FINISHES IN FABRICS

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Finishing is the general term for a multitude of processes and treatments which a fabric may undergo after it has been made (woven or knitted) and coloured (dyed or printed). It is the final processing of the cloth and its purpose is to make the fabric suitable for its intended end use. That may mean. for example, making the fabric shrink proof, softer, stiffer, water repellent, crease resistant or a combination of these properties.

CLASSIFICATION OF FINISHES

Textile finishes and finishing are classified in several ways. Persons concerned with end products (designers, merchandisers and sales personnel) usually categorize finishes as aesthetic finishes and functional finishes**.** The former modify the appearance and/or hand (feel) of fabrics, while the latter improve the performance of a fabric under specific end use conditions. Persons concerned with textile processing (chemists and finishers) categorize finishes into chemical finishes and mechanical finishes**.** These are also called wet finishing and dry finishing, respectively.

Finishes are also categorized by their degree of permanence. These finishes are called permanent**,** durable, semi-durable and temporary**.**

- **Permanent finishes** usually involve a chemical change in fibre structure and will not change or alter throughout the life of a fabric.
- **Durable finishes** usually last throughout the life of the article, but effectiveness becomes diminished after each cleaning, and near the end of the normal use life of the article, the finish is nearly removed.
- **Semi-durable finishes** last through several launderings or dry cleanings and many are renewable in home laundering or dry cleaning.

- **Temporary finishes** are removed or substantially diminished the first time an article is laundered or dry cleaned.

SOFTENING

Softening finishes are among the most important of textile chemical after treatments. With chemical softeners, textiles can achieve an agreeable, soft hand (supple, pliant, sleek and fluffy), some smoothness, more flexibility and better drape and pliability. The hand of a fabric is a subjective sensation felt by the skin when a textile fabric is touched with the finger tips and gently compressed. The perceived softness of a textile is the combination of several measurable physical phenomena such as elasticity, compressibility and smoothness.

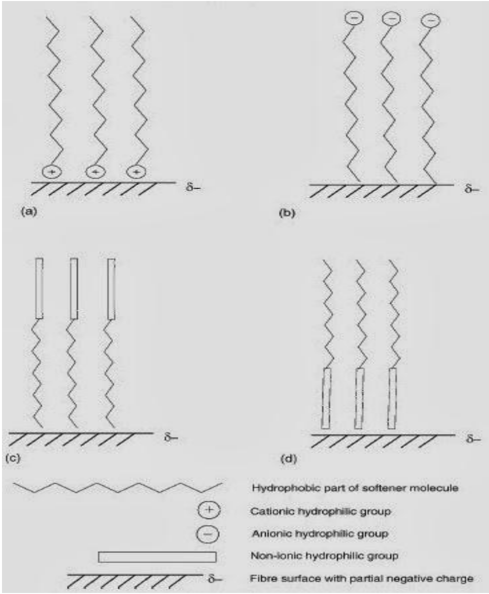
Softener

During preparation, textiles can become embrittled because natural oils and waxes or fiber preparations are removed. Finishing with softeners can overcome this deficiency and even improve on the original suppleness. Other properties improved by softeners include the feeling of added fullness, antistatic properties and sewability.

Disadvantages sometimes seen with chemical softeners include reduced crock-fastness, yellowing of white goods, changes in hue of dyed goods and fabric structure slippage.

MECHANISMS OF THE SOFTENING EFFECT

Softeners provide their main effects on the surface of the fibres. Small softener molecules, in addition, penetrate the fibre and provide an internal plasticization of the fibre forming polymer by reducing of the glass transition temperature. The physical arrangement of the usual softener molecules on the fiber surface is important and shown in Fig. It depends on the ionic nature of the softener molecule and the relative hydrophobicity of the fibre surface.



Schematic orientation of softeners on fibre surfaces. (a) Cationic softener and (b) anionic softener at fibre surface. Non-ionic softener at (c) hydro–phobic and (d) hydrophilic fibre surface.

Cationic softeners orient themselves with their positively charged ends toward the partially negatively charged fiber (zeta potential), creating a new surface of hydrophobic carbon chains that provide the characteristic excellent softening and lubricity seen with cationic softeners. Anionic softeners, on the other hand, orient themselves with their negatively charged ends repelled away from the negatively charged fibre surface. This leads to higher hydrophilicity, but less softening than with cationic softeners. The orientation of non-ionic softeners depends on the nature of the fiber surface, with the hydrophilic portion of the softener being attracted to hydrophilic surfaces and the hydrophobic portion being attracted to hydrophobic surfaces.

CREASE RESISTANT FINISH

Crease resistant finishes are popularly known as CRF finishes. They are used on cotton, rayon and linen because these three fibres wrinkle easily. CKF finishes are resin finishes; the fabric is saturated with resin and then the resin is cured at temperatures of about 360°F. The fabric becomes stiffer, less absorbent and more resistant to wrinkling. Resin treatments also results in tensile strength loss and reduction of abrasion resistance in cellulosic fibres. Most CRF finishes are durable.

ANTISTATIC FINISH

Anti-static finishes are chemical substances applied at the textile finishing mill for the purpose of reducing or eliminating static. These chemicals are actually substances which absorb small amounts of moisture from the atmosphere, thus reducing the dryness of the fabric. Anti-static finishes are not a truly satisfactory method for coping with the problem of static in textiles because they are merely semi-durable. These finishes wash out or wear out in several launderings or dry cleanings. Permanent anti-static effects are obtainable, however, with the man-made fibres which have been especially modified for this purpose.

ANTIBACTERIAL FINISH

The inherent properties of the textile fibres provide room for the growth of microorganisms. Besides, the structure of the substrates and the chemical processes may induce the growth of microbes. Humid and warm environment still aggravate the problem. Infestation by microbes cause cross infection by pathogens and development odour where the fabric is worn next to skin. In addition, the staining and loss of the performance properties of textile substrates are the results of microbial attack. Basically, with a view to protect the wearer and the textile substrate itself antimicrobial finish is applied to textile materials.

HISTORICAL ACCOUNT

During World War II, when cotton fabrics were used extensively for tentage, tarpaulins and truck covers, these fabrics needed to be protected from rotting caused by microbial attack. This was particularly a problem in the South Pacific campaigns, where much of the fighting took place under jungle like conditions. During the early 1940s, the US army Quartermaster Crops collected and compiled data on fungi, yeast and algae isolated from textiles in tropical and subtropical areas throughout the world.

Cotton duck, webbing and other military fabrics were treated with mixtures of chlorinated waxes, copper and antimony salts that stiffened the fabrics and gave them a peculiar odour. At the time, potential polluting effects of the application of, these materials and toxicity-related issue were not a major consideration. After World War II, and as late as the mid-to-late 1950's fungicides used on cotton fabrics were compounds such as 8-

hydroxygiunoline salts, copper naphthenate, copper ammonium fluoride and chlorinated phenols. As the government and industrial firms became more aware of the environmental and workplace hazards these compounds caused. Alternative products were sought.

A considerable amount of work was done by the Southern Regional Research Laboratory of the US Department of Agriculture, the Institute of Textile Technology (ITT) and some of the ITTs member mills to chemically modify cotton to improve its resistance to rotting and improve other properties by acetylation and cyanoethylation of cotton. These treatments had limited industry acceptance because of relatively high cost and loss of fabric strength in processing. In addition, the growing use of man-made fibres such as nylon, acrylics and polyester, which have inherent resistance to microbial decomposition, came into wider use to replace cotton in many industrial fabrics.

WHAT ARE MICROBES?

Microbes are the tiniest creatures not seen by the naked eye. They include a variety of microorganisms like bacteria, fungi, algae and viruses. Bacteria are unicellular organisms, which grow very rapidly under warmth and moisture. Further, sub divisions in the bacteria family are Gram positive (Staphylococcus aureus), Gram negative (E-Coli), spore bearing or non-spore bearing type.

Some specific types of bacteria are pathogenic and cause cross infection. Fungi, molds or mildew are complex organisms with slow growth rate. They stain the fabric and deteriorate the performance properties of the fabrics. Fungi are active at a pH level of 6.5. Algae are typical microorganisms, which are either fungal or bacterial. Algae require continuous sources of water and sunlight to grow and develop darker stains on the fabrics. Algae are active in the PH range of 7.0-8.0. Dust mites are eight legged creatures and occupy the household textiles such as blankets bed linen, pillows, mattresses and carpets. The dust mites feed on human skin cells and liberated waste products can cause allergic reactions and respiratory disorders.

SOME HARMFUL SPECIES OF THE BACTERIA AND FUNGI ARE LISTED IN TABLE.

Bacteria	**Fungi**
Gram positive bacteria	Cloth damaging fungi
Staphylococcus aurues or Pyogens	Aspergillusniger
Staphylococcus epidermidis	Aspergillusfurnigatus
Corynebacterium	Curvularialunota
Gram negative bacteria	Crop damaging fungi
Escherichia coli	Fusarium species
Proteus vulgaris	Sclerotiumrolfsii

NECESSITY OF ANTIMICROBIAL FINISHES

Antimicrobial treatment for textile materials is necessary to fulfill the following objectives:

1. To avoid cross infection by pathogenic microorganisms.
2. To control the infestation by microbes.
3. To arrest metabolism in microbes in order to reduce the formation odour.
4. To safeguard the textile products from staining, discolouration and quality deterioration.

REQUIREMENTS FOR ANTIMICROBIAL FINISH

Textile materials, in particular the garments are more susceptible to wear and tear. It is important to take into account the impact of stress strain, thermal and mechanical effects on the finished substrates. The following requirements need to be satisfied to obtain maximum benefits out of the finish:

1. Durability to washing, dry-cleaning and hot pressing.
2. Selective activity to undesirable microorganisms.
3. Should not produce harmful effects to the manufacturer, user and the environment.
4. Should comply with the statutory requirements of regulating agencies.

5. Compatibility with the chemical processes.
6. Easy method of application. No deterioration of fabric quality.
7. Resistant to body fluids; and resistant to disinfections/sterilisation.

ANTIMICROBIAL FINISHING METHODOLOGIES

The antimicrobial agents can be applied to the textile substrates by exhaust, pad-dry-cure, coating, spray and foam techniques. The substances can also be applied by directly adding into the fibre spinning dope. It is claimed that the commercial agents can be applied online during the dyeing and finishing operations. Various methods for improving the durability of the finish include:

1. Insolubilisation of the active substances in/on the fibre.
2. Treating the fibre with resin, condensates or cross-linking agents.
3. Micro encapsulation of the antimicrobial agents with the fibre matrix.
4. Coating the fibre surface.
5. Chemical modification of the fibre by covalent bond formation.
6. Use of graft polymers, homo polymers and/or co-polymerization on to the fibre.

MECHANISM OF ANTIMICROBIAL ACTIVITY

Negative effect on the vitality of the microorganisms is generally referred to as antimicrobial. The degree of activity is differentiated by the term cidal, which indicates significant destruction of microbes and the term, static represents inhibition of microbial growth without much destruction.

The activity, which affects the bacteria, is known as antibacterial and that of fungi is animistic. The antimicrobial substances function in different ways. In the conventional leaching type of finish, the species diffuse and poison the microbes to kill. This type of finish shows poor durability and may cause health problems. The non-leaching type or biostatic finish shows good durability and may not provoke any health problems. A large number of textiles with antimicrobial finish function by diffusion type.

The rate of diffusion has a direct effect on the effectiveness of the finish. For example, in the ion exchange process, the release of the active substances is at a slower rate compared to direct diffusion ad hence, has a weaker effect. Similarly, in the case of antimicrobial modifications where the active substances are not released from the fibre surface and so less effective. They are active only when they come in contact with microorganisms. These so-called new technologies have been developed by considering the medical, toxicological and ecological principles.

The antimicrobial textiles can be classified into two categories, namely, passive and active based on their activity against microorganisms. Passive materials do not contain any active substances but their surface structure (Lotus effect) produces negative effect on the living conditions of microorganisms (Anti-adhesive effect). Materials containing active antimicrobial substances act upon either in or on the cell.

ANTIMICROBIAL SUBSTANCES AND THEIR EFFECT

Many antimicrobial agents used in the textile industry are known from the food stuff and cosmetics sector. These substances are incorporated with textile substrates comparatively at lower concentrations. It must be ensured that these substances are not only permanently effective but also that they are compatible with skin and the environment. A wide palette of antimicrobial compounds is now in use but differ in their mode of action. The following list demonstrates the polyvalent effect of the various antimicrobial substances:

1. Materials with active finishes contain specific active antimicrobial substances, which act upon microorganisms either on the cell, during the metabolism or within the core substance (genome). However, due to the very specific nature of their effect, it is important to make a clear distinction between antibiotics and other active substances, which have abroad range of uses.

2. Oxidising agents such as aldehydes, halogens and proxy compounds attack the cell membrane, get into the cytoplasm and affect the enzymes of the microorganisms.
3. Coagulants, primarily alcohols irreversibly denature the protein structures. Radical formers like halogens, isothiazones and peroxo compounds are highly reactive due to the presence of free electrons. These compounds virtually react with all organic structures in particular oxidisingthiols in amino acids. Even at the lowest level of concentrations, these substances pose particular risk to nucleic acids by triggering mutations and dimerisation.
4. One of the most durable types of antimicrobial products is based on diphenyl ether (bis-phenyl) derivative known as either 2, 4, 4'-trichloro-2' hydroxydipenyl ether or 5-chloro-2-(2, 4-dichloro phenoxyl) phenol. Triclosan products have been used for more than 25 years in hospitals and personal care products such as antimicrobial soap, toothpaste and deodorants. Triclosan inhibits growth of microorganisms by using an electro-chemical mode of action to penetrate and disrupt their cell walls. When the cell walls are penetrated, leakage of metabolites occurs and other cell functions are disabled, thereby preventing the organism from functioning or reproducing. The Triclosan when incorporated within a polymer migrates to the surface, where it is bound. Because, it is not water-soluble, it does not leach out, and it continuously inhibits the growth of bacteria in contact with the surface using barrier or blocking action.
5. Quaternary ammonium compounds, biguanides, amines and glucoprotamine show poly cationic, porous and absorbent properties. Fibres finished with these substances bind microorganisms to their cell membrane and disrupt the lipo polysaccharide structure resulting in the breakdown of the cell.
6. Complexing metallic compounds based on metals like cadmium, silver, copper and mercury cause inhibition of the active enzyme centers (inhibition of metabolism). Amongst these, the silver compounds are very popular and already been used in the preparation of antimicrobial drinking water.
7. Chitosan is an effective natural antimicrobial agent derived from Chitin, a major component in crustacean shells. Coatings of Chitosan on conventional fibres appear to be the more realistic prospect since; they do not provoke an immunological response. Fibres made from Chitosan are also available in the market place. Natural herbal products can be used for antimicrobial finishes since, there is a tremendous source of

medicinal plants with antimicrobial composition to be the effective candidates in bringing out herbal textiles.

ANTIMICROBIAL TEXTILES

Actigard finishes from Clariant are used in carpets to combat action of bacteria, house dust mites and mould fungi. Avecia.sPurista-branded products treated with Reputex 20 which is based on poly (hexamethylene) biguanide hydrochloride (PHMB) claimed to possess a low mammalian toxicity and broad spectrum of antimicrobial activity. PHMB is particularly suitable for cotton and cellulosic textiles and can be applied to blends of cotton with polyester and nylon. In addition to the aforesaid antimicrobial agents, the fibres derived from synthetic with built-in antimicrobial properties are listed in Table 2.

Table 2 Antimicrobial fibre on the basis of synthetic polymers

Polymer	Company	Brand
Polyester	Trevira	Trevira Bioactive
	Montefibre	Terital SANIWEAR
	Brilen	Bacterbril
Polyacryl	Accordis	Amicor
	Sterling	Biofresh
Polyamide	Kaneba	Livefresh
	R-STAT	R-STAT
	Nylstar	Meryl Skinlife
Polypropylene	Asota	Asota AM Sanitary
Polyvinyl chloride	Rhovyl	Rhovyl's asAantibacterial
Regenerated cellulose	Zimmer AG	Sea Cell Activated

BENEFITS OF ANTIMICROBIAL TEXTILES

A wide range textile product is now available for the benefit of the consumer. Initially, the primary objective of the finish was to protect textiles from being affected by microbes particularly fungi. Uniforms, tents, defence textiles and technical textiles, such as, geo-textiles have therefore all been finished using antimicrobial agents. Later, the home textiles, such as, curtains coverings, and bath mats came with antimicrobial finish. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisure.

Novel technologies in antimicrobial finishing are successfully employed in nonwoven sector especially in medical textiles. Textile fibres with built-in antimicrobial properties will also serve the purpose alone or in blends with other fibres. Bioactive fibre is a modified form of the finish, which includes chemotherapeutics in their structure, ie, synthetic drugs of bactericidal and fungicidal qualities. These fibres are not only used in medicine and health prophylaxis applications but also for manufacturing textile products of daily use and technical textiles.

The field of application of the bioactive fibres includes sanitary materials, dressing materials, surgical threads, materials for filtration of gases and liquids, air conditioning and ventilation, constructional materials, special materials for food industry, pharmaceutical industry, footwear industry, clothing industry, automotive industry, etc.

EVALUATION OF ANTIMICROBIAL ACTIVITY

Various test procedures have been used to demonstrate the effectiveness of the antibacterial activity. Some of the tests used are:

1. Agar diffusion test.
2. Challenge test (Quantitative).
3. Soil burial test.
4. Humidity chamber test.
5. Fouling tests.

Agar diffusion test is a preliminary test to detect the diffusive antimicrobial finish. It is not suitable for non-diffusive finishes and textile materials other than fabrics. Objective evaluation of the antimicrobial activity is arrived at by making use of the challenge test where in which the difference between the actual bacterial count of the treated and untreated material is accounted for.

A series of test methods are available from AATCC (USA), DIN (International), JIS (Japan) and SN (Switzerland). The degree of antimicrobial activity of the active substance is expressed by the terms specific antimicrobial activity and general antimicrobial activity. The general activity or the bactericidal effect in the Japanese standard is based on the difference between the initial bacteria count on the non-modified material (Ma value) and the bacteria count of the modified material after 18 h of incubation (Mc value). The specific antimicrobial activity or bacteriostatic effects is based on the difference between the bacteria count of the reference value (Mb value) and the sample after 18 h of incubation (Mc value). Due to the limitations of the existing system, a new test system ISO/TC/38/WG23 (test methods for antimicrobial finished textile products) has been evolved by considering the technological, dermatological and ecological aspects of the finish.

EVALUATION OF THE INFLUENCE OF MODULE AND FUNGI

The influence of mould fungi is evaluated by three practical test methods:

i. At the growth test with a mixture of five different mould fungi it is evaluated how far the textile is supporting the fungus growth. The evaluation is not done only visually, but also material specific force elongation ratio is measured.
ii. In an inhibition zone test, the question is answered, if the tested finishing agent is protecting the textile from mould stains and mould over growth. The evaluation is done by rating the fungus growth in contact to test material and the viewing of the inhibition zone around the test sample in consequence of the diffusion of the antifungal agent.
iii. The third test the so called wet chamber test answers the question how a mould fungus contaminated textile performs in the wet chamber the evaluation is done visually by viewing the degree of growth or through tensile strength test.

WATER PROOF

"Waterproofing is nothing but preventing the passage of both air and water through a fabric."

PURPOSE OF WATER PROOFING:

For certain uses such as Tarpaulin, Umbrella cloth, Rain coat fabrics etc., it is required to give this type of finish as these type of fabrics are generally used against the air and water in the normal life. So they should have some property to prevent both air and water passing through them.

This finish makes the wearer feel uneasy and uncomfortable as the air circulation is not there.

Water proof fabric

PRINCIPLE OF WATER PROOFING:

A film on the surface of the fabric should be formed for the prevention of air and water. When a uniform coating of suitable substances such as rubber is produced on the surface of a fabric, the interstices between the warp and weft yarns are blocked by the continuous film or substance and both water and air not pass through the treated fabrics. It is a chemical and property giving finish.

- **REQUIREMENTS:**
  The fabric should not become unnecessarily stiff and the fabric should have soil release or soil repellent property.
- The finish should not alter the fastness properties or dyed material, feel, strength etc., of the fabric.

METHOD:

By two methods it can be carried out:

1. Methods by which hydrophobic substances are deposited on the cloth.
2. Methods by which the fabric itself becomes hydrophobic.

CHEMICALS USED:

1. Vulcanized natural rubber.
2. Oxidised oils of varnishes.
3. Polyvinyl chloro acetate.
4. Polyvinylidine chloride.
5. Cellulose acetate.
6. Cupprammonium hydroxide solution.

PROCESS:

A. The simplest method of water proofing is the coating of fabric with rubber as a thin film.

DISADVANTAGE:

- Unwanted stiffness and harshness.
- Fabric becomes harsh and brittle.

B. The application of natural oil will also produce this finish.

ADVANTAGE:

- No cracks or brittleness.

DISADVANTAGE:

- It is not permanent.

C. Coating of water impermeable substances like pitch, asphalt and molten waxes produce water proofing.

ADVANTAGE:

- It will give excellent proofing.

DISADVANTAGE:

- Many desirable properties of the fabric will be destroyed.

D. Using synthetic resins we can produce this finish.

Example: Polyvinyl chloro acetate, Cellulose acetate, Polyvinylidine chloride.

E. WATER PROOFING WITH WAX EMULSION.

- It can be applied on cotton, linen, wool, silk fabrics.
- Aluminium acetate is used along with the wax emulsion.

THERE ARE TWO STEPS INVOLVED IN PRODUCING THIS FINISH.

1ST STEP:

- ❖ Wax emulsion: 1-3 kg
- ❖ Water : 50 litres
- ❖ Pad the material with wax emulsion solution.

2ND STEP:

- ❖ In wet condition,
- ❖ Aluminium acetate: 1- 3 kg (12˚ Tw)
- ❖ Water : 50 litres
- ❖ Impregnate the fabric and squeeze thoroughly.
- ❖ Then dry the fabric in a stenter or on a drying range at 110˚ to 120˚C.

FLAME PROOF

There are two systems to make fabrics flame resistant. The first is to use selective fibres which have characteristic flame resistant properties. The second is by the use of flame resistant finishes.

All of the many types of flame retardant finishes now available suffer from at least one of the following shortcomings : (a) they cause stiffening and loss of fabric drapability; (b) they result in significant strength loss in fabric; (c) they are easily removed in laundering (nondurable); and (d) they become ineffective when laundered in household bleach, with soaps or with water softeners.

SOIL RELEASE

Soil release finishes in fabrics permit relatively easy removal of soils (especially oily soils) with ordinary home laundering.

There are several types of soil release finishes. All of them accomplish the end result of making the fibre more absorbent (hydrophilic), thus permitting better “wettability" for improved soil removal.

Most soil release finishes are applied at the same time that the resins are applied to textiles. Most are durable through 40 to 50 launderings and are routinely applied to fabrics for work clothes and table cloths. They are also often applied to fabrics for slacks and skirts. Several other benefits arise from the use of soil release finishes in durable press fabrics because of their increased absorbency. These include: improved antistatic properties, improved fabric Drapability and somewhat greater comfort in hot weather.

MOTH PROOFING:

“Moth proofing is a finishing which is given to prevent the growth of moth.” It is one kind of special finishing process of textile.

It is a chemical and property giving finish.

PURPOSE OF MOTH PROOFING:

It is mainly carried out on wool fabrics as the keratin molecules are consumed by moths as food. Since woolen fabrics are costlier, they have to be protected from moth. Moth is a small insect that feeds on substances like keratin and fibroin and so animal fibres are more susceptible to the attack of moth.

Moth proof finished bag

Woolen and worsted materials are attacked by moth and quickly eaten away and the housewives have to be very careful in preserving such garments.

REQUIREMENTS:

The finish should not affect the strength, drape, handle, softness, fastness property of dyed fabric and it should not cause any irritation to the human skin.

The finish should be fast to wash, light and laundering.

PROCESS OF MOTH PROOFING

Moth proofing can be done in the following ways:

1. By exposing the material to sunlight or sulphur-di-oxide.
2. Using Naphthalene balls and para dichloro benzene.
3. Using some substances containing fluorine such as Sodium fluoride, Aluminium fluoride, Potassium fluoride, and Sodium antimony fluoride.
4. Using soluble solvents such as DichloroBeneze, Sulphomethylamid and DichloroTrichloro ethane.
5. Evlan-BL and Mittin FF also produce moth proofing. These are the bet mothicides.

PROCESS SEQUENCE:

- Pad-dry-cure
- Concentration-20% on the weight of the material.

MICROENCAPSULATION TECHNIQUE IN FINISHING

Microencapsulated fabrics are among the latest generation of intelligent textiles. Microencapsulation involves encapsulating liquid or solid substances in tiny thin-walled natural or synthetic bubbles. Microspheres gradually release active agents by simple mechanical rubbing, which ruptures the membrane over time.

Encapsulation has allowed moisturisers, therapeutic oils, and insecticides to be incorporated into fabrics. Buzz Off is an encapsulation treatment designed to prevent mosquito bites. Originally developed for the military, Buzz Off uses microspheres containing permethrin, an all-natural insect repellent derived from the chrysanthemum plant, and is now being sold worldwide for cotton fabrics destined for holiday clothing.

Medical application of encapsulation has centeredon the delivery of drug treatments through clothing, to patients. One such application involves the delivery of antimicrobial treatments to cut down the bugs causing the hospital super-infection MRSA. The potential of microencapsulation for use in sportswear, underwear and work wear was soon recognized and now it is becoming a common treatment for fashion clothing. The use of microencapsulated antibacterial was encouraged by the difficulty of eliminating bacteria from clothing. One common treatment works by blocking the cell walls of the bacteria and cause them to starve, keeping garments fresh and hygienic.

Micro-encapsulation is also used in thermo-chromic and photo-chromic fabrics, which change colour with changes in temperature or light. The fabrics themselves are not thermo or photo-chromic, but their microencapsulated colourings are. For the time being, thermo-chromic micro-encapsulation is almost entirely limited to the lingerie and swimwear sectors and industrial clothing such as protective and safety clothes.

Micro-encapsulation also offers another way of maintaining body heat. Phase-change micro-encapsulation involves encapsulating a paraffin-based phase change material (PCM) in plastic shells. In contrast to the microcapsules used in cosmetic textiles, which must be thin-walled enough to allow for the gradual release of the material within the shell, the shells used for heat retention are hard; to protect the paraffin based substance from wear and tear. The spheres are small – about 1,000 microcapsules can fit on a single pinhead. The PCM is ultra-sensitive to temperature variations: below 37° the PCM remains in its solid state; above this temperature it turns to liquid, storing surplus body heat. When it solidifies again, the PCM releases body heat stored in the plastic shells and distributes it evenly around the body. This re-heating effect can last several hours. Fabrics containing PCM microcapsules are capable of storing at least 10 times more heat than untreated products