both consumer and medical markets. In case of Medical Textiles the main requirement of the textile material is bio receptivity and biocompatibility at the application site in human beings. Eg: antimicrobial sutures based on nylon and polypropylene mono filaments. Medical textiles are textile products and constructions for medical applications. They are used for first aid, clinical or hygienic purposes and rehabilitation.

Examples of their application include:

1. protective and healthcare textiles;
2. dressings, bandages, pressure garments and prosthetics;
3. hygiene products;
4. Antiseptic wound dressings.

The scope of meditech embraces all textile materials used in health and hygiene applications in both consumer and medical markets. Depending on the nature of application, many medical products are disposable and made out of nonwoven fabrics. Textile products are used in medical and healthcare sector in various forms. The complexity of applications has increased with research and developments in the area of medical textiles. The surgical gown, operating room garments and drapes require special antibacterial properties combined with the

wearers comfort. Other major uses of medical textiles are incontinence diapers, sanitary napkins and baby diapers. Wound dressing, bandages and swabs are also widely used conventional medical textiles. Textiles are also being used as sutures, orthopaedic implants, vascular grafts, artificial ligaments, artificial tendons, heart valves and even as artificial skins. Recent advances in medical textiles to be used as extracorporeal devices are also significant; these include artificial kidney, artificial liver, mechanical lungs etc. New materials are finding specialized applications like antimicrobial and antifungal fibres and additives used in barrier fabrics, abdominal post-operative binders, applications in neurodermatitis treatment and various other wound management and surgical treatments. Although the type of fibre used and the fabric structure varies with the specific end use, all medical fibres must be non-toxic, non-carcinogenic, non-allergic and capable of being sterilized without suffering chemical or physical damage. In addition, for many applications absorbency is essential, favoring the use of cotton or viscose. In most applications, cotton has been replaced by synthetics such as polyester (because of its durability and low linting characteristics), by polypropylene (the most popular fibre, largely due to its capillary & inert characteristics), and by viscose rayon (due to its absorbency and biodegradability).

2. Characteristics of the Medical Textiles Market

According to 'Technical Textiles and Industrial Nonwovens: World Market Forecast to 2010' published

by David Rigby Associates 1) (DRA), it is forecast that the world market for technical textiles and industrial nonwovens will increase by 3.5% per annum between 1995 and 2005, and 3.8% per annum from 2005 to 2010 in volume terms, to reach 23.8 mn tones with a value of \$ 126 bn by 2010. The division of technical textiles (according to DRA) into the different application areas is presented in Figure 1.

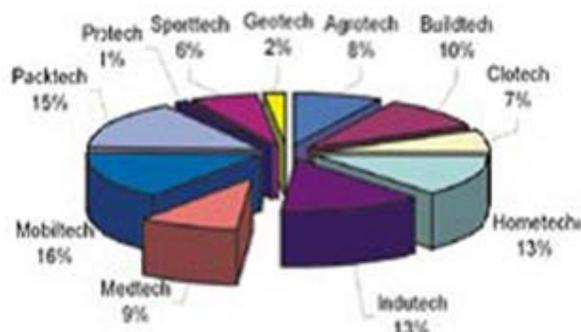


Figure 1. Divisions of technical textile

On the basis of DRA's research, over 1.5mn tons of textile materials, with a value of US\$5.4bn, were consumed worldwide in the manufacture of medical and hygiene products in 2000. This is predicted to increase in volume terms by 4.5% per annum to 2010 to reach 2.4 mn tons with a value of US\$ 8.2 bn. This sector probably offers the greatest scope for the development of the most sophisticated and highest value textiles for niche applications [7]. Technical textiles will find many different kinds of application with medical and hygiene products in the healthcare sector. The diversity of applications encountered in medical and healthcare products is quite remarkable, e.g. simple bandages, biocompatible implants and tissues, antibacterial wound treatment material, prosthetics, and intelligent textiles. Each of these categories covers a broad range of applications, and the many end-uses with their disparate requirements create opportunities for all kinds of textile such as fibres, mono- and multi-filament yarns, woven, knitted, nonwoven, braiding and composite fabrics [5,6].

Medical textiles embrace all those textile materials used in health and hygiene applications in both the consumer and medical markets. As such, it comprises a group of products with considerable variations in terms of product performance and unit value. Because of the nature of their application, many medical products are disposable items. Nonwovens account for a high part of the sector overall in terms of tons of fibre used [7]. Also, another feature of the medical textile market will be the growing proportion of composite materials used in wound management products. This will mean the combination of textiles with such

materials as films, foam and adhesives to form structures for the treatment of wound and healthcare products [8]. The increased use of textiles in composite applications will provide major growth fibre consumption in terms of volume. The hitherto increase and forecast in world consumption of medical textiles is presented in Figure 2.

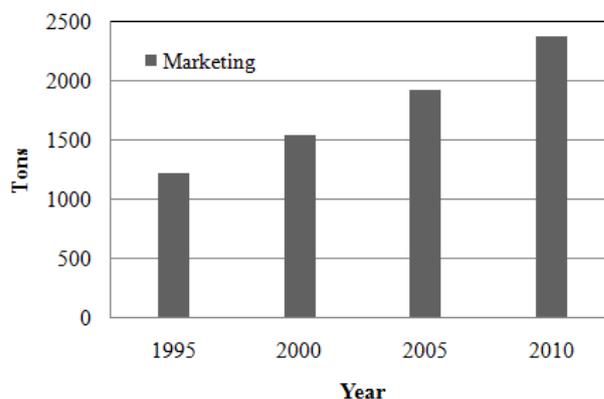


Figure 2. Consumption of technical textile

European producers are world leaders in the market for technical/industrial textiles and nonwovens, for example industrial filters, hygiene products or in the medical sector. Although the textile sector is marked by small- and medium-sized enterprises and local developments, it is important that research efforts take place in a more integrated way so as to achieve a critical mass and be competitive on the global market. The European technical textile sector should continue to develop highly specialised products. This is the case, for example, in medical textiles based on biomaterials, interactive and intelligent textiles provided for textile sensors and improving test methods [8].

3. Types of Medical Textile

Medical Textiles are the products and constructions used for medical and biological applications and are used primarily for first aid, clinical and -hygienic purposes. It consists of all those textile materials used in health and hygienic applications in both consumer and medical markets. As such it comprises a group of products with considerable variations in terms of product performance and unit value. Because of the nature of their application many medical products are disposable items. The increased use of textiles in composite applications will provide major growth fiber consumption in terms of volume Medical textiles are divided into four categories, which is shown Figure 3.

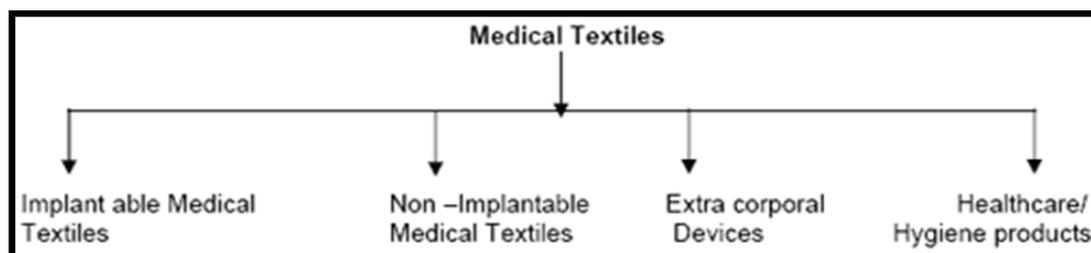


Figure 3. Application of medical textile

3.1. Implantable Medical Textiles

The materials are used in effecting repair to the body whether it is wound closure (sutures) or replacements surgery like vascular grafts, artificial ligaments, etc). There are many shapes and sizes, for duplications as found in human body. Filament, textures yarns used nowadays, which are coated to prevent leakage of blood while tissue, is forming on the inner walls. Carbon fibre is a popular material for tissue repair. Suspensors and reinforcing surgical meshes are used in plastic surgery for repairing defects of the abdominal wall. Surgical treatments of hernia in Urology etc Hydrophobic snivels felt dressings are high porosity textiles made from man- made fibres designed for treatment of bums and different dermatological defects. Some of polymer fibers which are used for implantable are mention in Table 1.

Table 1. Fibre for Implantable Medical Textile [9]

S. No	Fibre Type	Fabric Structure	Application
1	Collagen, catgut, polyglycolide fibre, polylactide fibre	Monofilament, braided	Biodegradable sutures
2	Polyester fibre, polyamide fibre, PTFE fibre, polypropylene fibre, polyethylene fibre	Monofilament, braided	Non-biodegradable sutures
3	PTFE fibre, polyester fibre, silk, collagen, polyethylene fibre, polyamide fibre	Woven, braided	Artificial tendon
4	Polyester fibre, carbon fibre, collagen	Braided	Artificial ligament
5	Low-density polyethylene fibre	-	Artificial cartilage
6	Chitin	Nonwoven	Artificial skin
7	Poly (methyl methacrylate) fibre, silicon fibre, collagen,	-	Eye-contact lenses and artificial cornea
8	Silicone, polyacetyl fibre, polyethylene fibre	-	Artificial joints/bones
9	PTFE fibre, polyester fibre	Woven, knitted	Vascular grafts
10	Polyester fibre	Woven, knitted	Heart valves

3.2. Non - Implantable Materials

These materials are used for external applications on the body and may or may not contact with skin. They are made from co-polymer of two amino acids. They are employed as covering, absorbent, protective and supports for injured or diseased part. They are different types of non-implantable material which is wound dressing, plaster etc. A number of wound-dressing types are available for a variety of medical and surgical applications. The functions of these materials are to provide protection against infection, absorb blood and exudate, promote healing, and, in some instances, apply medication to the wound. Common wound dressings are composite materials consisting of an absorbent layer held between a wound-contact layer and a flexible base material. The absorbent pad absorbs blood or liquids and provides a cushioning effect to protect the wound. The wound contact layer should prevent adherence of the dressing to the wound and be easily removed without disturbing new tissue growth. The base materials are normally coated with an acrylic adhesive to provide the means by which the dressing is

applied to the wound [10]. Textile materials used for wound-dressing applications include gauze, lint, and wadding. Gauze is an open-weave, absorbent fabric, which, when coated with paraffin wax, is used for the treatment of burns and scalds. In surgical applications, gauze serves as an absorbent material when used in pad forms (swabs); yarns containing barium sulphate are incorporated so that the swab is X-ray-detectable. Lint is a plainweave cotton fabric that is used as a protective dressing for first-aid and mild-burn applications. Wadding is a highly absorbent material, which is covered with a nonwoven fabric to prevent wound adhesion or fibre loss.

Bandages are designed to perform a wide variety of specific functions, depending upon the final medical requirement. They can be woven, knitted, or nonwoven and are either elastic or non-elastic. The most common application for bandages is to hold dressings in place over wounds. Such bandages include lightweight knitted or simple open-weave fabrics made from cotton or viscose, which are cut into strips and then scoured, bleached, and sterilised. Elasticated yarns are incorporated into the fabric structure to impart support and conforming characteristics. Knitted bandages can be produced in tubular form in varying diameters on either warp- or weft-knitting machines. Woven light-support bandages are used in the management of sprains or strains, and the elasticated properties are obtained by weaving cotton crepe yarns that have a high twist content. Similar properties can also be achieved by weaving two warps together, one beam being under a normal tension and the other under a high tension. When applied under sufficient tension, the stretch and recovery properties of the bandage provide support for the sprained limb [11]. Some of non-implantable fiber which is used for medical purpose is mention in Table 2.

Table 2. Non-implantable fibers for medical Application [10]

S. No	Product Application	Fibers types	Fabric Types
1	Wound-care		
*	Absorbent pad	Cotton viscose	Nonwoven
*	Wound contact layer	Silk, polyamide fiber, viscose, polyethylene fibers, plastic film	Knitted, woven, nonwoven
*	Base material	Viscose, plastic film	Nonwoven, woven
2	Bandage		
*	Simple inelastic/elastic	Cotton, viscose, polyamide fiber, elastomeric-fiber yarns	Woven, knitted, nonwoven
*	Light support	Cotton, viscose, elastomeric-fiber yarn	Woven, knitted, nonwoven
*	Compression	Cotton, polyamide fiber, elastomeric-fiber yarns	Woven, knitted
*	Orthopedic	Cotton, viscose, polyesters fiber	Woven, nonwoven
3	Plaster	Viscous plastic film, cotton, polyesters fibers, glass fiber	Woven, knitted, nonwoven
4	Gauzes	Cotton, viscous	Woven, nonwoven
5	Lint	Cotton	Woven
6	Wadding	Viscose, cotton linter, wood pulp	Nonwoven

3.3. Extra Corporeal Devices

Extra corporal devices are mechanical organs that are used for blood purification and include the artificial

kidney, the artificial liver and the mechanical lungs. Fibres which are used for extra implantable are mention in [Table 3](#).

hollow polyester fibre slightly latest than capillary vessels Fabric which is used to remove waste products from patient's blood. The artificial kidney shown in [Figure 4](#).

Table 3. Fibres used for extra corporeal device [9]

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

3.3.1. Artificial Kidney

Tiny instrument are about the size of a two - cell flashlight, made with hollow hair sized cellulose fibres or

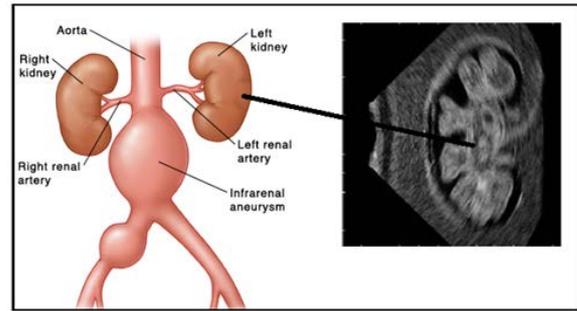


Figure 4. Artificial kidney manufacturing technical textile [12]

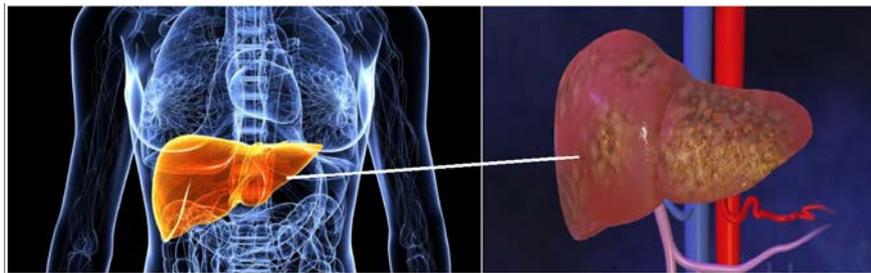


Figure 5. Artificial liver manufacturing technical textile [13]

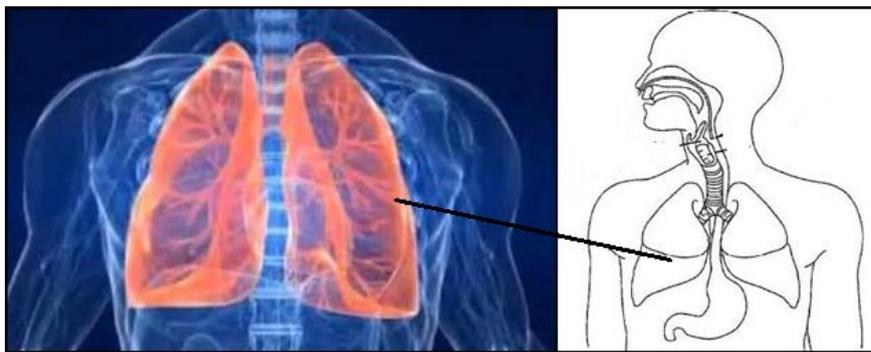


Figure 6. Artificial lung manufacturing technical textile [14]

3.3.2. Artificial Liver

The artificial liver utilises hollow fibres or membranes similar to those used for the artificial kidney to perform their function. 10. The artificial liver is shown in [Figure 5](#).

lung allowing oxygen to come into contact with the patient's blood. 10,22. The artificial lung is shown in [Figure 6](#).

3.3.3. Artificial Lung

The micro porous membranes of the mechanical lung possess high permeability to gases but low permeability to liquids and functions in the same manner as the natural

3.3.4. Artificial Heart

An 8 - ounce plastic pump lined with dacom velour to reduce damage to blood and is a chambered apparatus about the size of a human heart. Silastic backing makes the fabric imperious to emerging gas that is not desirable in the blood. The artificial heart is shown I n [Figure 8](#).

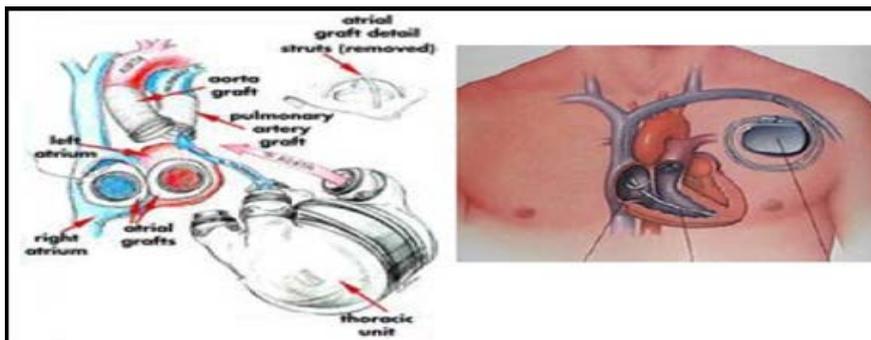


Figure 7. Artificial heart manufacturing technical textile [15]

3.4. Healthcare/Hygiene Products

Fibres used in relation to health care and surgery may be classified depending on whether they are natural or synthetic, biodegradable or non-biodegradable. All fibres used, however, must be non-toxic, non-allergenic, non-carcinogenic and must be able to be sterilised without imparting any change in their physical or chemical characteristics [16,17]. Traditionally, natural fibres such as cotton, silk and later viscose have been extensively used in all areas of medical and surgical care. One such area of application is on the wound, where moisture and liquid that exude from the wound are absorbed by the fibrous structure to promote healing in relatively dry conditions. However, upon healing, small fibrous elements protruding from the wound dressing are usually trapped in the pores of the newly formed tissues which make their removal distressing to the patients. Some of the hygiene products from fiber with application are mention in the Table 4.

Table 4. Fibres for hygiene products [9]

Fibre Type	Fabric Structure	Application
Cotton, polyester fibre, polypropylene fibre,	Woven, nonwoven	Surgical gowns
Viscose	Nonwoven	Surgical caps
Viscose, polyester fibre, glass fibre	Nonwoven	Surgical masks
Polyester fibre, polyethylene fibre,	Woven, nonwoven	Surgical drapes, cloths
Cotton, polyester fibre, polyamide fibre, elastomeric-fibre yarns	Knitted	Surgical hosiery
Cotton, polyester fibre	Woven, knitted	Blankets
Cotton	Woven	Sheets, pillowcases
Cotton, polyester fibre	Woven	Uniforms
Polyester fibre, polypropylene fibre	Nonwoven	Protective clothing, incontinence, diaper/sheet, coverstock
Superabsorbent fibres, wood fluff,	Nonwoven	Absorbent layer
Polyethylene fibre,	Nonwoven	Outer layer
Viscose, lyocell	Nonwoven	Cloths/wipes

4. Conclusions

Medical textiles are one of the most dynamically expanding sectors in the technical textile market. Growth rates are above average as a result of increases in consumption in developing countries in Asia and growth

rates in the Western market. The prospects for medical textiles are rather better, especially for nonwoven materials and disposable medical textiles used in surgical rooms. Combination of textile and its application in medical sciences has been proof that the painful days of patients and surgeons converting into the comfortable days. The major requirements for biomedical polymers are-Non toxic, Nonallergenic response, mechanical properties, strength, elasticity, durability and biocompatibility.

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