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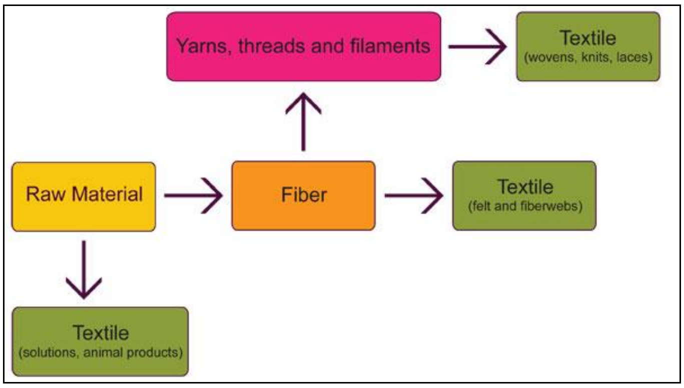
Comparative study on ring spun yarn and compact spun yarn

R Divya, Dr G Manonmani and M Jayakumari

Abstract
The smallest element of a knitted fabric is the loop. The constituent loop of a weft knitted fabric has the general shape. During knitting the loop is extended due to take down force applied to the fabric. The vast majority of the aforementioned studies deal with the properties of compact yarn as it is in yarn form. Several experts have described the technical principles of compact spinning that result in a more organised structure without peripheral fibres and with a better twist distribution.
As a result of this enhanced structure, it has been shown to effectively improve yarn quality and its performance during downstream processing.

Keywords: Compact yarn, knitting, spinning

Introduction
A Textile or cloth is flexible material consisting of a network of natural or artificial fibers. Yarn is produced by spinning raw fibers of wool, flax, cotton or other material to produce long strands. Textiles are formed by weaving, knitting, crocheting, knotting or felting. The words fabric and cloth are used in textile assembly trades as synonyms for textile. However there are subtle differences in these terms in specialized. Textile refers to any material made of interlacing fibers. Fabric refers to any material made through weaving, knitting, spreading or bonding that may be used in production of further goods. Cloth may be used synonymously with fabric but often refers to a finished piece of fabric used for a specific purpose.



Natural fibers may be obtained from plant, animal and mineral sources. Those from plant sources include cotton, flax, hem, sisal, jute, kenaf and coconut. Fibers from animal sources include silk wool, mohair. Those from mineral fibers include asbestos and metal fibers.
Synthetic or man-made fibers are the result of extensive research by scientists to improve on naturally occurring animal and plant fibers. In general synthetic fibers are created by extruding fiber forming materials through spinnerets into air and water, forming a thread. Before synthetic fibers where developed, artificially manufactured fibers were made from polymers obtained from petro chemicals. These fibers are called synthetic or artificial fibers. Some fibers are manufactured from plant derived cellulose. Synthetic fibers include polyester, nylon, acrylic, rayon, olefin, spandex etc.

Compact Spinning

Compact spinning is recognized as a revolution in ring spinning. This technology is claimed to offer superior quality and better raw material utilization. Although the properties and appearance of compact yarn have been compared with those of conventional ring yarn, there is no study available concerning the inner structure of this yarn. In ring spinning the main source of the fiber migration is acknowledged to be the tension differences between fibers during the yarn formation. When a thin ribbon-like fiber bundle is transformed into a roughly circular shape by twist insertion, fibers at the edges of bundle are faced with tension whereas fibers in the middle are subjected to compression unless there is excessive yarn tension. To release the stress, fibers subjected to tension try to shorten their path length in the yarn whereas fibers under compression try to lengthen it.

As a result of this, fibers leave their perfect helical path and migrate between layers of the yarn. In compact spinning, tension differences between fibers during the twist insertion is expected to be smaller than those in ring spinning due to the elimination of the spinning triangle. Therefore fiber migration in compact yarns could be considered to be less than that in conventional ring spun yarns. One of the claimed advantages of compact spinning is the possibility of attaining yarn strength identical to that in conventional ring spinning, but with approximately 20% lower twist. This, in turn, means a softer yarn, increased production and reduced energy consumption.

Knitting

Knitting is a method by which yarn is manipulated to create a textile or fabric. Knitting creates multiple loops of yarn, called stitches, in a line or tube. Knitting has multiple active stitches on the needle at one time. Knitted fabric consists of a number of consecutive rows of interlocking loops

Dyeing

Dyeing is the process of adding color to textile products like fibres, yarns and fabrics. Dyeing is normally done in a special solution containing dyes and particular chemical material. After dyeing, dye molecules have un cut chemical bond with fibre molecules. The temperature and time controlling are two key factors in dyeing. There are mainly two classes of dye, natural and man-made.

Acrylic fibres are dyed with basic dyes, while nylon and protein fibres such as wool and silk are dyed with acid dyes, and polyester yarn is dyed with disperse dyes. Cotton is dyed with a range of dye types including vat dyes, and modern synthetic reactive and direct dyes.

Finishing

In textile manufacturing, finishing refers to the processes that convert the woven or knitted cloth into a usable material and more specifically to any process performed after dying the yarn or fabric to improve the look, performance, or hand of the finish textile or clothing.

Silicone Finishing

Silicone finishes for textiles offer durable soft finish to cotton and its blended fabrics apart from offering aesthetic features. The performance of a silicone finish varies depending upon the functionality and molecular weight of the silicone polymer. The chemistry of silicone for textile treartment is big and the commonly silicones in textile have amino, amido, organo and epoxy functionalities. Depending upon the functionality in the polymer chain, they offer a wide range of performance properties like, durable softness, sewability, lubricity, elasticity, hydrophobicity, hydrophilicity, wrinkle and stretch recovery. Silicone finishes are increasingly preferred due to their versatile nature in finishing of fabrics.

Finishing Techniques

Some finishing techniques such as bleaching and dyeing are applied to yarn before it is woven while others are applied to the grey cloth directly after it is woven or knitted. some finishing techniques such as fulling, have been in use with hand weaving for centuries; others such as mercerization, are byproducts of the industrial revolution.

Methodology

The GSM testing methods are used to measure the material mass (or density) per square meter. GSM comes from “Gram per Square Meter”. It is a standard unit of measurement commonly used all over the world, even in countries where the usual unit of measurement is the pound (U.S.A). The reason is that the GSM testing methods are the most accurate ones.

GSM testing methods: industries and products concerned

The textile industry is using this test all the time. However the GSM testing methods also apply to other products such as the acrylic sheets, aluminum and foils, cotton bags and luggage, plastic made products, paper and leather, blankets, belts, foot ware, packaging materials, boxes, polyester & BOPP films, home furnishing items, Teflon products, thermal paper, even toilet paper!

GSM cutter and weighing scale

The GSM tests are more or less the same even if the product is different. It exist different GSM cutters depending on the material we want to cut. Apart from that the method consists in cutting a circle of material from 10 to 100 cm² to check its weigh. Two tools are used:

A GSM cutter (also called “round cutter”) and a weighing scale.

Yarn and thread

Cotton count

- **Ne** (Number English) or cotton count is another measure of linear density. It is the number of hanks (840 yd or 770 m) of skein material that weigh 1 pound (0.45 kg). Under this system, the higher the number, the finer the yarn. In the United States cotton counts between 1 and 20 are referred to as coarse counts. A regular single-knit T-shirt can be between 20 and 40 count; fine bed sheets are usually in the range of 40 to 80 count. The number is now widely used in the staple fiber industry.
- Hank: a length of 7 leas or 840 yards (770 m)
- One lea – 120 yards (110 m)

Yarn length

l/m = 1693 × l_m/Nec × m/kg, where l/m is the yarn length in meters, l_m/Nec is the English cotton count and m/kg is the yarn weight in kilograms.

English cotton count (Nec) is an indirect counting system, that is, the higher the number the finer the yarn.

- Thread: a length of 54 inches (1.4 m) (the circumference of a warp beam)
- Bundle: usually 10 pounds (4.5 kg)
- Lea: a length of 80 threads or 120 yards (110 m) [7]

To convert denier to cotton count: $l_m/Nec = 5315/\rho/den$, where l_m/Nec is the cotton count and ρ/den is the density in denier.
To convert tex to cotton count: $l_m/Nec = 590.5/\rho/tex$, where l_m/Nec is the cotton count and ρ/tex is the density in tex.

Thread
Thread is cotton yarn measure, equal to 54 inches (1.4 m).

Mommes
Mommes: (mm), traditionally used to measure silk fabrics, the weight in pounds of a piece of fabric if it were sized 45" by 100yards. One momme = 4.340 grams per square meter; 8 mommes is approximately 1 ounce per square yard or 35 grams per square meter.
The momme is based on the standard width of silk of 45 inches wide (though silk is regularly produced in 55-inch widths, and, uncommonly, in even larger widths).The usual range of momme weight for different weaves of silk are:

- Chiffon—6 to 8 mm (can be made in double thickness, i.e. 12 to 16 mm)
- Crepe de Chine—12 to 16 mm
- Gauze—3 to 5 mm
- Raw silk—35 to 40 mm (heavier silks appear more 'wooly')
- Organza—4 to 6 mm
- Charmeuse—12 to 30 mm

The higher the weight in mommes, the more durable the weave, and the more suitable it is for heavy-duty use. And, the heavier the silk, the more opaque it becomes. This can vary even between the same kind of silk. For example, lightweight charmeuse is translucent when used in clothing, but 30-momme charmeuse is opaque.

Thread count

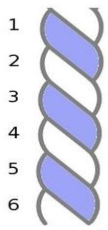
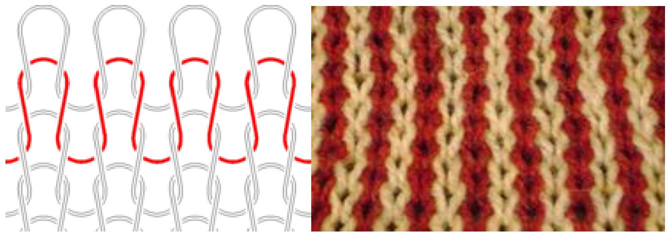


Image showing how to determine the number of twists per inch in a piece of yarn

Thread count: or threads per inch (TPI) is a measure of the coarseness or fineness of fabric. It is measured by counting the number of threads contained in one square inch of fabric or one square centimeter, including both the length (warp) and width (weft) threads. The thread count is the number of threads counted along two sides (up and across) of the square inch, added together. It is used especially in regard to cotton linens such as bed sheets, and has been known to be used in the classification of towels.

Industry standard: Thread count is often used as a measure of fabric quality, so that "standard" cotton thread counts are around 150 while good-quality sheets start at 180 and a count of 200 or higher is considered percale Some, but not all, of the extremely high thread counts (typically over 500) tend to be misleading as they usually count the individual threads in "plied" yarns (a yarn that is made by twisting together multiple finer threads). For marketing purposes, a fabric with 250 two-ply yarns in both the vertical and horizontal direction could have the component threads counted to a 1000 thread count although "according to the National textile association (NTA), which cites the international standards group ASTM, accepted industry practice is to count each thread as one, even threads spun as two- or three-ply yarn.
The Federal Trade Commission in an August 2005 letter to NTA agreed that consumers 'could be deceived or misled' by inflated thread counts. In 2002, ASTM proposed a definition for "thread count" that has been called "the industry's first formal definition for thread count". A minority on the ASTM committee argued for the higher yarn count number obtained by counting each single yarn in a plied yarn and cited as authority the provision relating to woven fabric in the *Harmonized Tariff Schedule of the United States*, which states each ply should be counted as one using the "average yarn number."

Courses and wales



Structure of stockinette, a common knitted fabric. The meandering red path defines one *course*, the path of the yarn through the fabric. The uppermost white loops are unsecured and "active", but they secure the red loops suspended from them. In turn, the red loops secure the white loops just below them, which in turn secure the loops below them, and so on.
Alternating wales of red and white knit stitches. Each stitch in a wale is suspended from the one above it.
Like weaving, knitting is a technique for producing a two-dimensional fabric made from a one-dimensional yarn or thread. In weaving, threads are always straight, running parallel either lengthwise (warp threads) or crosswise (weft threads). By contrast, the yarn in knitted fabrics follows a meandering path (a *course*), forming symmetric loops (also called bights) symmetrically above and below the mean path of the yarn. These meandering loops can be easily stretched in different directions giving knit fabrics much more elasticity than woven fabrics. Depending on the yarn and knitting pattern, knitted garments can stretch as much as 500%. For this reason, knitting was initially developed for garments that must be elastic or stretch in response to the wearer's motions, such as socks and hosiery
If they are not secured, the loops of a knitted course will come undone when their yarn is pulled; this is known as *ripping out*, *unravelling* knitting, or humorously, *frogging* (because you 'rip it', this sounds like a frog croaking: 'rib-bit') [1]. To secure a stitch, at least one new loop is passed through it. Although the new stitch is itself unsecured ("active" or "live"), it secures the stitch(es) suspended from it. A sequence of stitches in which each stitch is suspended from the next is called a *wale*. To secure the initial stitches of a knitted fabric, a method for casting on is used; to secure the final stitches in a wale, one uses a method of binding/casting of. During knitting, the active stitches are secured mechanically, either from individual hooks (in knitting machines) or from a knitting needle or frame in hand-knitting.

Loop Length

How to Measure Loop Length of Knits Fabric?

Knitted fabric is made by loop formation. Some of the fabric properties depend on loop length. So, sometimes we need to know loop length of the fabric that we are going to use in garments. In this article I have mentioned a method for measuring loop length of your sample.

To measure loop length of a knits fabric sample use following steps-

Step #1: Take your sample and cut fabric swatch of 10 cm X 10 cm from the fabric sample. While cutting fabric swatch consider cutting on the wales line. Count number of wales in the 10 cm of fabric swatch. For example see the right side image, that has 6 wales.

Step #2: Take out yarns by pulling the loop. Don't consider yarns those are not full length of swatch. Take five yarns of complete length and stretch yarns to remove curling on yarns.

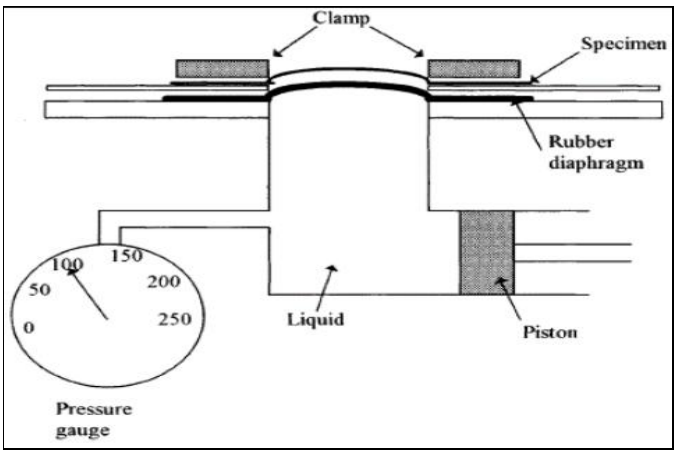
Step #3: Measure yarn length. Use measuring tape or scale to measure yarn length. Measure all 5 sample yarns. Note yarn lengths in a paper or note book. Calculate average length of the sample yarns.

Step #4: Calculate the loop length. Now divide average length of the yarns by no. of loops on the fabric sample.

Suppose you count 'X' no. of loops (wales) in the swatch and average length of the stretched yarns are 'Y' cm. Therefore loop length of the sample fabric will be equal to Y/X centimeters.

Bursting Strength

Pressure at which a film or sheet (of paper or plastic, for example) will burst. Used as a measure of resistance to rupture, burst strength depends largely on the tensile strength and extensibility of the material. Determined by procedures such as Mullen burst test, it is expressed commonly in pounds per square inch (psi). Burst strength of packaging material used in shipment of merchandise is usually printed on the package. Also called bursting strength\



Air Permeability

The air permeability of a fabric is a measure of how well it allows the passage of air through it. The ease or otherwise of passage of air is of importance for a number of fabric end uses such as industrial filters, tents, sailcloth's, parachutes, raincoat materials, shirting's, down proof fabrics and airbags.

Air permeability is defined as the volume of air in milliliters which is passed in one second through 10Os mm2 of the fabric at a pressure difference of 10mm head of water.

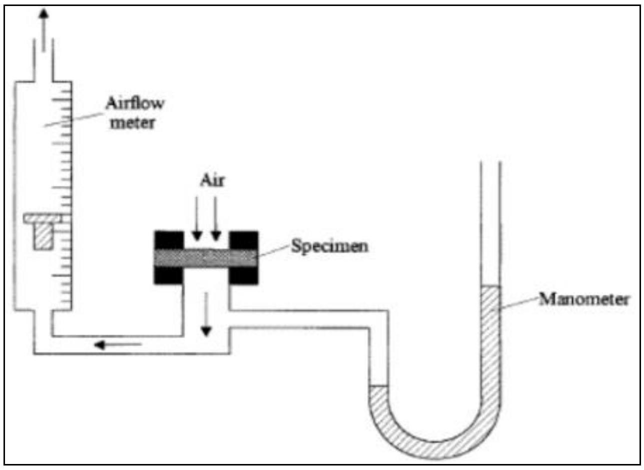
In the British Standard test the airflow through a given area of fabric is measured at a constant pressure drop across the fabric of 10mm head of water. The specimen is clamped over the air inlet of the apparatus with the use of rubber gaskets and air is sucked through it by means of a pump. The air valve is adjusted to give a pressure drop across the fabric of 10mm head of water and the air flow is then measured using a flow meter.

Five specimens are used each with a test area of 508mm2 (25.4mm diameter) and the mean air flow in ml per second is calculated from the five results. From this the air permeability can be calculated in ml per 100mm2 per second.

The reciprocal of air permeability, air resistance, can be defined as the time in seconds for ImI of air to pass through 100s mm2 of fabric under a pressure head of 10mm of water. The advantage of using air resistance instead of air permeability to characterize a fabric is that in an assembly of a number of fabrics, the total air resistance is then the sum of the individual air resistances.

The Air Permeability Test

To obtain accurate results in the test, edge leakage around the specimen has to be prevented by using a guard ring or similar device (for example, efficient clamping). The pressure drop across the guard ring is measured by a separate pressure gauge. Air that is drawn through the guard ring does not pass through the flow meter. The pressure drops across the guard ring and test area are equalised in order that no air can pass either way through the edge of the specimen. A guard ring of three times the size of the test area is considered sufficient.



DRAPE

Drape is the term used to describe the way a fabric hangs under its own weight. It has an important bearing on how good a garment looks in use. The draping qualities required from a fabric will differ completely depending on its end use, therefore a given value for drape cannot be classified as either good or bad. Knitted fabrics are relatively floppy and garments made from them will tend to follow the body contours. Woven fabrics are relatively stiff when compared with knitted fabrics so that they are used in tailored clothing where the fabric hangs away from the body and disguises its contours. Measurement of a fabric s drape is meant to assess its ability to do this and also its ability to hang in graceful curves.

Drape Co-Efficient Test

In the drape test the specimen deforms with multi-directional curvature and consequently the results are dependent to a certain amount upon the shear properties of the fabric. The results are mainly dependent, however, on the bending stiffness of the fabric.

In the test a circular specimen is held concentrically between two smaller horizontal discs and is allowed to drape into folds under its own weight. A light is shone from underneath the specimen as shown in Fig. 10.4 and the shadow that the fabric casts, shown in Fig. A, is traced onto an annular piece of paper the same size as the unsupported part of the fabric specimen.

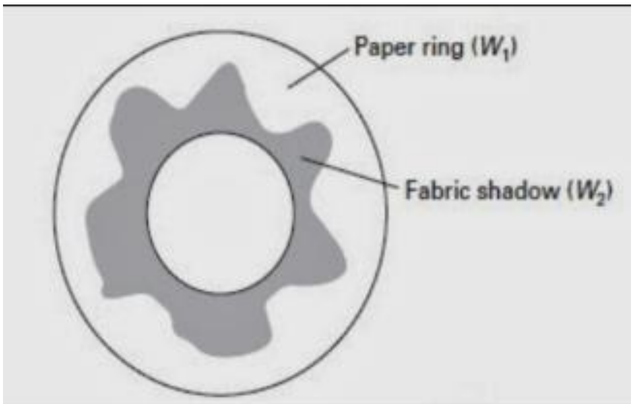
The stiffer a fabric is, the larger is the area of its shadow compared with the unsupported area of the fabric. To measure the areas involved, the whole paper ring is weighed and then the shadow part of the ring is cut away and weighed. The paper is assumed to have constant mass per unit area so that the measured mass is proportional to area. The drape coefficient can then be calculated using the following equation:

The higher the drape coefficient the stiffer is the fabric. At least two specimens should be used, the fabric being tested both ways up so that a total of six measurements are made on the same specimen. There are three diameters of specimen that can be used:

• A 24cm for limp fabrics; drape coefficient below 30% with the 30cm sample;
• B 30cm for medium fabrics;
• C 36cm for stiff fabrics; drape coefficient above 85% with the 30cm sample.

Pe Test Top View Of Draped Fabric

It is intended that a fabric should be tested initially with a 30cm size specimen in order to see which of the above categories it falls into. When test specimens of different diameter are used, the drape coefficients measured from them are not directly comparable with one another. Figure B shows a drape tester fitted with a video camera and computer for instantaneous measurement of the drape coefficient.



Sem – Scanning Electro Microscope

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens can be observed in high vacuum, in low vacuum, in wet conditions (in environmental SEM), and at a wide range of cryogenic or elevated temperatures. The most common SEM mode is detection of secondary electrons emitted by atoms excited by the electron beam. The number of secondary electrons that can be detected depends, among other things, on the angle at which beam meets surface of specimen, [citation needed] i.e. on specimen topography. By scanning the sample and collecting the secondary electrons that are emitted using a special detector, an image displaying the topography of the surface is created.

Fourier Transform Infrared Spectroscopy (Ftir) Analysis

FTIR (Fourier Transform Infrared spectroscopy) analysis and testing identifies chemical compounds.

FTIR analysis helps clients understand materials and products. Analytical testing sample screens, profiless and data interpretation are available on a global basis. FTIR testing identifies chemical compounds in consumer products, paints, polymers, coatings, pharmaceuticals, foods and other products. Laboratories with FTIR expertise are located throughout the Intertek global laboratory network. FTIR offers quantitative and qualitative analysis for organic and inorganic samples.

Fourier Transform Infrared Spectroscopy (FTIR) identifies chemical bonds in a molecule by producing an infrared absorption spectrum. The spectra produce a profile of the sample, a distinctive molecular fingerprint that can be used to screen and scan samples for many different components. FTIR is an effective analytical instrument for detecting functional groups and characterizing covalent bonding information.

FTIR can be used with other molecular spectroscopy techniques available in Intertek laboratories, including Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS), Infrared-spectroscopy coupled to Thermogravimetric Analysis (FTIR/TGA), Nuclear Magnetic Resonance Spectroscopy (NMR), Gas Chromatography - Mass Spectrometry (GC/MS), Liquid Chromatography - Mass Spectrometry (LC/MS), UV/Vis spectroscopy, Near Infra Red (NIR) and Raman scattering. FTIR combined with these techniques provides complementary data regarding a molecule's molecular structure.

Results and Discussion

Process Parameter Comparison

Compact spinning is one of the special invention in the field of spinning. It brings a good recovery for the hairiness property of all short fibred yarns. Basically natural fibres are short fibres by nature and it needs compact spinning, but man made fibres can also be spun by using compact method, it brings a perfect drooping of hairiness to fibres and increase the fabric quality.

Particulars	PV
Roving hang	1.9c
Draft	16.0
Count	30s
Break draft	1.18
Spacer	3.25
TPI	15.71
Spindle speed	16000RPM
Travellar	1/0E/UDR

Single Yarn Tenacity and Elongation (Utr)

Particulars	PV
Actual strength	561.5
CV% of strength	7.91
Elongation%	9.55
CV% of elongation	5.72
RKM	28.52

U% Imperfection at All Sensitivity

Particulars	PV
Mean U%	10.42
Mean CVM%	13.31
Thin plates (50%)	21
Thick plates (50%)	66
Neps (200%)	233

Hairiness Index-Uster (Additional)

Particulars	PV
Hairiness-H	6.00
Standard deviation of hairiness-sh	1.43

Basic Fabric Testing: GSM

Cotton	1.525
Polyviscose	1.280

Coarse Length: Cotton

Scale Reading	10”
Coarse Length	80”

Polyviscose

Scale Reading	10”
Coarse Length	90”

Coarse and Wales

Particulars	Wales	Coarse
Cotton	31	46
Polyviscose	32	43

Loop Length

Cotton	0.3mm
Polyviscose	0.4mm

Bursting

Cotton	10kgs
Polyviscose	10kgs

Count

Cotton	35s
Polyviscose	35s

Air Permeability

Cotton	10.5
Polyviscose	11

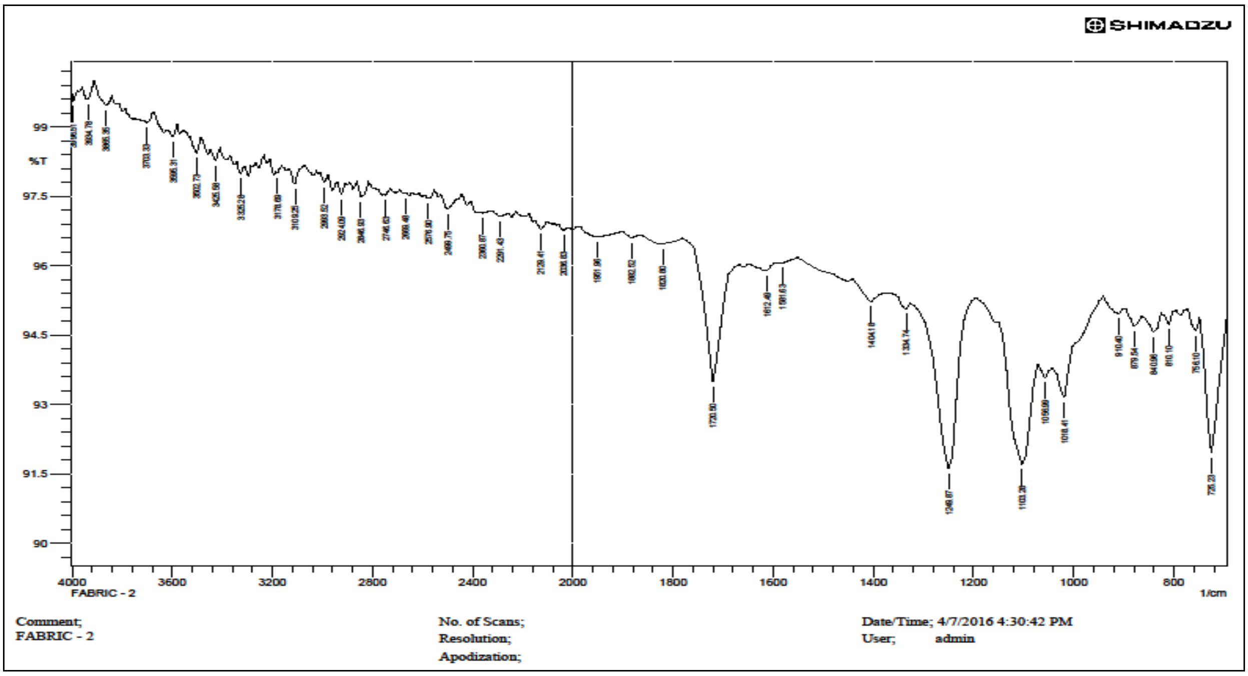
Drape

Cotton	53.20%
Polyviscose	34.66%

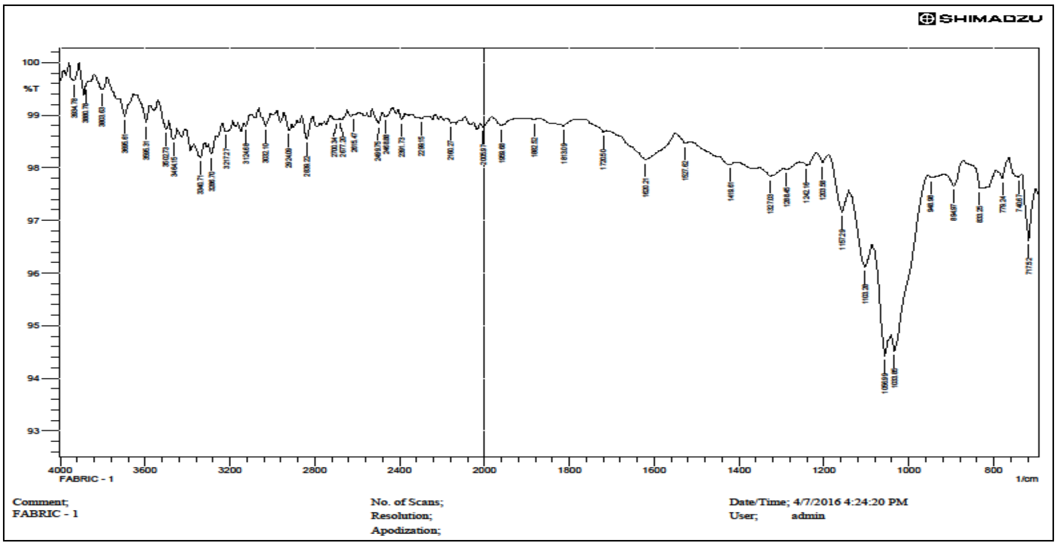
Tightness Factor

Cotton	0.073
Polyviscose	0.96

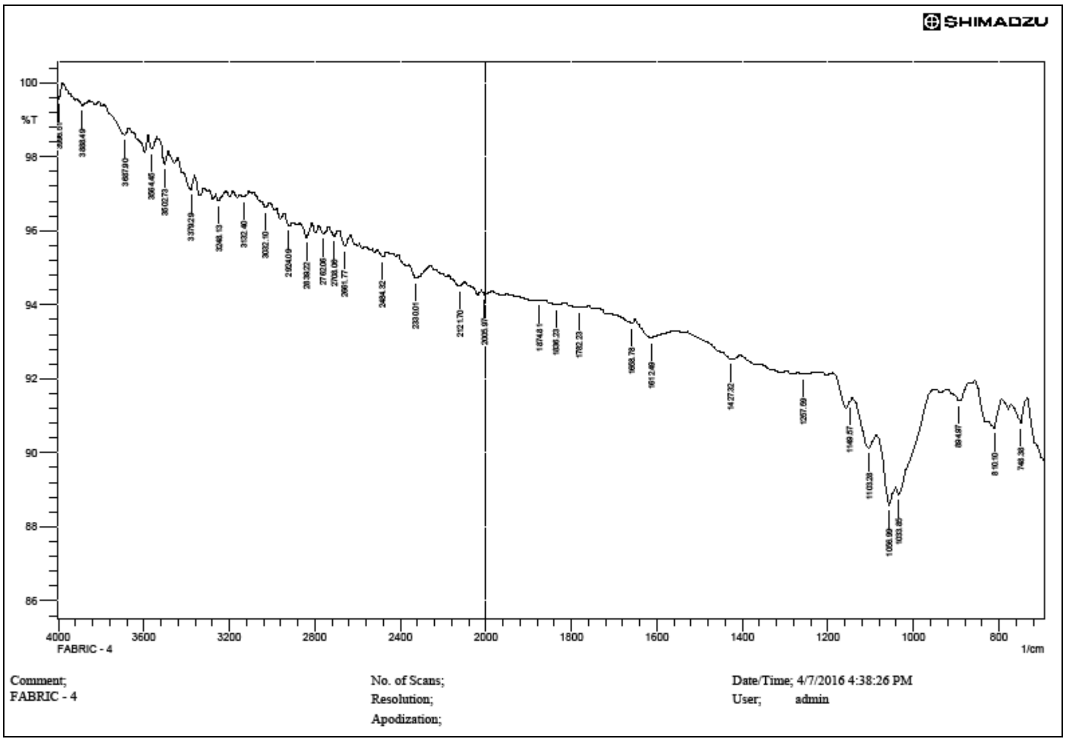
Ftir Test: Cotton



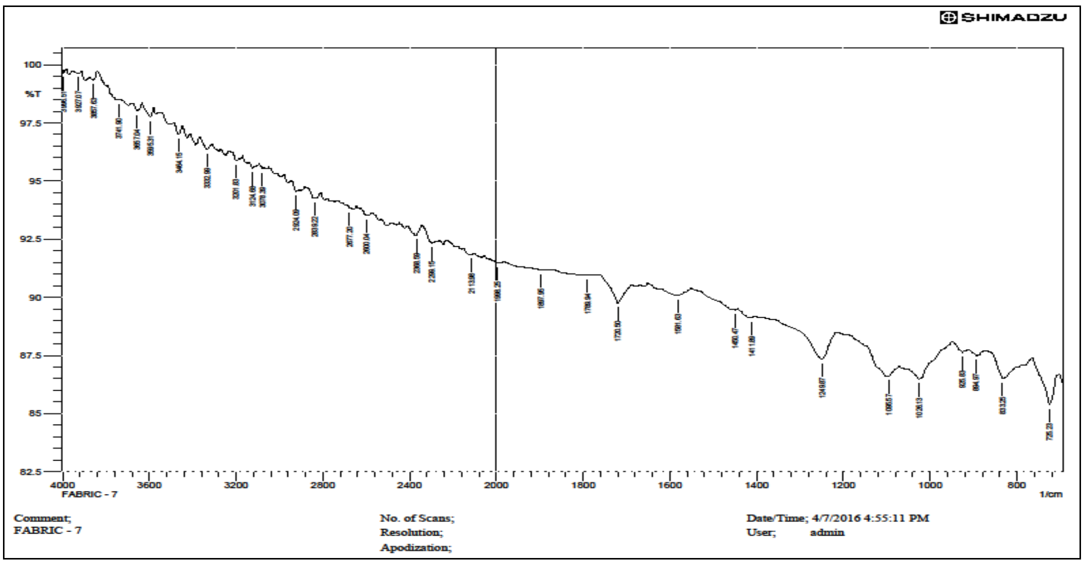
Polyester Viscose



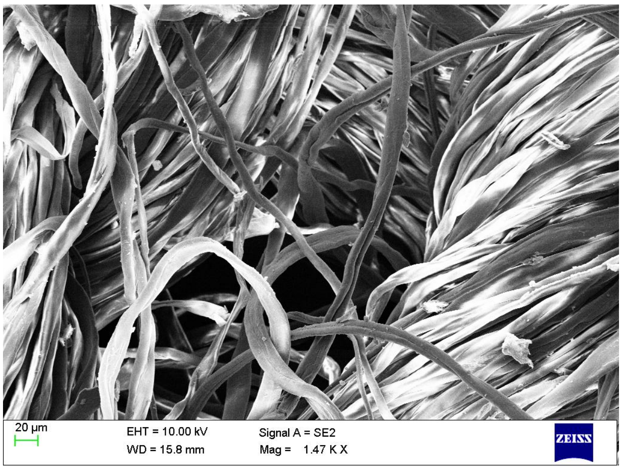
Cotton – Silicon

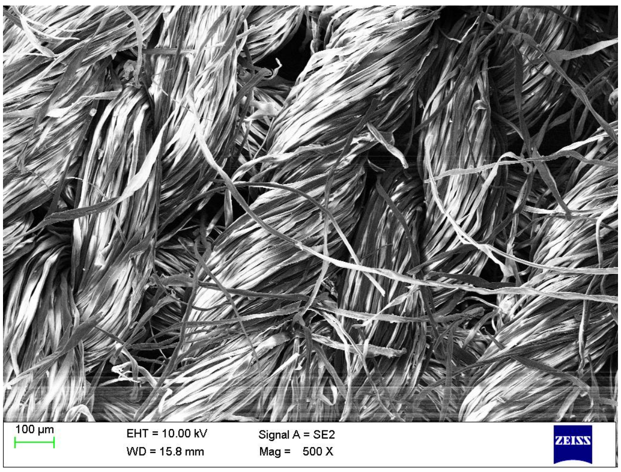


Polyester Viscose – Silicon



Sem Test: Cotton





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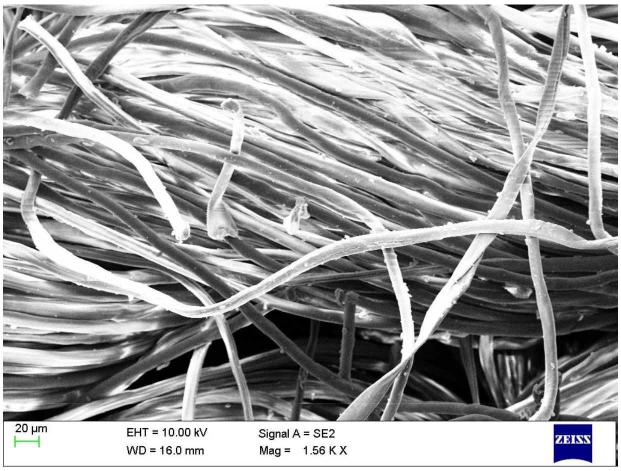

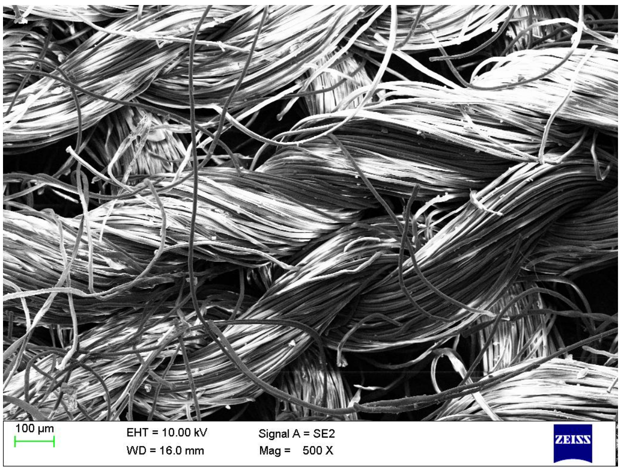

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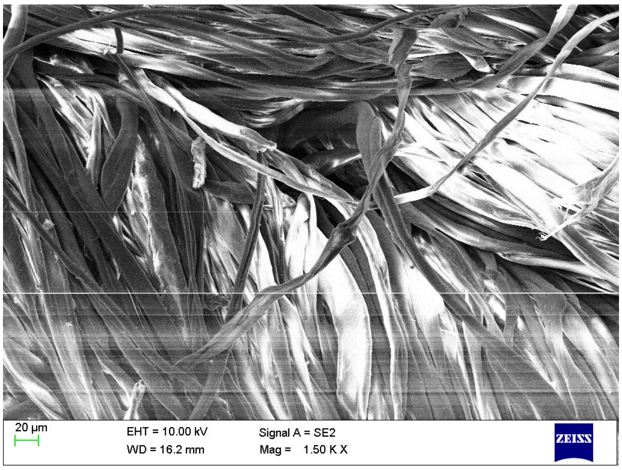
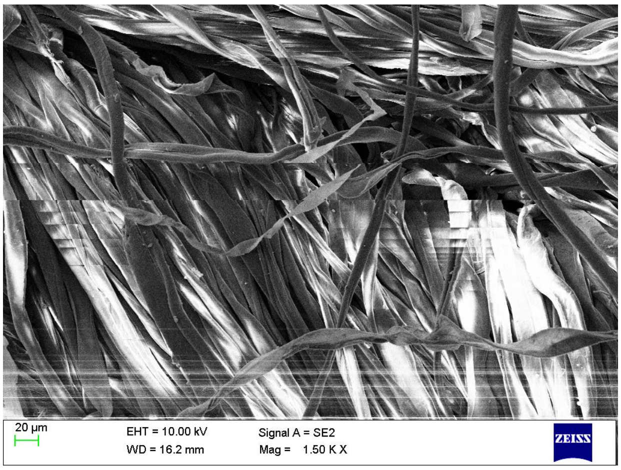
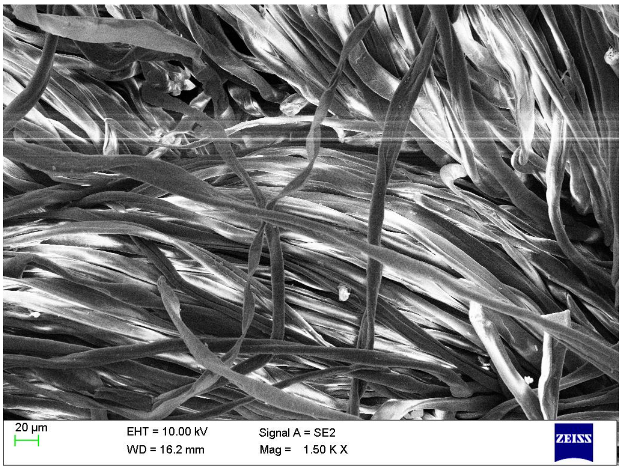
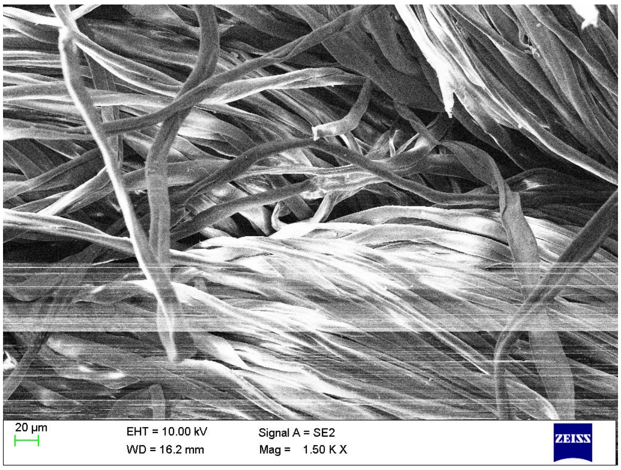
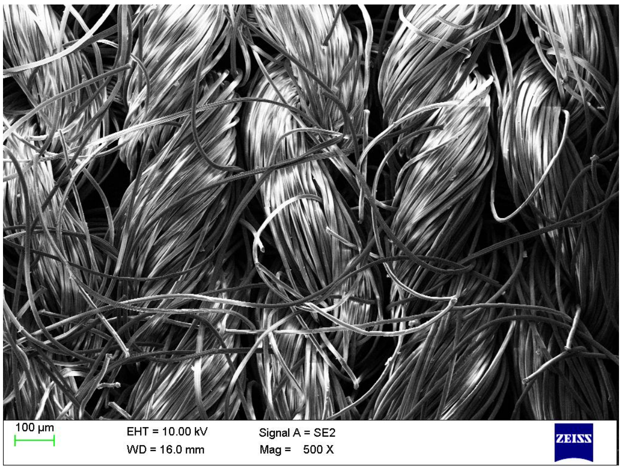


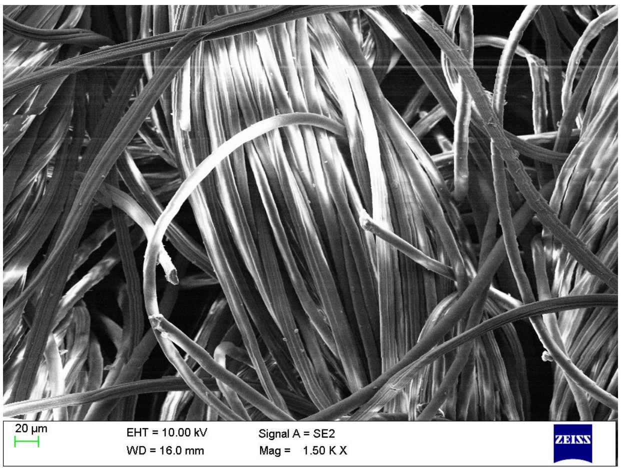


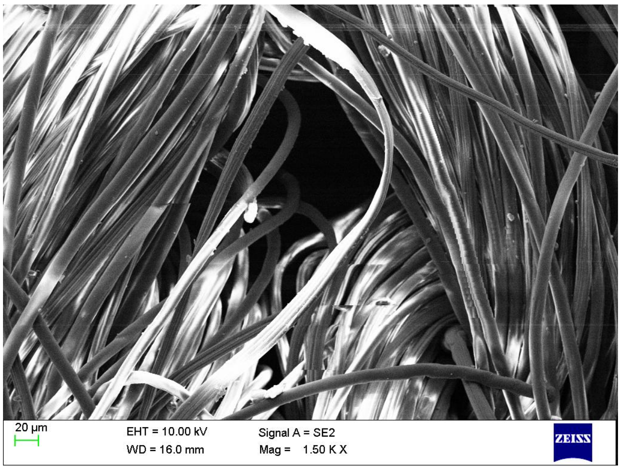




Polyester Viscose – Silicon







Summary and Conclusion

The advantageous compact yarns can be economically utilised in a variety of ways and all these possibilities are opening a wide field for the creation and development of future products and applications. In recent years, however a bonafied innovation has occurred. It is called compact or condensed spinning, because it minimises width and height of the spinning triangle associated with ring spinning.

Now compact spinning is the undisputed accomplishment. With the market introduction of “Compact Ring Spinning” in late 1990s, the situation in ring spinning has changed fundamentally in all relevant quality criteria. Genuine condensed or compact yarns are substantially superior to conventional ring yarn to such a degree that it is no longer possible to speak of a standard market value. In the best sense of the word.

This is a revolution in ring spinning and even at this point in time, one can categorically say that the future belongs to compact yarns. Compact spinning technique can be used universally for all raw materials, blends as well as for the complete count range without restriction.

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