National Composites Network

Best Practice Guide

Technical Textiles and Composite Manufacturing

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Technical Textiles and Composite Manufacturing

1. INTRODUCTION

This document aims to look further into the manufacturing of technical textiles, including their diverse and varied range of applications, the growth of the market worldwide and what they are driven by.

Technical Textile materials and products are those where the fabric or fibrous component is selected principally but not exclusively for its performance and properties as opposed to its aesthetic or decorative characteristics.

Technical textiles comprise a diverse range of manufacturing activities tied to broad end-use markets. The industry embraces products ranging from wiping cloths for domestic use to the more high performance market such as heart valves, aerospace composites and architectural fabrics. The supply chain that connects fibre producers with end-use markets is a long and complex one. It embraces different sized companies from fibre producers through yarn and fabric manufacturers, finishers, converters, and fabricators who incorporate technical textiles into their own products or use them as an essential part of their business operations.

2. MARKET OVERVIEW

The technical textiles sector represents a significant proportion of the world textile manufacturing and trade. Studies (the Australian report) within the field indicate that up to 40% of fibre consumption within developed countries is in the manufacture of technical textiles. The growth in the technical textiles sector in developed countries generally is being driven by:

- Increasingly stringent environmental regulations
- The need for increased energy efficiency and utilisation of waste
- High performance
- Life cost factors
- Changing needs of an ageing population
- An increased focus on leisure

The size and relative importance of the technical textile sector has been greatest within the developed countries (US, European Union and Japan). Asia however is becoming the powerhouse of both production and end-use consumption for technical textiles. China, in particular, is emerging as a new technical textiles ‘super power’ although the potential of other developing countries, in particular India, to make an important impact is already becoming evident. Following a period of rapid growth in the 1980s, the first half of the 1990s proved to be a watershed for many sections of the technical textiles industry. Rapid and largely unplanned growth has now given way to a more competitive global market

Distribution patterns in technical textiles follow the same general lines as in apparel and domestic textiles. The main difference is that in the latter, the “fabricators”, clothing manufactures or other ‘cut and sew’ operations, are fairly homogenous in character while in technical textiles they represent a varied group ranging from the manufacture of parachutes to makers of golf clubs. The technical textiles industry, however, uses the traditional distribution chain.

The fibre producers operate with their own sales force on a world scale. There is a need for technical textile companies to become expert in fields other than textiles so that they can provide textile 'solutions' to their customers’ problems. A significant obstacle to exporting is the lack of common standards. Differences in national standards make it difficult to compete with local producers and effectively exclude them from government contract work. Research and development is geared to product and applications development, which is market driven, similar to the fashion driven market of apparel.

Despite the generally optimistic outlook and high overall textile industry growth, rates of increase in end-use consumption in most application areas, product groups and geographical markets are likely to be lower in the next decade than in the past one. The industry, especially in developed country markets, will increasingly face problems of market maturity, over-capacity and global competition.

The transportation (Mobiltech) market, for example, while continuing to be the largest and most valuable application sector for the foreseeable future, is expected to experience some distinctly contrasting trends with declines in the per unit consumption of reinforcing textiles for tyres, hoses and belts due to changing product technologies and longer working lifetimes being only partially offset by newer applications, such as air bags and composite materials. A trend towards smaller cars, lighter weight materials and a projected slow down in total vehicle construction before all add to the complexity of the situation facing suppliers to this market.

Meanwhile, the highest growth rates are to be found in relatively small and newer application areas for technical textiles such as geotextiles (fabrics used in conjunction with soil), protective clothing, sport textiles and environmental products. Nonwovens are projected to become the largest single product group overtaking woven fabrics. Better prospects are seen for knitted and braided textiles, but the use of fibres and textiles for composite reinforcement is the only area where higher growth rates are expected more or less across the board.

3. APPLICATIONS, DRIVERS AND TRENDS

The need to take a broader view of the scope of technical textiles has prompted re-evaluation of their importance within the textile industry as a whole. To this end, quantitative projections of end-use consumption worldwide have recently been made on the basis of models developed by David Rigby Association; further, that study covered the main application areas defined and listed in Figure 1 with relevant volume used in 2000.

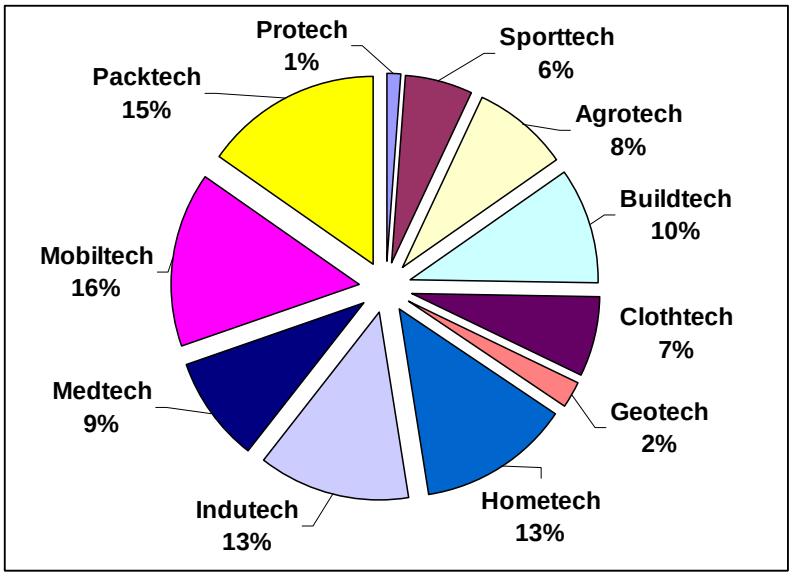

Figure 1: World end-use consumption of technical textiles by area of application in 2000 (Percentage)

The inclusion of clothing-related textiles into the technical textiles basket (viz. Clothtech, Protech, Sporttech) is a consequence of two key trends. First, the clothing sector's use of more technically intense fabric has accelerated. Second, new production technologies and machineries for both woven and nonwoven industrial textiles have been readily adapted for the production of clothing-related textiles. Technical textiles increasingly refer to the broader field of fibre and fabric whether destined for industrial, household or personal use provided that functional properties rather than aesthetics properties are the dominant commercial characteristics. A brief description of each of the application areas as well as the market drivers and trends for each is given below and the full details can be found in 150 end use products in technical textiles and nonwovens. World Market Forecast to 2010. DRA. 2003, Davis Rigby Associates, Textile Strategy and Marketing Consultants.

3.1. AGROTECH

The fundamental application of technical textiles in this field is with the protection of food produced, animals or land. This sector accounted for 8% of the technical textile consumption by volume and only 6% in terms of value in 2000.

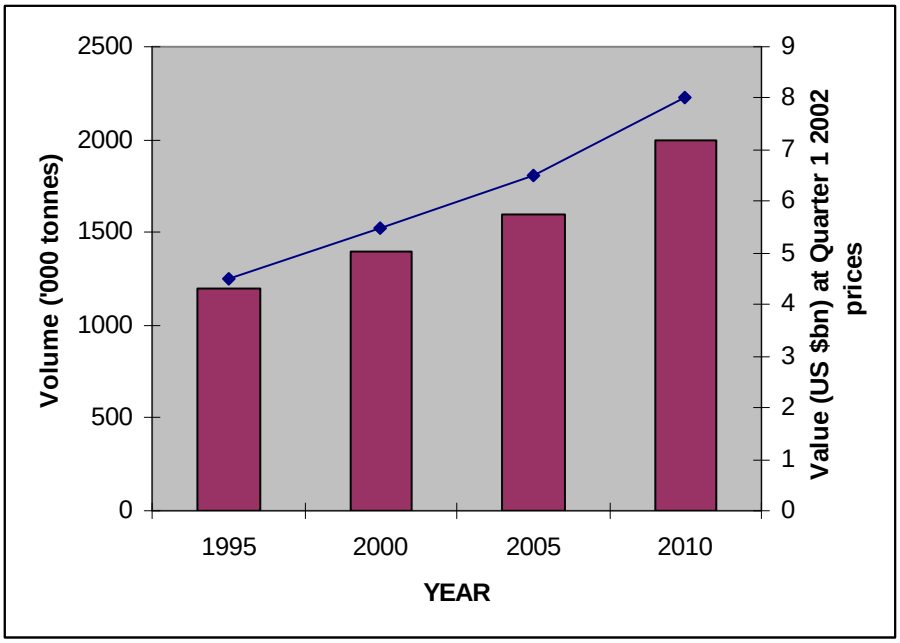

Figure 2: Agrotech world end-use consumption 1995-2010 ('000 tonnes and US $bn)

Agrotech end use products

Table 1 Agrotech end use products

Product	**Products and description**
Woven crop cover	General agricultural woven fabrics for protection of wind-breaks, ground matting, tobacco cloth, etc (including tarpaulins).
Land netting	Nets for crop protection, fruit collection, etc. Including bale wrap nets.
Non woven cover crop protection	Fabrics for crop cover and protection, mulching, etc.
Capillary matting	Heavy weight nonwovens for capillary matting, ground cover etc. For agriculture and horticulture.
Finishing ropes	Fabrics for use as substrates in single ply roofing.
Fishing line	Lines for fishing, long line, rod and line.
Fishing nets	Nets for all fishing purposes, including seine nets, fish farms etc.
Baler twine	Twine used to tie bales of hay.

Market Drivers:

- Ever expanding population
- Fishing; particularly selective sea life catching nets
- Land base: declining area of agricultural land means intensive use and frequent yield. Here textiles can contribute by for example controlling the climate environment.
- In cases such as soft fruit and vegetable products where quality is important textiles can save on pesticide and others, and is the preferred root.
- Also water conservation pressure is also encouraging the use of textiles particularly in densely populated arid regions. Textile used to cover soil, provide physical protection and improves water retention.

Market trends:

- Floating covers which rise as the crops grow, providing protection and insulation
- Capillary nonwovens for horticultural application that provide consistent watering of plants
- Windbreaks around or on farms to improve environment for animals
- Shade netting to protect outdoor plants or around glass houses to reduce heat loss
- Nonwoven protection fleeces and mulch fabrics to cover seed beds or plants
- Protection nets placed over young plants and fruit to shield them from birds and insects or provide vertical or climbing support
- Raschel knitted bale nets for packing hay bales.
- Collection nets to gather various fruits and other crops.

3.2. BUILDTECH:

Textiles are increasing their market share in construction and architectural applications where their mechanical properties and or environmental resistance better or superior to traditional materials. This sector used 1.65m tonnes of technical textiles in 2000 with an estimated value of $5.9bn.

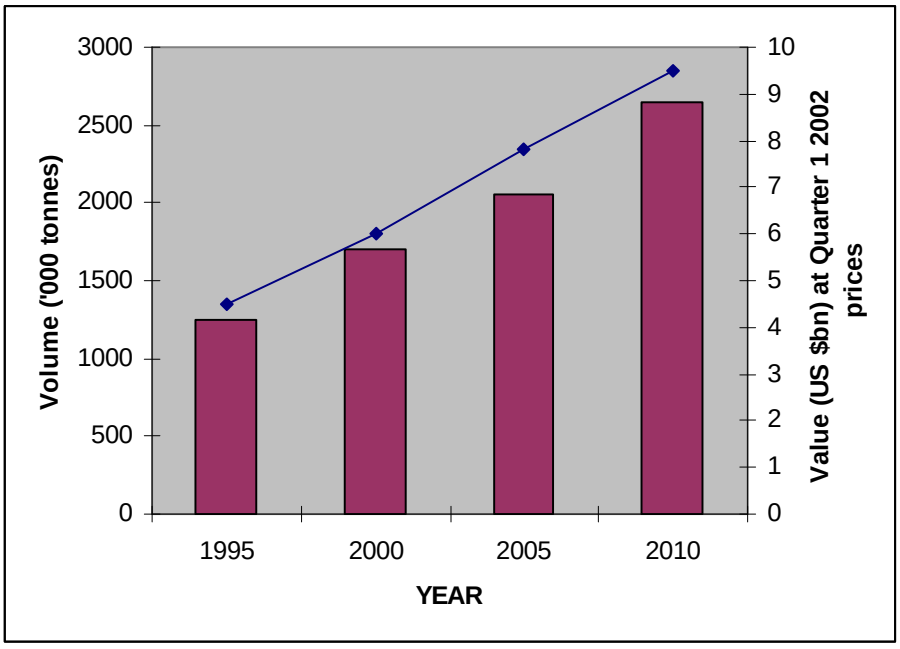

Figure 3: Buildtech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Buildtech End-Use products

Table 2 Buildtech end use product

Product name	**Products included and brief description**
Tarpaulins	Heavy woven and industrial knitted fabrics for protection and storage applications.
Textile structures	Heavy woven and robust knitted fabrics for marquees, tenting, roofs, etc- including architectural tensile membranes.
Awnings and canopies	Woven and knitted fabrics for commercial and industrial use.
Roofing felts	Support for non-woven (e.g. felt)
Woven roofing	Fabrics for use as substrates in single ply roofing.
Roof scrims	Impregnated fabrics with bitumen or similar substances, for use as roofing felts and sewer linings.
Hoardings	Fabrics for billboards, hoardings and advertising.
Scaffold nets	Scaffolding nets to protect against falling debris and façade netting.
Housewrap	Membranes for insulating houses, sometimes breathable.
Concrete reinforcement	Loose fibre to reinforce concrete.
Composites	Fibre reinforced plastic for buildings, civil engineering, components, road signs, wind blades, shower trays etc.

Market drivers

- Rapid population growth and reduction in average family size
- Hypermarket, office and shopping-complex buildings
- One off projects for tensile structures such as stadiums for the Olympic games
- Temporary structures such as garden Marquees
- Global warming and increase demand for UV protection
- Growing expenditure on outdoor advertising
- National building regulations with stringent legislation on particular component properties such as flame redundancy

Market trends

- Roof felts, sewer lining, reinforcing roof scrim, new shingle products stimulating the consumption of glass fibres, breathable membranes
- Reinforcement, GRP swimming pools, tensile membranes, debris netting, banners and holdings, tarpaulins
- Wind turbines.

3.3. CLOTHTECH

This sector encompasses the functional (largely hidden) components of clothing and footwear. This is a medium sized application area with one of the slowest growth rates. This sector consumed 1.2m tonnes in volume summing up to $5.2bn in 2000.

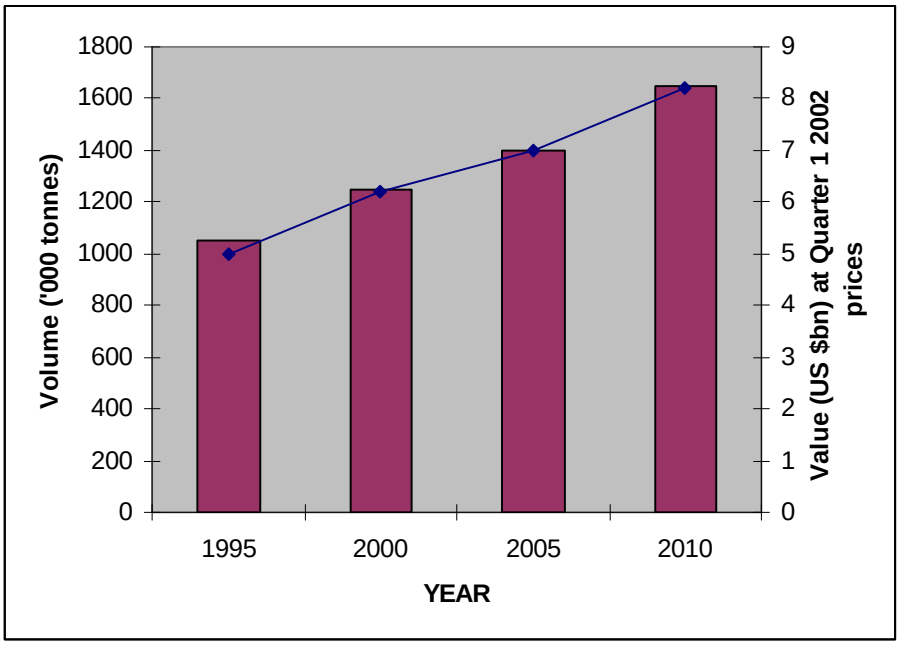

Figure 4: Clothtech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Clothtech End-Use products

Table 3 Clothtech end use products

Product name	**Products included and brief description**
Interlinings, woven and knits	Woven and knitted fabrics used to provide support and structure to garments.
Interlinings, non woven	Non woven fabrics used to provide support and structure to garments/ footwear.
Wadding	Wadding fibre fill to provide insulation and shaping in garments.
Shoe laces	Shoe boot laces and lacing detail on garments.
Shoe components	Linings, components for shoes and trainers (excluding artificial suede, leather substrates and PVC substrates)
Sewing threads	Threads used in all garment production.
Fasteners	a) Zipper teeth b) Velcro c) Hook and eye fasteners
Labels	Printed, woven and stitched labels for all applications.

Market drivers

- Clothing and footwear production and consumption
- Change in trade rules increasing free trade between EU members and tariff barriers with outsiders
- Changing location of garment component production particularly to South Korea and Taiwan.

Market trends

- Sewing components (threads, high performance threads, zips, labels, hook and eye fasteners)
- Alternative garment assembly technologies: Laser welding
- Insulation and structure products: Nonwoven interlinings, High performance interlining, fibres for wadding
- Shoe components: shoe lining where the market desires constant innovation and change, shoe laces
- Garment counterfeiting such as holograms on labels or monoclonal antibody based marker detectors.

3.4. GEOTECH

Woven, nonwoven and knitted textile materials used mainly by the civil engineering industry to provide a range of functions such as support drainage and separation and or below ground level. This sector accounted for 250k tonnes in 2000 (1.5% of the overall technical textile market) with an estimated value of 0.75bn. The sector is forecast to have the highest growth rate of all the applications.

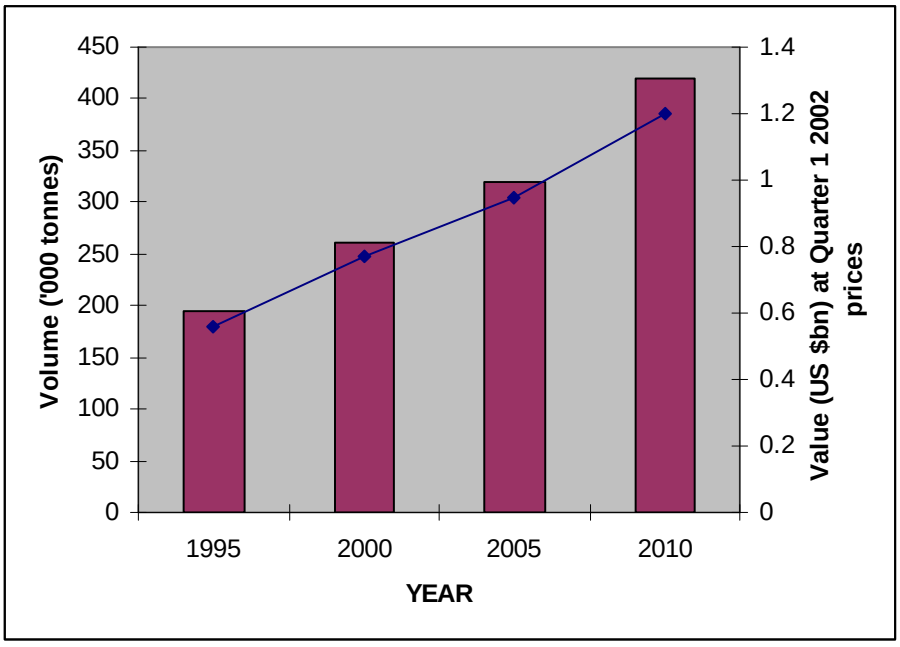

Figure 5: Geotech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Geotech End-Use products

Table 4: Geotech end use products

Product name	Products included and brief description
Ground stabilisation	Geotextile fabrics for stabilisation, separation, drainage.
Soil reinforcement	Geotextile fabrics for reinforcement of soil.
Pit linings	Geotextile fabrics for lining waste ponds, pits, landfill, etc.
Erosion control	Geotextile fabrics for erosion control.

Market drivers

- Economic growth and government expenditure in capital projects
- Industry move towards quality and consistency leading to need for standardisation and specifications
- Environmental pressures particularly waste contaminants in developed economies
- Increasing knowledge and acceptance of geotextiles.

Market trends

- Cost reduction is as important as performance.
- Move towards nonwoven construction due to more closely controlled and closely specified properties. This is offset by strong growth from knitted fabrics.
- The market is divided based on Principle functions: Reinforcement, stabilisation, erosion control, separation, filtration and drainage, protection.

3.5. HOMETECH

Technical textiles play an essential role in the construction of many household textiles, furnishings and floorings for domestic consumption and contract end uses. Including applications for carpet backings, curtain tapes, and fibrefill for products such as pillows etc as well as linings, wadding and bases for furniture and mattresses.

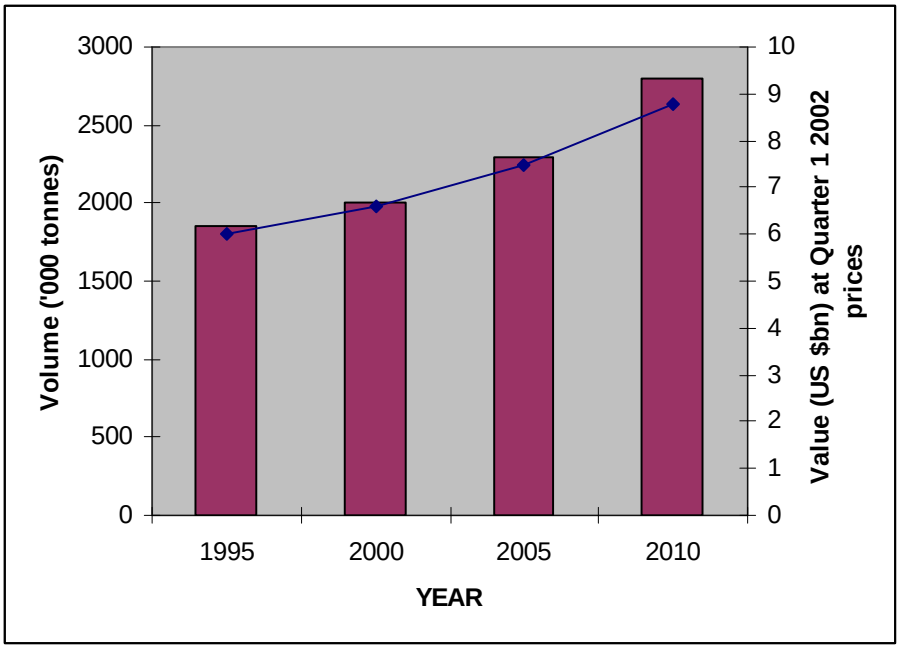

Figure 6: Hometech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Hometech End-Use products

Table 5: Hometech end use products

Product name	**Products included and brief description**
Woven and knit wipes	Cleaning wipes for domestic applications in woven and knitted forms.
Nonwoven wipes	Cleaning wipes for domestic applications in non woven forms including mop heads.
Vacuum filters	Machine drive and power transmission belting including flat and coated products.
HVAC filters	Filter media for domestic and industrial vacuum cleaners.
Pillow ticking's	Ticking for Filled products for duvets pillows and cushions.
Mattress components	Flanges and quilt backing for mattresses.
Mattress ticking	Outer fabrics for wrapping mattresses.
Mattress spring wrap	Fabrics used to wrap springs in sprung beds.
Spring insulators	Flat fabrics used to wrap sprigs in sprung beds.
Platform cloth	Fabrics used as base cloths on upholstered surfaces.
Dust cloth	Fabrics attached to base furniture.
Other furniture components	Skirt linings and other fabrics used to upholster furniture and bedding.
Fibre fill and wadding	Pillow cushion and duvet filling.
Furniture webbings	Strapping used to support seating.
Curtain tapes	Header drapes for drapes and nets.
Woven carpet backings	a) Woven fabrics used as primary fabric backing for tufted carpets. b) Woven fabrics used as secondary fabric backing for tufted carpets.
Non woven carpet backings	a) Nonwovens for primary backing for carpets. b) Nonwovens for secondary backing for carpets and underlay.
Carpet ground yarns	Ground yarns for woven carpets.
Sewing threads	Threads used in all furnishing, and household textile applications.
Composites	Fibre reinforced plastic materials for household use.

Market drivers

- The demand fluctuates with economic cycle due to many products being big ticket consumer purchases that are easily deferrable.
- Health issues are driving the use of textiles that can minimise exposure to possible aggravating agents

Market trend

- Opportunities for low cost suppliers into more developed markets
- Increase in average disposable income in western countries means the home textile market can continue to grow.

3.6. INDUTECH: FILTRATION AND OTHER INDUSTRIAL APPLICATIONS

This is an extremely diverse application sector from separating and purifying industrial products to transporting materials between processes or acting as substrates for abrasive sheets and other coated products. It is also one of the largest end use applications in value terms.

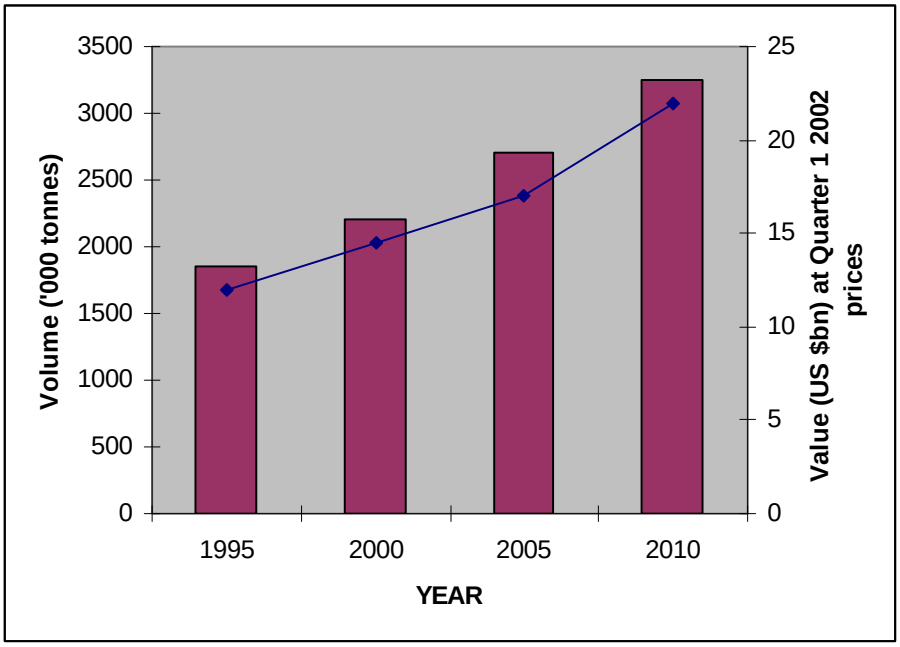

Figure 7: Indutech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Indutech End-Use products

Table 6: Indutech end use products

Product name	**Products included and brief description**
Conveyer belting	Woven fabrics for conveying and speciality applications.
Hoses	Braids, woven and knitted fabrics use to reinforce rubber and polymer hoses for industrial application.
Drive belting	Machine drive and power transmission belting including flat and coated products.
Brushes	Bristles for brushes of all types.
Abrasives	Fabrics for a variety of polishing and abrasion applications.
Woven and knit wipes	Cleaning wipes for industrial application in knit and woven form.
Nonwoven wipes	Cleaning wipes for industrial application in non woven form.
Woven filters	Al woven filters for use in Industrial applications.
Nonwoven air filters	High efficiency particulate HEPA and ultra low penetration and other products and other non-HVAC air filters for industry.
Non woven dust filters	Filter media for dust-bag houses.
Nonwoven liquid filters	Filter media for swimming pools, food, vessel bags etc.
Other non woven filters	All other non-woven filters.
Cigarette filters	Tow for cigarette filters.
Paper making felts	Bating and support elements of press forming and dying fabrics or felts in paper making.
Battery separator etc	a) Fabrics for battery separators. b) Fabrics for floppy disc liners, transformers etc.
Cable components	Central strength area for rip cord yarns for use in cables.
Electrical composites	c) PCBs d) Other GRP composites for electrical application including other producer durable equipment.
Seal gaskets	Materials used for industrial seals and gaskets.
Fibrefill	Fibrefill and wadding for miscellaneous industrial applications.
Anti corrosion composites	Anti corrosion for Storage tanks, pipes etc
Lifting webs	Webs for roundsling lifting purposes.
Ropes	Ropes and cords for use in industry.
Miscellaneous coated fabrics	a) coated fabric storage silos b) coated fabrics for oil booms c) Heavy coated covers for miscellaneous applications

Market drivers

- Demand driven by industrial output, as many of these products are consumable products
- Increase in process and materials handling automation
- Increased level drive for protection of environment
- The level of use depends on the level and rate of industrialisation of a market
- Cigarette production is a specific driver.

Market trend

- Potential in developing regions due to faster development and accelerating labour costs, automation and environmental concerns: filtration (nonwoven products growing while woven products loosing market share), cigarette products, paper makers felt.
- Electrical components: printed circuit boards, fibre optic reinforcements, expanding battery separators.
- Cleaning products: wipes and abrasive cloths and brushes.
- Conveyor belts, hoses, lifting webs and ropes, corrosion protection in pipes and tanks, machinery casing.

4. MEDTECH

All the textile materials used in health and hygiene applications, in both consumer and medical markets. These are a well defined band of products with considerable variation in performance and unit value.

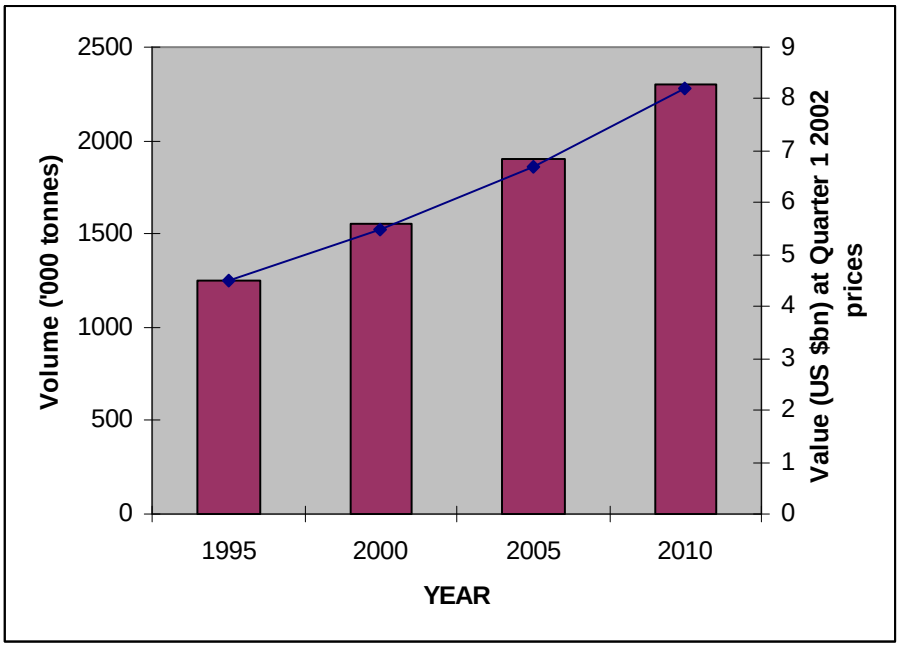

Figure 8: Medtech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Medtech End-Use products

Table 7: Medtech end use products

Product name	Products included and brief description
Woven gowns, drapes	Patient and surgeon gowns, drapes and garments used in surgical and other medical applications (excluding nurse type garments).
Non woven gowns, drapes	Lightweight non woven garments used in protective and medical situations.
Wound care woven, knit	Wadding fibre fill to provide insulation and shape in garments
Wound care non woven	Shoe and boot laces.
Sterile packaging	Linings, components etc for most shoes and trainers (excluding artificial suede, leather substrates and PVC substrates)
Medical mattresses	Threads used in all garment production.
Cover stock	d) Zipper teeth e) Velcro f) Hook and eye fasteners
Cotton wool	Printed, woven and stitched labels for all applications.
Wipes	Wipes for cleansing skin, face , hands, etc

Market drivers

- Aging, long living population
- Baby nappies
- Incontinence goods
- Disposable absorbent products
- Feminine hygiene
- Disposable bed sheets, surgical drapes, gowns and caps.

Market trend

- Biocompatible fibres
- Softer and more comfortable nonwoven products
- Less bulk, greater absorbance and superior leak control
- Wipes
- Protective fabrics which are providing more comfort e.g. pressure relieving bedding, breathable surgical masks
- Wound dressing and bandages with functionalities like antiseptic particles or phase change material
- Immerging innovative products: bio-functional textiles, drug eluting textiles, wound dressing that change colour depending in the level of infection, smart textiles etc
- Fibre production is also moving towards bio-functional smart fibres such as antibacterial and antimicrobial fibres.

4.1. MOBILTECH

This is the single most valuable world market for technical textiles. This sector embraces textiles used in construction, equipment and furnishing of all means transportation of passenger, goods, civil and military by land or air.

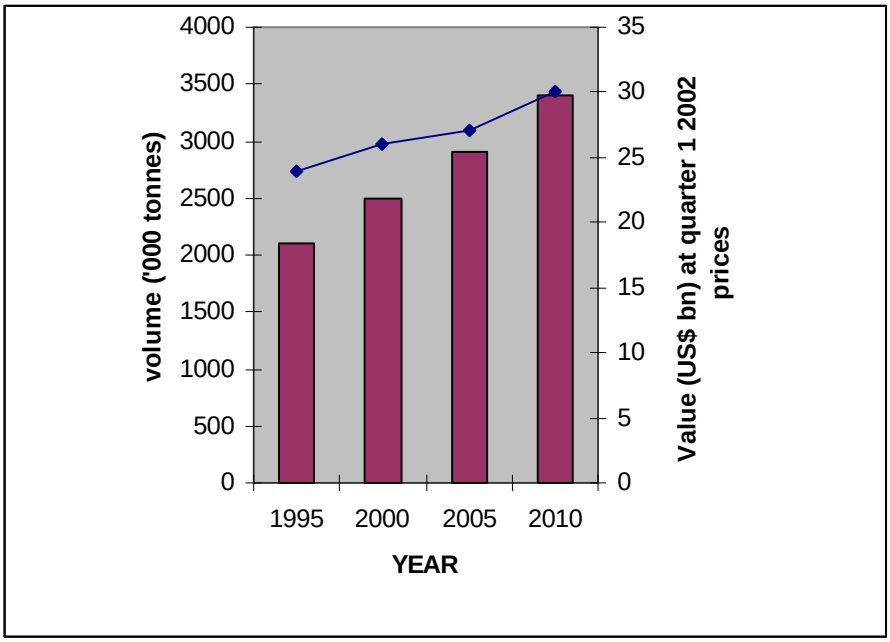

Figure 9: Mobiltech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Mobiltech End-Use products

Table 8: Mobiltech end use products

Product name	Products included and brief description
Car tyre cord	Fabric reinforcement for car tyres.
CV tyre cord	Fabric for reinforcement other than for cars.
Auto drive belt	Fabric reinforcement for automotive drive belts etc.
Auto hose	Fabric reinforcement for automotive hoses.
Cabin filters	Filter media for automotive, mainly cabin filters, engine filters air intake filters and fuel filtration.
Seat belts	Narrow woven safety belt fabric for vehicles.
Airbags	Fabric for reinforcement of automotive safety air bags.
Tufted carpets	Tufted automotive floor coverings- face fabric only.
Needled carpets	Needle punched non woven automotive floor covering.
Auto carpet backing	Primary and secondary carpet backing for automotive end users.
Woven and knit trim	Woven knitted automotive trim boot liners, head liners, shelving and door panels.
Non woven trim	Nonwoven automotive trim boot liners, head liners, shelving and door panels.
Upholstery	Woven and knitted automotive seating face and backing fabrics.
Insulation	Insulation for engine compartments, wheel arches, foot-wells etc.
Truck covers	Heavy woven fabrics for truck covers, curtain sides and any other storage applications.
Tiedowns	Non woven belts for truck curtain ties and cargo restraints.
Transport composites	FRP for use in cars, trains buses (mostly components)
Marine composites	Glass fibre for use in boat bodies GRP- hand lay-up etc.
Ropes	Ropes used in transport, including marine, tethering etc.

Market drivers

- Rapidly expanding population of developing countries
- Fibre usage in applications such as airbags, foam replacements by nonwovens and cabin air filters is offsetting their decline in functional end uses such as mechanical rubber goods, tyre cords, belts and hoses.
- Weight savings
- Increasing demand for commercial and public service vehicles

Market trends

- Passenger cars in volume markets: airbags and seatbelts, upholstery, trim, floor covering, filters and heat and noise insulations
- Composites for automotives particularly recyclable or natural materials
- Aerospace composites; suffering from collapse of demand for air travel and decline in defence related expenditures. However there will be a longer term recovery in the airline industry
- Boat building sector is the single largest end user of composites. Particularly relevant to technical textiles is the higher performance more sophisticated boats such as racing yachts and minesweepers.
- Marine ropes especially high performance polymer ropes for critical application to replace steel. Particularly for oil and gas off shore industries.

4.2. PACKTECH

This is the largest end use application by weight and includes textiles used for temporary containment, carriage, storage and protection of industrial agricultural and other goods.

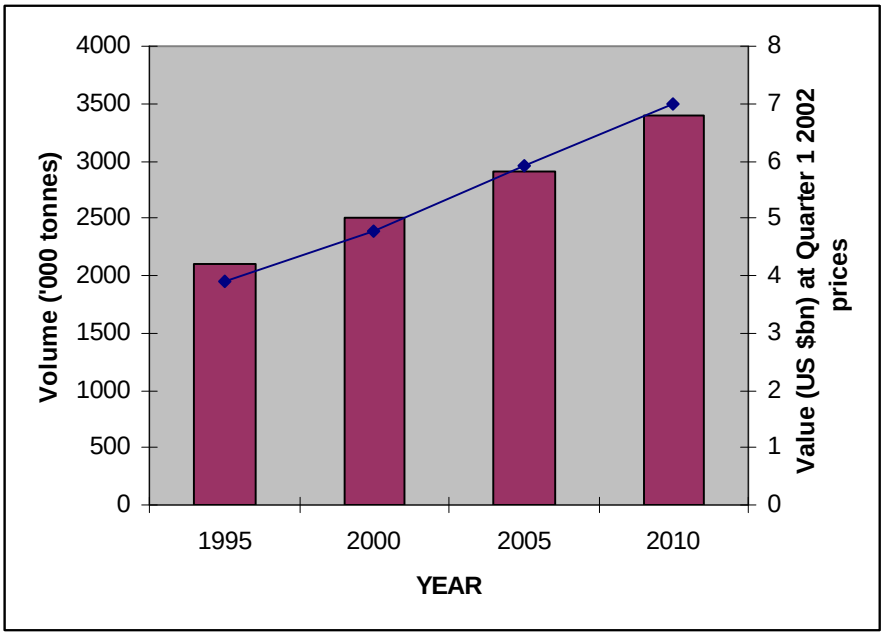

Figure 10: Packtech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Packtech End-Use products

Table 9: Packtech end use products

Product name	Products included and brief description
Packtech: FIBC big bags	a) Flexible bulk containers. b) Laundry bags and other bulk packaging products.
Packtech: Sacks	Sacks for storage, etc.
Packtech: Twine	Twine and string for tying packages, etc (excludes agricultural applications).
Packtech: Teabags	Non-paper teabags and coffee filters.
Packtech: Miscellaneous, non woven packaging	a) Food soaker pads. b) All other non woven packaging items except tea bags e.g. envelopes, durable papered
Packtech: Netting	Net packaging for storing, packing, transporting, retailing foodstuffs, toys and other.
Packtech: Misc. woven packaging	g) Woven fibre strapping. h) Miscellaneous woven packaging items such as light weight mailbags.

Market driver

- Disposable and recycling of textile packages forcing change
- Nonwoven packaging for consumer products as they need higher level of engineering and performance compared to industrial packaging.

Market trends

- Hydrocarbon free jute sacking to reduce the contamination occurring from oils applied during the conventional processing of jute.
- Trends toward bulk handling are leading to the replacement of small and medium sized sacks by “big bags”. Including antistatic bags to avoid explosion when transporting combustible materials. Others included bags with leak proof seams or aluminium lining.
- Growth for nonwoven products as durable synthetic papers. For shipping envelopes, medical packaging, industrial BAGS and military, electronic and inflatable packaging.
- Nonwovens for food packaging such as tea bags, coffee filters and absorbent pads to reduce leakage and spread of blood and other juices from meat packaging.
- Narrow woven polypropylene strappings are now growing in popularity to replace metals which could be dangerous when cut under tension.
- Growth of net packaging due to overall movement of food as well as pre-packaging of the food which has been otherwise sold loosely (e.g. fruits)
- Intelligent packaging, including functional packaging such as temperature, freshness, traceability markers and security detectors.

4.3. PROTECH TEXTILES FOR PROPERTY AND PERSONAL PROTECTION

This includes all the textile materials and products used in the production of protective clothing of various types.

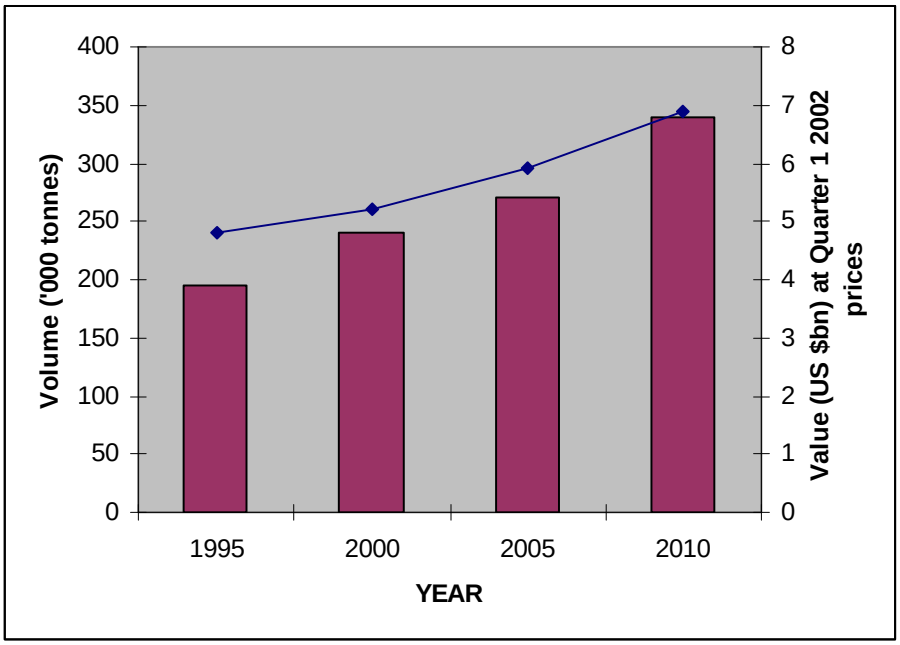

Figure 11 Protech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Protech End-Use products

Table 10: Protech end use products

Product name	Products included and brief description
FR clothing	Fabrics for use in clothing worn to protect against flame and heat.
NBC	Fabrics to protect against nuclear, biological and chemical exposure.
Cut slash protection	Fabrics for garments and glove to protect from knives, glass or other sharp implements, chain saw protection.
Ballistic protection	Fabrics designed to deflect or absorb impact of bullets, etc.
Face masks	Face masks for medical, industrial and domestic applications.
Dust protection	Lightweight barrier fabrics for garments worn to provide protection against dust or other small particles
Disposable chemical protection	Fabrics for disposable garments worn to provide protection against harmful chemicals and gases and pesticides.
Durable chemical protection	Fabrics for durable garments and gloves worn to provide protection against harmful chemicals and gases and pesticides.
FWC	Fabrics for foul weather clothing using coating or laminates for all end users.
HI vis	Fluorescent and phosphorescent (not retro-reflective) fabrics for gilets trousers, etc
Harnesses	Safety straps for workers climbing push chairs child seats, etc.

Market drivers

- Increase of protection performance to more conventional work wear used at low risk applications
- Increase in violent crime and military action
- Increase in use of outdoor clothing in day to day applications.

Market trends

- Foul weather has increased and is increasing the demand for outdoor consumer clothing
- Garment design and fabric development as there is more emphasis on comfort and corporate image
- Restriction and move to reduce the use of formaldehyde in cotton treatment
- Particulate matter (dust) protection
- Gas and chemical protection
- Fire and heat protection
- Ballistic and impact protection
- Cut and abrasion protection
- High visibility garment

4.4. SPORTTECH TEXTILES FOR SPORTING AND LEISURE APPLICATIONS

This sector covers the consumption of textile materials goods and equipment, particularly in the form of synthetic fibres and coatings. This sector is small in terms of volume (the third smallest application area in 2000) however the unit values are high reflecting the finished nature of what are mainly consumer goods.

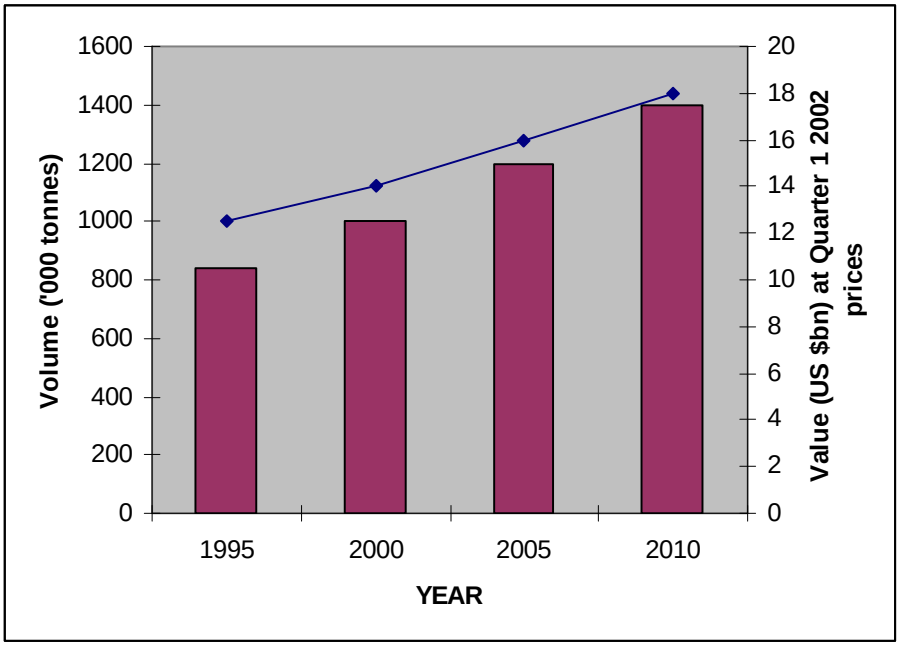

Figure 12 Sporttech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Sporttech End-Use products

Table 11: Sporttech end use products

Product name	Products included and brief description
Boat covers	Geotextile fabrics for stabilisation, separation, drainage.
Book cloth	Substrate for leather-type covering of hard backed books.
Shopping bags	Outer fabrics plus substrates for artificial leather handbags and luggage.
Artificial leather substrates	Coating substrates for artificial leather hand bags, luggage and small goods.
Sports bags, luggage	Face fabrics and substrates for soft luggage, sports bags and rucksacks.
Sailcloth	Fabrics used in mainsails, foresails and spinnakers.
Artificial turf	Materials for surfaces for sporting activities.
Climbing ropes	Ropes and cords used for climbing, yachting, etc.
Sports nets	Nets for soccer, tennis, cricket and court protection.
Footballs	Artificial leather coating substrates to cover footballs.
Equipment composites	Materials used in the production of skis, racket frames canoes, jet skis.
Air sport fabrics	Fabrics for balloons, kites, para-gliders, parachutes.
Tents	Fabrics used in lightweight portable tents for personal camping/sleeping purposes.
Sleeping bag fabrics	Outer fabrics for sleeping bags.
Sleeping bag filling	Fibrefill /wadding for sleeping bag insulation.
Animal webbing	Pet lead collars, horse halters etc.
Flags	Fabrics for flags, bunting, pennants, shows and advertisement.

Market drivers

Increase use of sporting goods due to increase in leisure time, interest of the aging population on health related activities, early retirement and new sports etc.

Market trends

- Luggage components of low specification
- Sailcloth
- Air-sport fabrics
- Ropes
- Composites for sport equipments such as skies and rackets
- Artificial turf
- Tents and sleeping bags
- Marine fabrics

4.5. OEKOTECH: ENVIRONMENT PROTECTION

Although the idea of using technical textiles for protecting the environment is not new it is difficult to arrive at a precise definition of the scope of the sector to allow collection or estimation of all the relevant production and end use statistics.

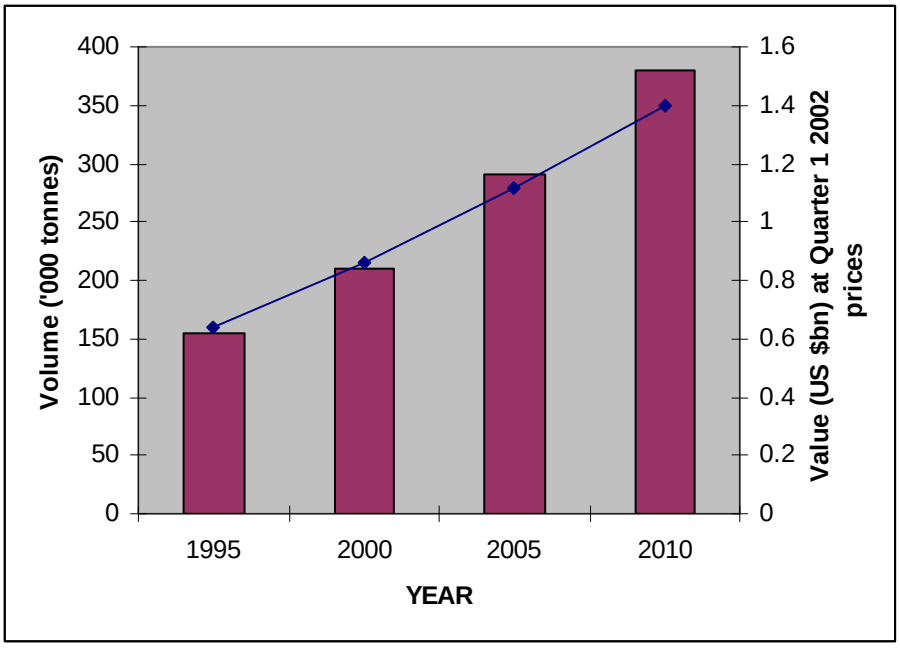

Figure 13: Oekotech world end-use consumption 1995-2010 ('000 tonnes and US$bn)

Oekotech End-Use products

Table 12: Oekotech end use products

Product name	**Products included and brief description**
Buildtech housewrap	Geotextile fabrics for stabilisation, separation, drainage.
Geotech pit linings,	Geotextile fabrics for reinforcement of soil.
Geotech erosion control	Geotextile fabrics for lining waste ponds, pits, landfill, etc
Indutech woven filters	Geotextile fabrics for erosion control.
Indutech dust filters	Filter media for dust bag houses.
Mobiltech noise insulation	Insulation for the engine compartments, wheel arches, foot-wells etc.

Table 13: Products not included in Oekotech

Product name	**Products included and brief description**
Mobiltech	Automotive cabin filters.
Geotech	Reinforcement, protection, filtration and drainage.
Hometech	Air-conditioning filtration media.
Indutech	Liquid filtration, seals and gaskets.

Market drivers

- Protection and preservation are leading many economical and technological changes
- Disposal and recycling of technical textiles
- Increased environment al pressure against certain chemicals e.g. azo dyes and formaldehyde

Market trend

- Dominated by synthetic woven
- Filtration textiles
- Insulation products
- Geotextiles
- Treatment of oil spills
- FRP wind turbines
- Low formaldehyde linings
- Eco friendly nappies

5. PRODUCT FABRICATION USING TECHNICAL TEXTILES

The technical textiles sector operates on two levels:

5.1. HIGHER-END

Those companies involved in the development and manufacture of more complex technical textiles, e.g.: carbon fibres; polyester; polyamide; acrylic; polyolefin's; glass; Aramid; nonwovens; and composites; etc.

Global Composites Market 2004-2010: Materials, Market and Technologies, 2005, E-Composites, Inc., Grandville, USA.

The composite industry in general is one of the main consumers of technical textiles in this sector and composite products can fall under almost all of the application areas described earlier. Examples include wind turbine blades, shower trays, swimming pools, sports equipment etc. This industry is unique as it does not produce products for direct consumption but its products are used by other industries to manufacture their own products. Driver for the emerging materials in composite industry are not too dissimilar from that of technical textiles and are listed below:

- Environmental
- Low cost
- Recyclability
- Flame retardancy
- Ease in processing
- Light weight
- Increase in leisure activities

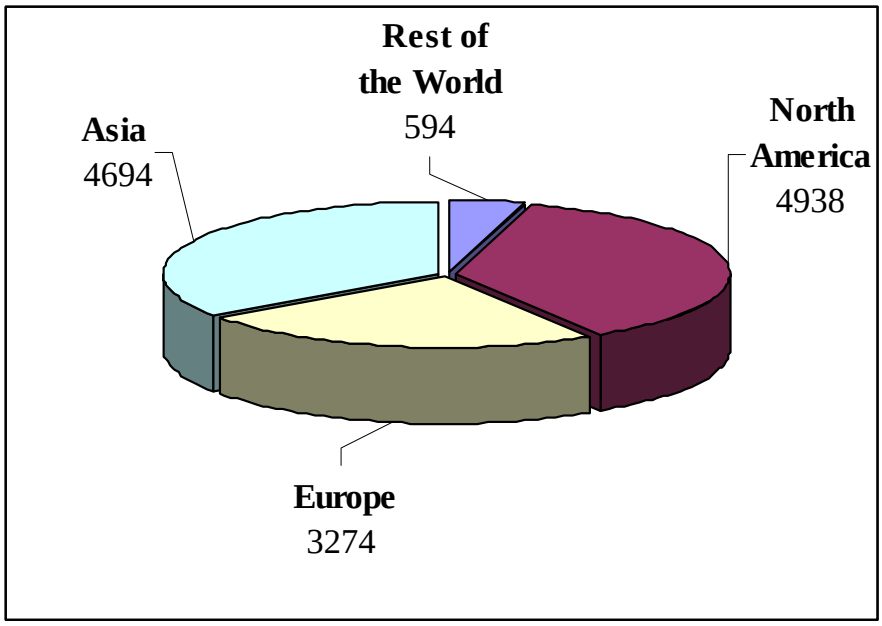

Figure 14: Global composite shipment (mil lbs) by region in 2004

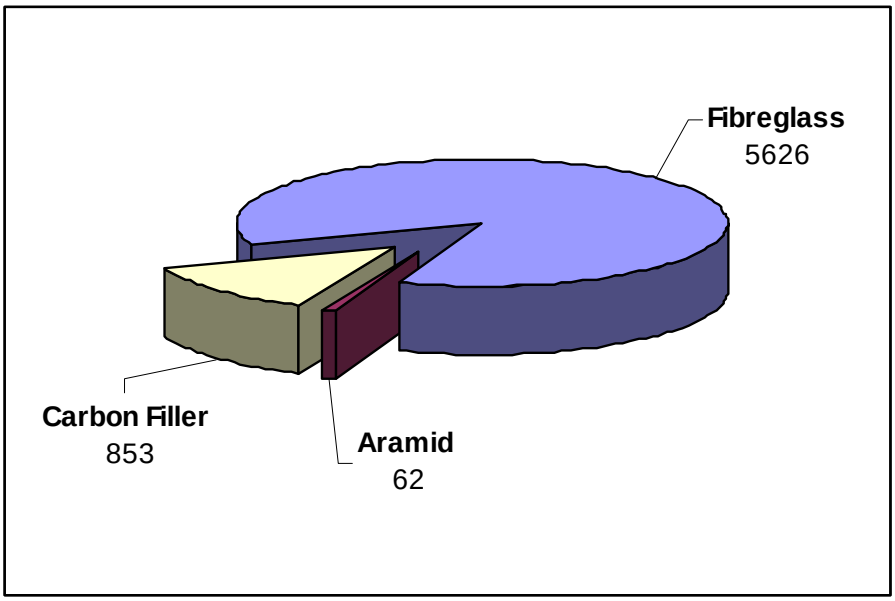

Figure 15: Global reinforcement shipment ($ mil lbs) by fibre type in 2004

Today there are many manufacturing techniques used for composite production (Figure 16). The most relevant to the use of technical textiles are the closed mould processes (Figure 17).

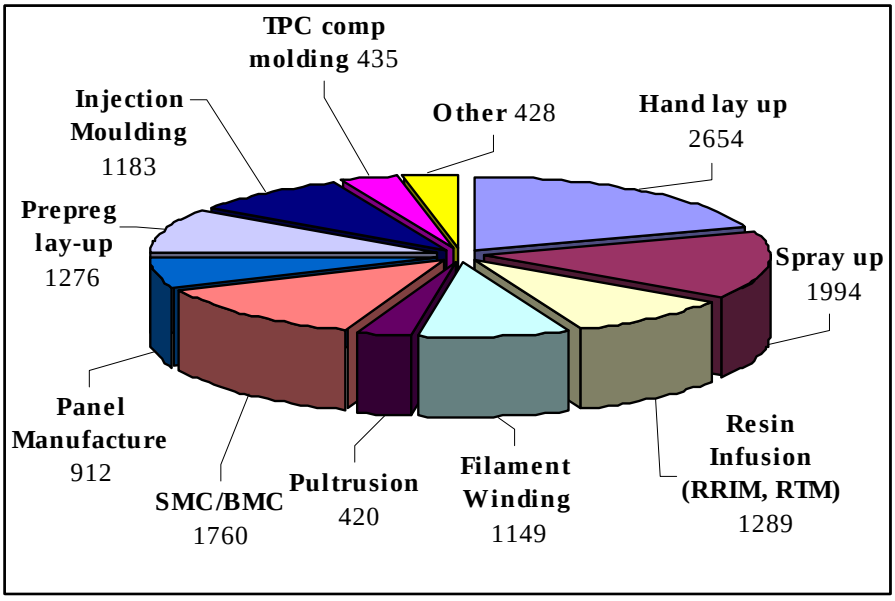

Figure 16: Global composites shipment (mil lbs) by manufacturing process

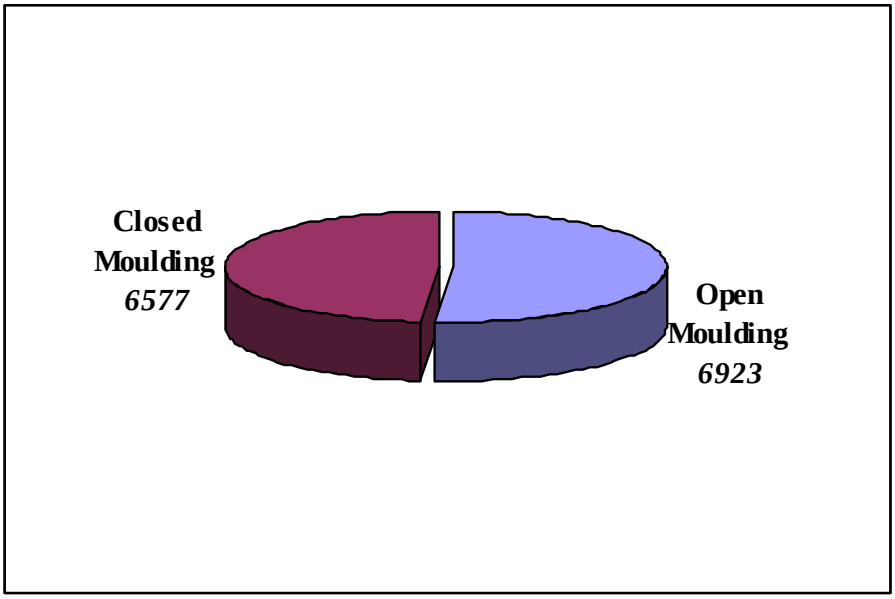

Figure 17: Open and closed moulding shipment (mil lbs) in global composites market in 2004

Amongst the many composite manufacturing processes the one that would directly impact the use of technical textiles as defined in this report are resin transfer moulding (RTM) processes. RTM and it associated moulding processes are briefly describes below.

5.1.1. Resin transfer moulding

Fabrics are laid up as a dry stack of materials. These fabrics are sometimes pre-pressed to the mould shape, and held together by a binder [1]. These 'pre-forms' are then more easily laid into the mould tool. A second mould tool is then clamped over the first, and resin is injected into the cavity. Vacuum can also be applied to the mould cavity to assist resin in being drawn into the fabrics. This is known as Vacuum Assisted Resin Injection (VARI). Once all the fabric is wet out, the resin inlets are closed, and the laminate is allowed to cure. Both injection and cure can take place at either ambient or elevated temperature (Fig. 18).

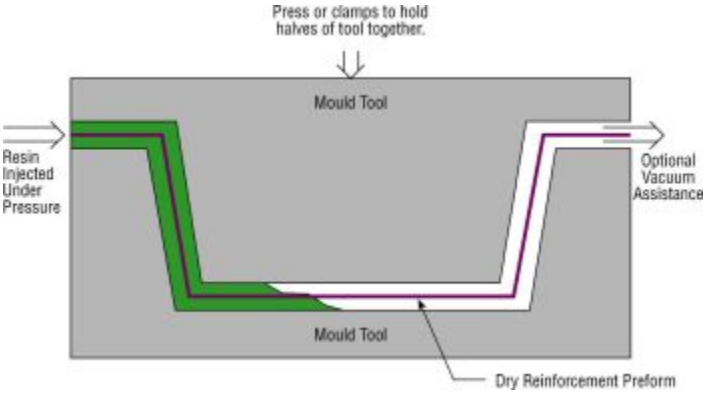

Figure 18 Schematic of VARI process [1].

Materials options:

- Resins: Generally epoxy, polyester, vinylester and phenolic, although high temperature resins such as bismaleimides can be used at elevated process temperatures.
- Fibres: Any. Stitched materials work well in this process since the gaps allow rapid resin transport. Some specially developed fabrics can assist with resin flow.
- Cores: Not honeycombs, since cells would fill with resin. Pressures involved can crush some types of foam.

Main advantages:

- High fibre volume laminates can be obtained with very low void contents.
- Good health and safety, and environmental control due to enclosure of resin.
- Possible labour reductions.
- Both sides of the component have a moulded surface.

Main disadvantages:

- Matched tooling is expensive and heavy in order to withstand pressures.
- Generally limited to smaller components.
- Un-impregnated areas can occur resulting in very expensive scrap parts.

Typical applications:

Small complex aircraft, automotive components and train seats.

5.1.2. Other Infusion Processes - SCRIMP, RIFT, VARTM

Fabrics are laid up as a dry stack of materials as in RTM. The fibre stack is then covered with peel ply and a knitted type of non-structural fabric. The whole dry stack is then vacuum bagged, and once bag leaks have been eliminated, resin is allowed to flow into the laminate. The resin distribution over the whole laminate is aided by resin flowing easily through the non-structural fabric, and wetting the fabric out from above (Fig. 19). Other variations can use flow enhancing structural fabrics in the lay-up.

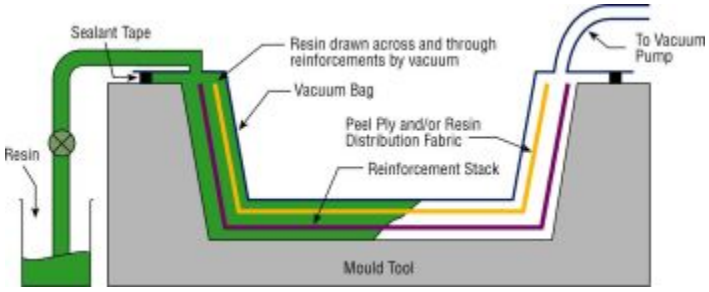

Figure 19 Schematic of RITF process [1]

Materials options:

- Resins: Generally epoxy, polyester and vinylester.
- Fibres: Any conventional fabrics. Stitched materials work well in this process since the gaps allow rapid resin transport.
- Cores: Any except open cell form. Also honeycombs can only be used if they are sealed.

Main advantages:

- As RTM above, except only one side of the component has a moulded finish.
- Much lower tooling cost due to one half of the tool being a vacuum bag, and less strength being required in the main tool.
- Large components can be fabricated.
- Standard wet lay-up tools may be able to be modified for this process.
- Cored structures can be produced in one operation.

Main disadvantages:

- Relatively complex process to perform well.
- Resins must be very low in viscosity, thus compromising mechanical properties.
- Un-impregnated areas can occur resulting in very expensive scrap parts.
- Some elements of this process are covered by patents (SCRIMP).

Typical applications:
Small yachts, train and truck body panels.

5.1.3. Light resin transfer moulding (LRTM)

LRTM**,** process for composites (Fig.20) is best described as a complimentary process to RTM. LRTM mould costs are basically half the price of equivalent RTM moulds but they produce, at best, at half the rate of RTM however the process provides moulders an introductory route into closed mould production. In LRTM, resin flow rates cannot be speeded up above an optimum level in order to fill the mould more quickly as the recommended LRTM mould construction and

the atmospheric mould clamping pressures limit overall in-mould pressures to less than 0.5 bar (8 psi) [9]. As with any composite closed mould production technique LRTM is no exception to the rule in demanding high quality accurate composite moulds in order to provide good mould life and consistent production of good parts.

Main advantages:

- Engineered finished/smooth both sides moulded part
- Zero emissions during moulding operation
- High quality, zero void content laminate parts
- Gel coat or un-gel-coated mouldings possible
- Up to 10 times faster than hand lay-up
- Relatively low start up investment.
- No consumables needed by mould apart from production resin and glass.
- Resin wastage ranging from less than 5% to 1%

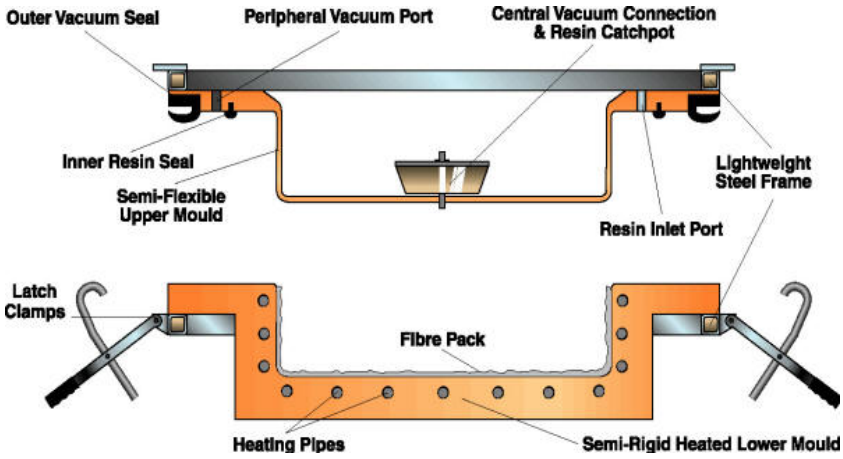

Figure 20 Schematic of LRTM process [9].

5.1.4. Resin Film Infusion (RFI)

Dry fabrics are laid up interleaved with layers of semi-solid resin film supplied on a release paper. The lay-up is vacuum bagged to remove air through the dry fabrics, and then heated to allow the resin to first melt and flow into the air-free fabrics, and then after a certain time, to cure. Variations include Semipreg or Sprint such as Hex-Fit from Hexcel and Z-preg from ACG.

Materials options:

- Resins: Generally epoxy only.
- Fibres: Any.
- Cores: Most although PVC foam needs special procedures due to the elevated temperatures involved in the process.

Main advantages:

- High fibre volumes can be accurately achieved with low void contents.
- Good health and safety and a clean lay-up, like prepreg.
- Good resin properties due to solid state of initial polymer material and elevated temperature cure.
- Potentially lower cost than prepreg, with most of the advantages.

Main disadvantages:

- Not widely proven outside the aerospace industry.
- An oven and vacuum bagging system is required to cure the component as for prepreg, although the autoclave systems used by the aerospace industry are not always required.
- Tooling needs to be able to withstand the process temperatures of the resin film (which if using similar resin to those in low-temperature curing prepregs, is typically 60-100°C).
- Core materials need to be able to withstand the process temperatures and pressures.

Typical applications:
Aircraft radomes and submarine sonar domes.

5.1.5. 'Quickstep' Out-of-autoclave Processing Method

Quickstep is a polymer composite manufacturing technique for out-of-autoclave processing of high-quality, low-cost, components. The Quickstep process uses a liquid to transfer heat to the uncured laminate stack, enabling precise control of the stack temperature and a considerable reduction of cure-cycle times. Plant and tool structural requirements are significantly reduced compared to those of an autoclave process by eliminating the need for high consolidation pressures [12]. The Quickstep processed material has similar or slightly improved properties over those of the autoclave-processed material. The Quickstep process also achieves a significant reduction in the overall cure-cycle time and estimated manufacturing costs.

This process utilises a fluid-heated, balanced-pressure, floating mould for the curing, partial curing and joining of composite materials. The process works by rapidly applying heat to an uncured laminate stack that is moulded to a rigid (or semi-rigid) tool floating in a Heat Transfer Fluid (HTF). The mould and laminate stack are separated from the circulating HTF by a flexible membrane. The temperature and pressure of the HTF behind the mould and flexible membrane stay the same. The process uses vacuum, combined with vibration, to evacuate air and volatiles from the laminate as well as to compact, heat and cure the part. The laminate may be thermoset or thermoplastic prepreg or a wet resin/dry fibre combination. Typically, parts manufactured using this process have equivalent, and in many instances superior, strength, stiffness, surface finish and appearance when compared to autoclave cured components. The laminate stack is assembled on a single-sided tool using conventional lay-up, sealed in a vacuum bag and then installed in a low-pressure chamber containing a glycol based HTF. The tool and laminate are supported between two flexible membranes in the pressure chamber (see Fig.21).

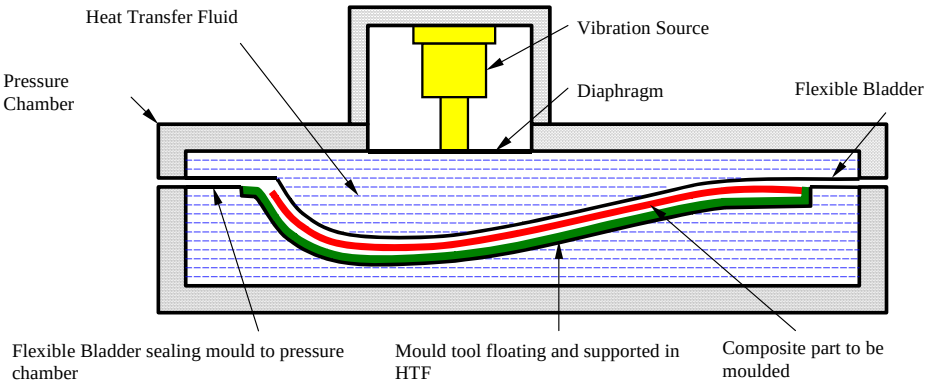

Figure 21 Schematic of Quick step process [12].

Main advantages

- Quick cycle times.
- Significant savings from reduced scrap rates.
- Ability to stop the cure reaction over any area of a curing laminate, at any time in the cure cycle.
- Possible to join such partially cured material to other uncured or partially cured material in a secondary cure-cycle (melding).
- Melding offers an opportunity for novel new product designs to be produced and enables the fabrication of large composite components.
- Versatile production facilities.
- Reduced capital, tooling and operational costs.

Main disadvantages

- Fewer parts are manufactured per Quickstep cycle for interrupted cure cycles, reduced tooling requirements and increased flexibility in part manufacture order.

An emerging trend in composite reinforcement in recent years is the demand for continual advancements in weaving technology for unique applications in the aerospace and defence industries. The trend, toward more control over fibre orientation and architecture while increasing productivity, is seen in 3-D weaving technology where preforms are produced that offer many advantages in both performance and economics.

5.2. TRADITIONAL

Those companies in ‘traditional’ textile sectors who develop and manufacture products which are included in the broader definition of technical textiles and are in the application areas listed above. These companies tend to utilise waste materials or focus on low cost technical textile solutions. Therefore the technical textiles sector is not just about high-tech development and manufacturing. There is an increasing role and, importantly, markets available for manufacturers in the traditional textile sectors.

The main fabrication process in this case is joining of the textiles used, these include:

- Adhesive bonding
- Heat sealing
- Hot air/wedge
- Ultrasonic welding
- High frequency welding
- Laser welding

More info at www.twi.co.uk

Laser welding in particular is an up coming process particularly in the application areas where higher value consumer products are manufactured e.g. Sporttech.

5.2.1. Laser welding

Laser welding is a high volume production process with the advantage of creating no vibrations and generating minimum weld flash. The technique relies on the initial outlay for a laser system, however, the benefits of a laser system include; a controllable beam power, reducing the risk of distortion or damage to components; precise focussing of the laser beam allowing accurate joints to be formed; and a non contact process which is both clean and hygienic. Laser welding may be performed in a single-shot or continuous manner, but the materials to be joined require clamping. Weld speeds depend on polymer absorption. Laser welding can be produced in two ways either as transmission or direct both of which are shown schematically in figures 22 and 23 respectively. Figure 24 shows a range of industrial jackets produced as part of a European collaborative project at TWI, using the laser welding techniques, it is suited well to this application for its waterproof and airtight seams.

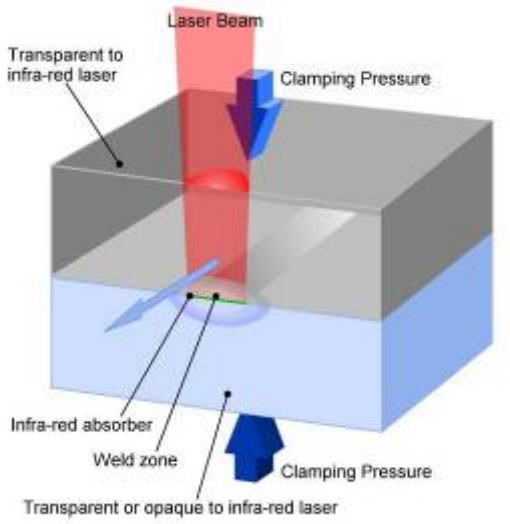

Figure 22 schematic of through transmission laser welding

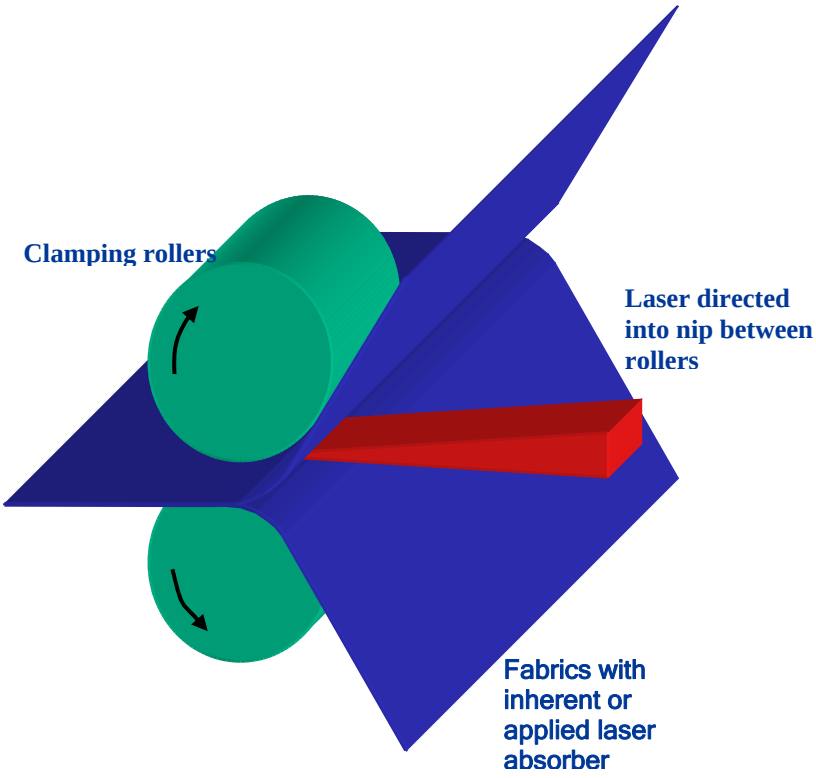

Figure 23 Schematic of direct laser welding

Figure 24 Examples of Laser welded garments produced at TWI as part of a European Collaborative project.

6. THE UK'S TECHNICAL TEXTILE INDUSTRY

UK opportunities

- Capitalising on the high rate of growth which has been experienced and is expected to continue in the technical textiles sector worldwide and in the UK
- Building upon the sporadic and fragmented success UK has achieved to date in the design, development and manufacture of high-tech technical textiles
- Nurturing the development of an innovation culture
- Improving the performance of UK in the development of a synthetic and man-made fibre capability.

7. TECHNOLOGY PROVIDERS

Technical Textiles: Applications in Industry is a new programme delivered by a dedicated team from the University of Leeds at the Textile Centre of Excellence covering:

- Nonwoven Materials Technology
- Fibres and Technical Textiles
- Sport and Performance Clothing
- Smart Materials
- Design, Innovation and Product Development

Learning can be undertaken via a virtual learning environment with learner support through weekly drop-in sessions and video conferencing. The programme can be completed in 'bite-size' chunks or over longer periods, taking around 12 weeks per module.