Rieter Yarn

Advantages of COM4® yarns in knitting

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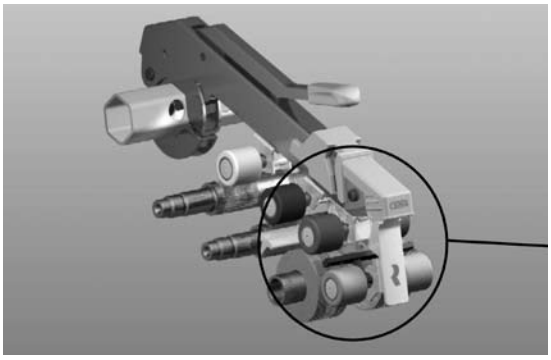
APPLICATION AND ADVANTAGES OF COM4® YARNS IN KNITTING

This article is concerned with the compact spinning technology of Rieter spun yarn Systems known under the name of COM4®. When this technology was introduced, attention was focused primarily on processing properties in spinning, weaving and the resulting end products. In several cases the application of COM4® yarns revealed astonishing advantages and excellent results. The reason for the market launch in the weaving sector was that the advantages of the increase in yarn tenacity and the smooth yarn structure in woven articles could very easily be calculated in cash terms. In addition, the new yarn structure has enabled it to become established as the standard with the clothing manufacturers and the trade for many end products such as fine quality shirts and blouses. A start was then made to define the advantages of the smooth yarn structure in the knitting sector. However, we are still far from knowing all the potential and advantages for this sector today. As a technology company, Rieter has set itself the task of continuously elaborating and expanding this technology know-how, and thus supporting our customers and their customers in their product development. It has also become evident in knitting that the manufacture of high-quality articles offers considerable opportunities and potential by virtue of their silky luster, clear structures and pleasant handle. Advantages which make the use of COM4® yarns interesting have also become apparent in the knitting manufacturing process.

Fig. 1 Application of COM4® yarns for knitted goods

Fig. 2 Patterned knitwear with clear design (l) and socks with high abrasion resistance (r)

K 44 weighting arm with compacting elements



Perforated drum with pressure roller

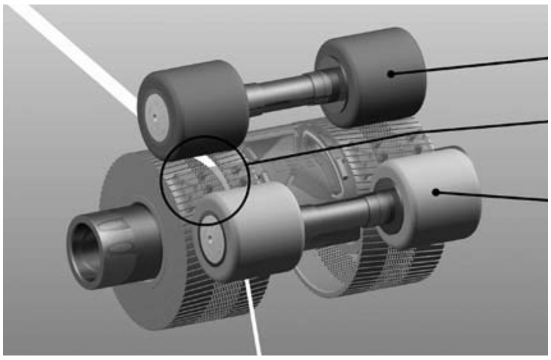
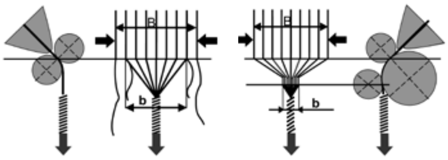


Fig. 3 + 4 COM4® compacting process

Operating principle

Ring spinning **ComforSpin**



$B_{ring} = B_{COM4}$
$b_{ring} > b_{COM4}$

Fig. 5 Reduced spinning triangle with COM4®

THE COM4® PRINCIPLE

The COM4® system differs from the conventional ring spinning system in that the drafted fiber web is compacted on the pair of delivery cylinders by means of a vacuum and special air guidance. The unit consists of the delivery cylinder in the compacting zone and the clamping rollers.

The process of compacting the drafted fibrous web results in a smaller spinning triangle, so that the fibers are incorporated more effectively into the yarn.

The compacting process results in the following yarn properties:
– lower hairiness
– less fiber fly
– lower fiber abrasion in yarn
– higher abrasion resistance
– lower dust in yarn
– higher yarn tenacity
– lower pilling

The ComforSpin system features non-wearing technology components such as a perforated drum, suction inserts and air guide elements.

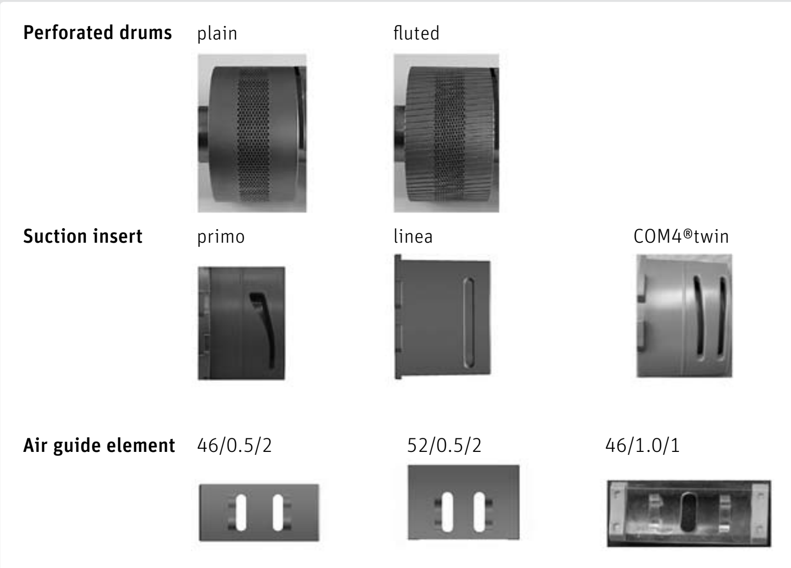


Fig. 6 Technology components COM4® and COM4®twin

Depending on the raw material and the number of fibers in the cross section, i.e. the yarn count, the technology components and settings differ for achieving the best possible compacting result. A new development in technology components also enables a COM4®twin yarn to be produced.

APPLICATION POTENTIAL OF COM4®

There is a wide variety of opportunities to avail the special yarn properties in knitting. Ultimately, however, selective and individual product development must take place on the basis of the objectives of the knitting manufacturer and the end user. The calculation profitability analyses has already become possible in weaving operations on the basis of experience gained over the years. This is scarcely possible in knitting operations. However, the technological potential of the use of compact yarns can be shown as follows:

PRIMARY OPPORTUNITIES	LOW POTENTIAL
Strength +	Low cost sheeting
Elongation +	Commodity yarns
Hairiness ++	“Air friendly” yarns
IPI values +	Towels
Soft hand +	Denim
Abrasion resistance +	Bulky and hairy products
fly reduction ++	Brushed or raised knitwear
dust reduction +	Low cost fabrics
Improved downstream process	
Shirting	
knits (quality products) ++	

The following summary gives some examples of the benefits that are possible when using compact yarns, taking into account the end product and the given yarn count. The possibilities range from using less expensive raw material to savings in the subsequent treatment of yarns and knitted fabrics. For example, it is quite possible to dispense with singeing or mercerizing in some cases. Mercerizing gives cotton a higher brilliance and silky luster.

COM4® – LOWER HAIRINESS AND NEPS

Yarn fabric property	Application	Typical yarn counts [tex]	COM4® instead of …
Hairiness/Neps	Shirting	8–10	– singeing – Perla – mercerizing
For more efficient processing, better visual appearance and more brilliance	High density fabric (bed ticking)	7–20	– see above
	Knitting	7–50	– 2 ply
	Denim	15–120	– better raw material – Perla – singeing
	Warp knitting	10–30	– better raw material – Perla – rotor yarn – singeing

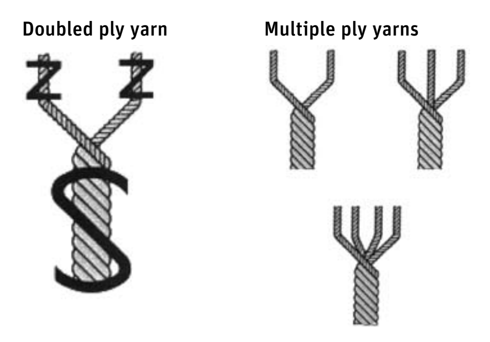


Fig. 7 Ply yarn principle

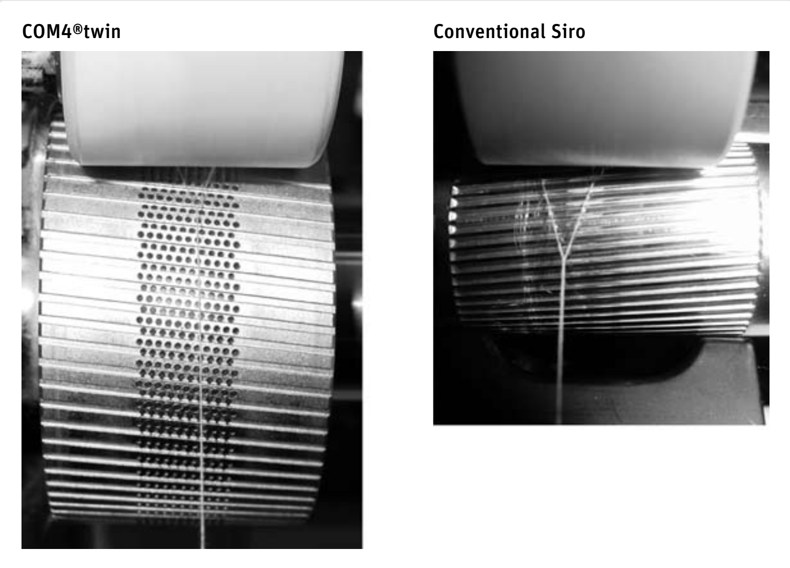
APPLICATION POTENTIAL OF COM4® TWIN

The manufacture and product development of ply yarns can also be an important theme for the knitting sector. Here the main emphasis is on high abrasion resistance and low pilling tendency. Not only in the long staple sector (wool and man-made fibers such as acrylics), where some 50–60% of ply yarns are used worldwide, but also in the short staple sector (cotton and man-made fiber segment), the use of ply yarns amounts to some 15–20%. Alongside these advantages, reasons related to knitting manufacture, such as reduced loop skew when processing certain products, can also play a part. Finally the question also arises as to the potential for developing new knitted fabrics for certain areas of application on the basis of the specific yarn structure.

Classical ply yarn

Classical ply yarn has the following objectives:
- to increase tear strength;
- to make irregular yarns more uniform;
- to create coarser structures;
- to achieve special effects.

Depending on the type of manufacture, a distinction is made between doubled and multiple ply yarns. In doubled ply yarns 2, 3 or more yarns are folded, i.e. combined into a yarn bundle and then twisted together into a ply yarn in a single operation. As in the case of yarns, the letters S and Z describe the direction of twist. The direction of twist of the ply yarn is usually opposite to that of the preceding spun yarns. The twist is described as loose, normal or hard, depending on the number of twists per unit of length. For certain areas of application, such as in the medical field, they can also be twisted in the same direction as the individual yarns in order to achieve greater elongation.



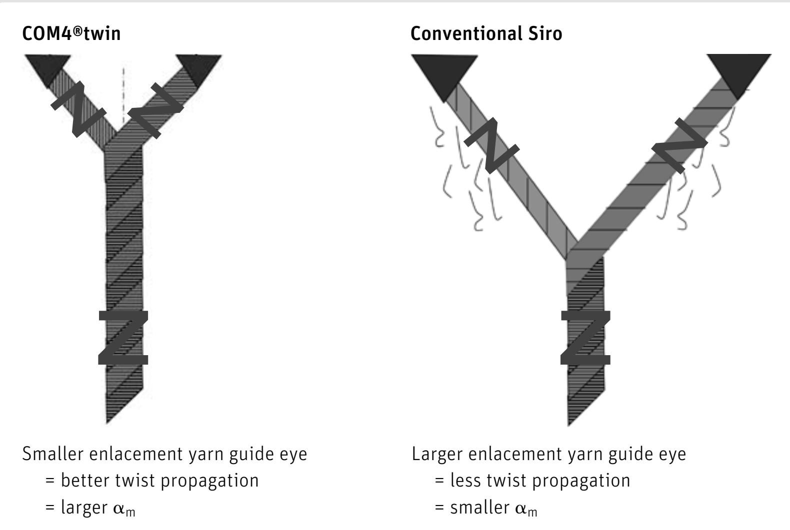


Fig. 8 + 9 The difference between COM4®twin and conventional Siro yarn is apparent in the spinning triangle

COM4®twin for knitting

Drafting two separate rovings and twisting the two components over one spindle each, i.e. with two spinning triangles and one yarn triangle, was already developed for wool by the CSIRO (Commonwealth Scientific International Research Organization) in Australia in 1975 and launched in 1977 with the REPCO machinery works. Due to the direction of spindle rotation on the ring spinning machine, however, this always produces a yarn whose direction of twist is the same in both yarn components and the finished yarn, i.e. either Z or S. Even then the quality of the yarn already displayed clear advantages compared to single-end yarn. However, a major disadvantage was that an end down did not always occur in the event of a yarn thread break. The winding on the cop then had only half the yarn mass over an extended length of thread. The division of the yarn mass also results in a smaller number of fibers in the spinning triangle and also a lower twist factor in the yarn triangle, which often resulted in ends down. This usually had to be compensated for by a substantial reduction in thread tension and thus spindle speed. Therefore spindle speed has to be reduced with these false ply yarns and it must also be ensured that the twist factor in the yarn triangle and the fiber mass is as high as possible. On the COM4® system the conditions for producing a false ply yarn are much better than with conventional ring spinning. In this case the improved spinning conditions also result in many more qualitative advantages in the yarn. The better spinning conditions on the COM4® system will therefore now be explained in technological terms. The big difference between the two ring spinning systems in the yarn triangle is clearly recognizable in the manufacture of a false ply yarn. The width and thus also the length of the yarn

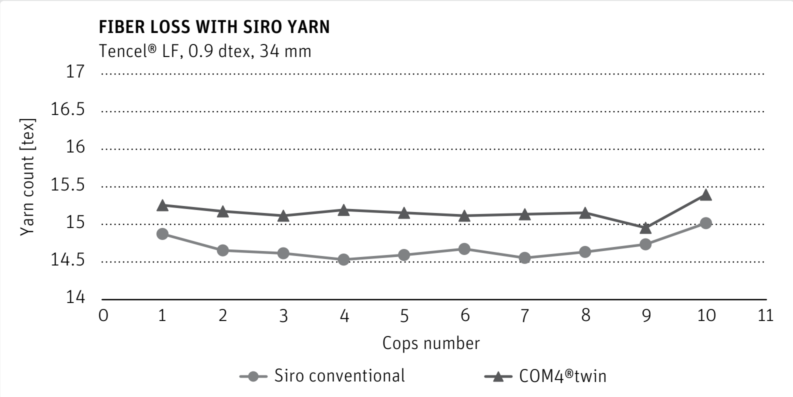


Fig. 10 Less fiber loss with the COM4® technology

	Angle β	Traverse stroke	Roving feed width into drafting system	Spindle speed rpm	Traveler weight ISO
COM4®twin	48°	4 mm	8 mm	13'000	56
Conventional system	38°	10 mm	8 mm	13'000	56

Fig. 11 Geometrical conditions

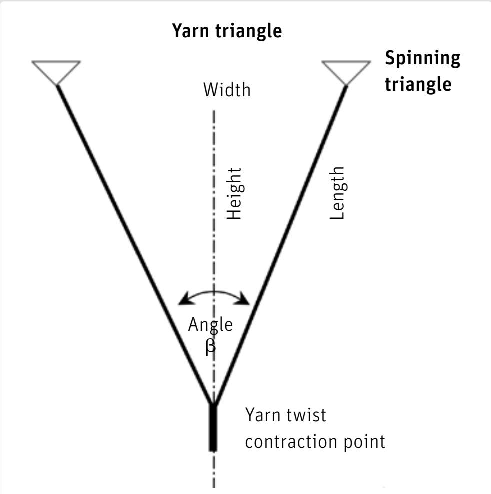


Fig. 11.1 Yarn triangle

triangle is much smaller on the COM4® system and thus more favorable than on the conventional ring spinning system.

Fiber losses also occur in the conventional ring spinning system, with fibers passing to the extraction system via the suction tubes. Fiber losses can be relatively high, depending on the raw material. When processing Lenzing Lyocell this was only about 3%, due to the very low short fiber content. When manufacturing COM4® twin the much lower fiber losses therefore have a positive effect on running properties. (Fig. 10)

The geometrical conditions show the very different yarn triangle of the two systems, using Micro Lyocell with a yarn count of 15 tex as an example. (Fig. 11 & Fig. 11.1)

The two rovings are guided over the drafting system by means of the feed condenser. The thread width is influenced by roving or web guidance. However, roving feed width via the feed condenser is not the crucial dimension for the width of the yarn triangle. Fiber web guidance and the gaps between them are very important; the special suction insert on the COM4® system for manufacturing a false ply yarn ensures this. (Fig. 12)

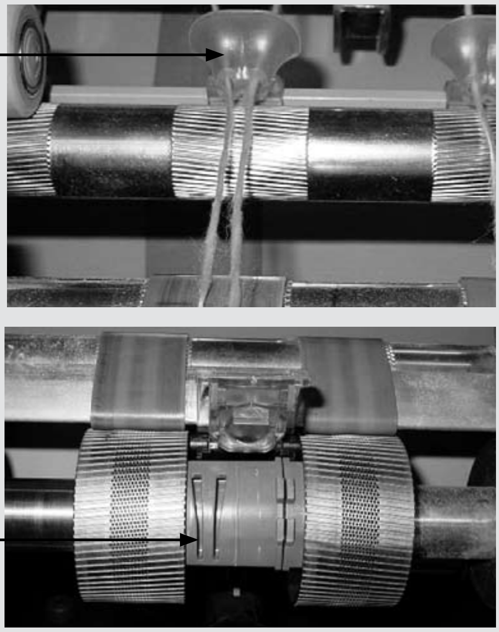


Fig. 12 Back condenser and suction insert space

The height of the twist triangle is influenced by the following factors:
– yarn twist, i.e. fiber angle
– thread tension
– spinning triangle, i.e. fiber web width
– yarn twist propagation

Yarn triangle width and yarn triangle height (yarn twist contraction point) are smaller on the compact system. This results in a shorter yarn triangle length. The available twist is therefore distributed over a shorter yarn triangle length, which results in better fiber integration in the spinning triangle. The importance of this is also apparent if it is borne in mind that the twist factor in the yarn is thus much lower, due to the halved fibrous mass, and yarn twist propagation into the yarn is some 20% lower than in the final yarn.

Good yarn twist propagation results in:
– shorter yarn length
– more twist in the yarn
– better incorporation in the spinning triangle

Lower yarn hairiness also results in less resistance to twist propagation and promotes the ability of the yarn twist contraction point to propagate itself further upward toward the drafting system. The yarn triangle height is therefore influenced by how much resistance is generated at the yarn twist contraction point. In the current situation this means that when manufacturing false ply yarn on the conventional system a higher yarn twist setting has to be expected in order to achieve the same ends down frequency as on the COM4® system. In other words, the production of false ply yarn on the COM4® system will be more economical in terms of ends down frequency alone. It can also be assumed that by virtue of the low fiber loss on the COM4® system this will have a more favorable impact on yarn quality than on the conventional system. The production of false ply yarns on the COM4® compact system will shortly be made available by Rieter Spun Yarn Systems under the COM4®twin name. The current manufacturing range on this machine is between 3.7 tex x2 (7.5 tex) and 10 tex x2 (20 tex).

Fig. 13 Fiber fly in knitting accumulated on the package

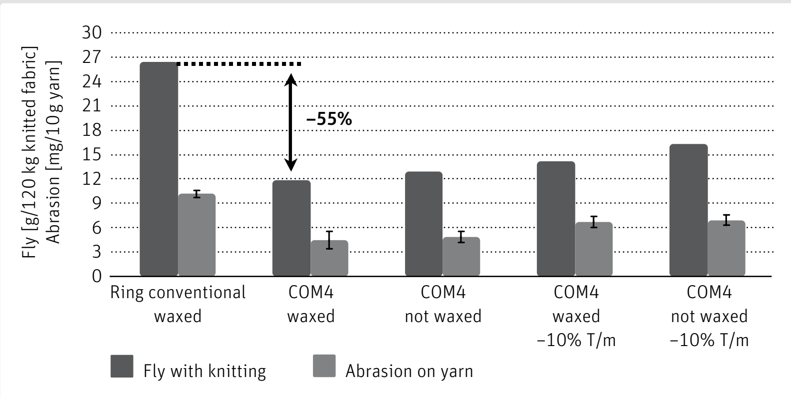


Fig. 14 Amount of fiber fly after producing 120 kg of knitted fabric

FIBER FLY AND DUST IN THE KNITTING PROCESS

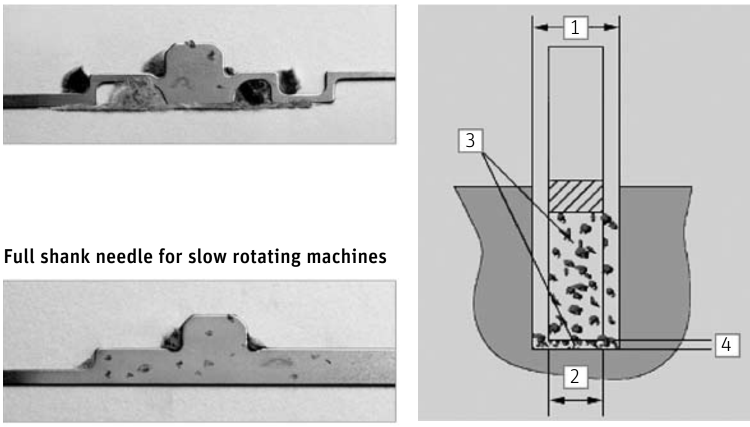
During knitting lots of fiber fly, dust and trash occurs, (Fig. 13) collecting in needle recesses and tracks; mixed with oil and metal abrasion dust, this dirty mixture consolidates in time and attaches itself in critical locations. Fiber fly can thus become a considerable problem in knitting mills.

This can become a real problem with higher short fiber content, lower yarn twist and coarser yarn. Knitted-in accumulations of fiber fly can result in complaints. The problem can make itself even more seriously apparent if knitting machines operate with different raw materials and yarn colors, and the fiber fly from one raw material shows up again in knitted fabric made from another raw material.

The tendency to generate fiber fly can be quantified by measuring the abrasion behavior and hairiness of the yarns. However, it is not possible to draw conclusions regarding the specific volume of fly or indeed the number of complaints on this basis.
However, the example in Fig. 14 shows what impact hairiness and abrasion values have on fiber fly for a given quantity of knitted fabric. The COM4® yarn with the knitted fabric produced about 55% less fiber fly than conventional yarn (result of 120 kg produced knitted fabric).

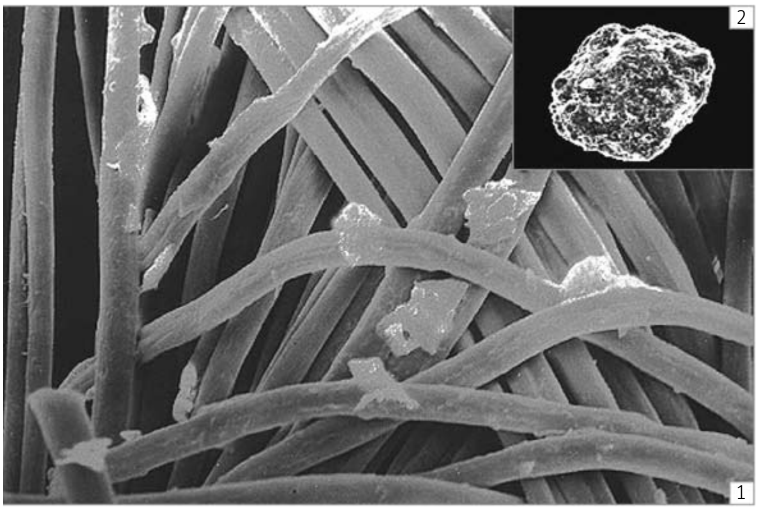
Meander shape needle for high productivity

Full shank needle for slow rotating machines



1 = Track width
2 = Needle thickness
3 = Dirt
4 = Lifted

Fig. 15 Fiber fly accumulated on the knitting needle (Source: GROZ-BECKERT®)



1 = Man-made fiber contain matting agents, such as Titanoxyd
2 = Silicates with natural fibers

Fig. 16 Needle wear in knitting (Source: GROZ-BECKERT®)

The deposits of dirt cause a narrowing of the needle bed track and increase friction and thus the sluggishness of the needles, which can result in stripes in the knitted fabric. The pads of fiber in the meander arcs and between the bottom edge of the needle and the base of the track can even raise the needles so that they rub against the cams. (Fig. 15)

Contamination is much less apparent with full-stem needles for slow-running machines and therefore does not present a problem. However, low profile meander shape needles are currently the standard needles for modern high-performance machines by virtue of their performance potential. Soiling in the needle recesses means that the machines have to be cleaned 4 to 8 times a year, depending on fiber fly.

Poor latch mobility due to fiber fly can also have a negative impact on loop uniformity. The lower yarn hairiness when using compact yarns results in fewer needle scarf blockages and improved latch mobility due to reduced fiber fly.

Remaining trash from cotton husks, dust particles and silicates on the yarn bundle as well as abrasive substances such as titanium oxide (Fig. 16) in man-made fibers have a negative influence on knitting needle wear. The particles, some of which are harder than the needle steel, scratch the surface of the needle and inevitably cause wear.

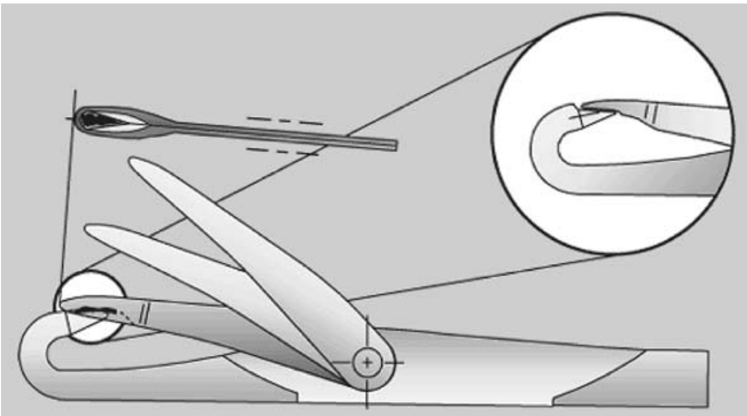


Fig. 17 Needle wear in knitting (Source: GROZ-BECKERT®)

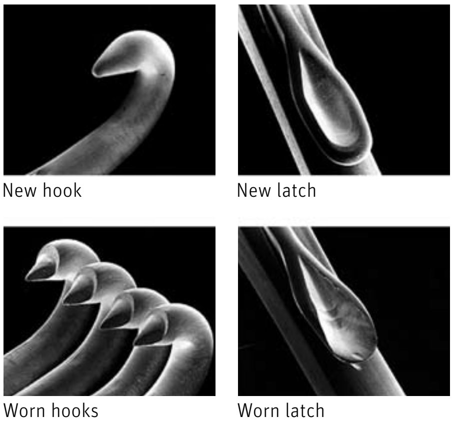


Fig. 18 New and worn hooks and latches in knitting (Source: GROZ-BECKERT®)

Typical wear patterns occur, for example, on the needle latch and the beard. The red dirt particles accumulate in the latch groove and on the beard. The latch strikes against the beard every time it closes. As illustrated in Fig. 17 and Fig. 18, the dirt particles cause wear on the needle steel due to the resulting pressure and friction.

Another typical wear pattern occurs between the latch guide and the latch bearing. Here the dirt particles get into the slot between the latch shank and the cheeks, and between the rivet and the latch hole. Wear results from the combination of latch movement and dirt particles.

A wear test on the inside arc of the head is intended to show the effects, between the two yarn types – COM4® and conventional ring-spun yarn – under otherwise identical conditions such as fiber preparation in the spinning mill. Here needle wear was measured in μm per simulated running time by the Groz-Beckert company. The COM4® yarn displayed much lower needle wear on the inside arc of the head.

Wear on latch guidance and latch bearing

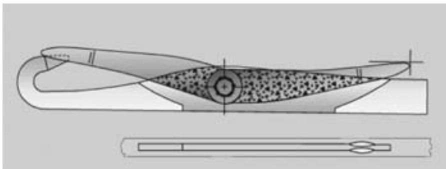


Fig. 19 Wear on latch guidance and latch bearing (Source: GROZ-BECKERT®)

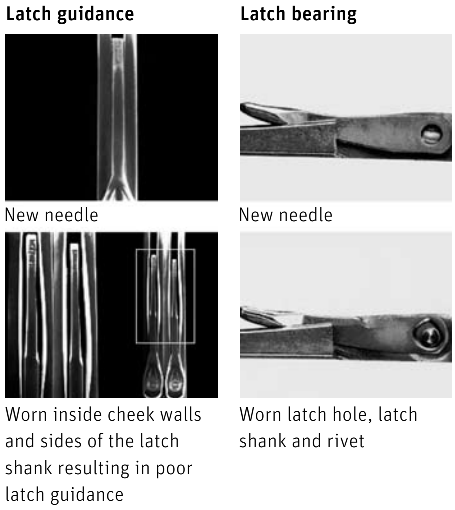


Fig. 20 Needle wear in knitting (Source: GROZ-BECKERT®)

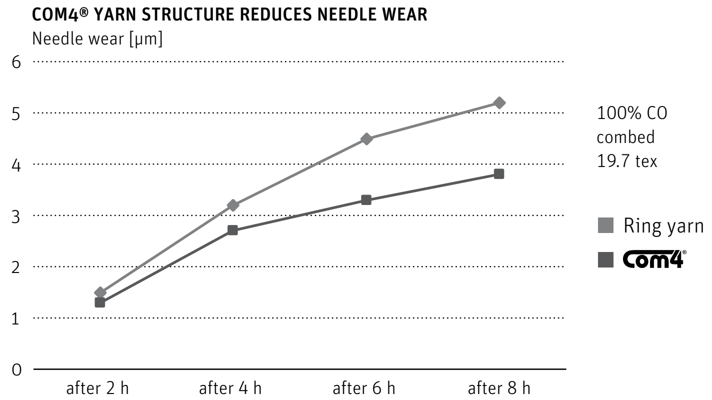


Fig. 21 Reduced wear of needles with COM4® yarn (Source: GROZ-BECKERT®)

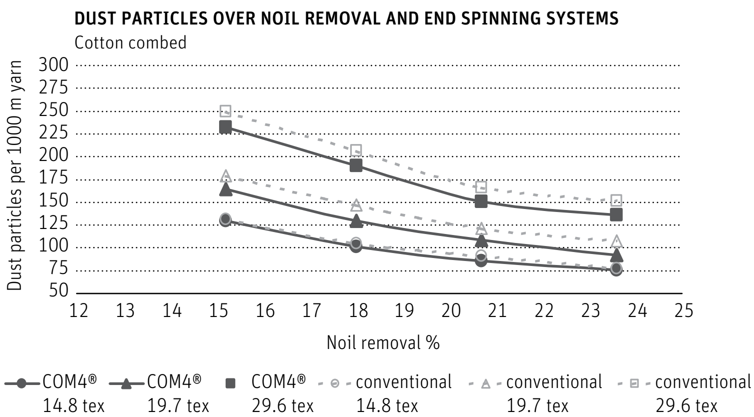


Fig. 22 Less dust particles with COM4® yarn reduce wear on needles

Trash and dust particles can very easily be measured using Uster measuring sensors. With increasing noil removal on the comber, more trash is eliminated. The combing process results in a massive reduction in fine dust particles (<500 μm) in particular. Finally spinning also has a significant influence on dust particle size. Compared with conventional ring-spun yarn, the COM4® yarn shows significantly fewer dust particles when combed cotton is used. Some of the particles can be removed via the suction cylinder or result in reduced particle wear due to improved fiber integration. The COM4® system results in less dust in the yarn, depending on yarn count. Coarser yarns also contain more dust particles due their larger periphery.

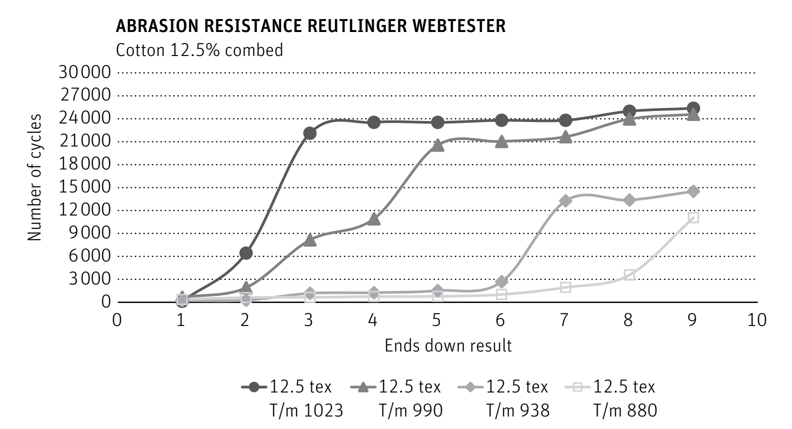


Fig. 23 The abrasion resistance declines with less twist of the yarn (12.5 tex)

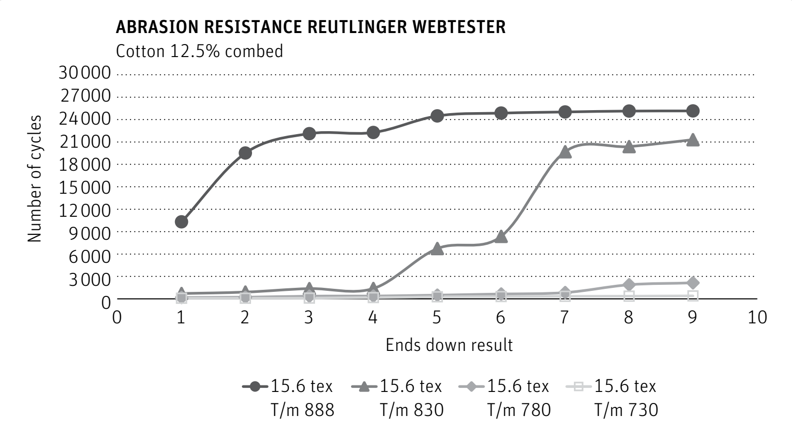


Fig. 24 The abrasion resistance declines with less twist of the yarn (15.6 tex)

ABRASION RESISTANT COM4® YARNS

Abrasion resistance is an important criterion in the downstream stages of yarn processing and the serviceability properties of textile fabrics. The abrasion tendency after a certain number of cycles was tested for this purpose using the Reutlinger Webtester.

This measuring method enables the resistance of the yarns when used as warp ends in weaving to be simulated very accurately. At this point the measured values should be consulted as a criterion for the precision of fiber integration in the yarn. This criterion is also quite interesting for determining how resistant COM4® yarn is in the knitted fabric in comparison to conventional ring-spun yarn. Only the future will show how many opportunities and ideas exist for developing new fabrics with new properties.

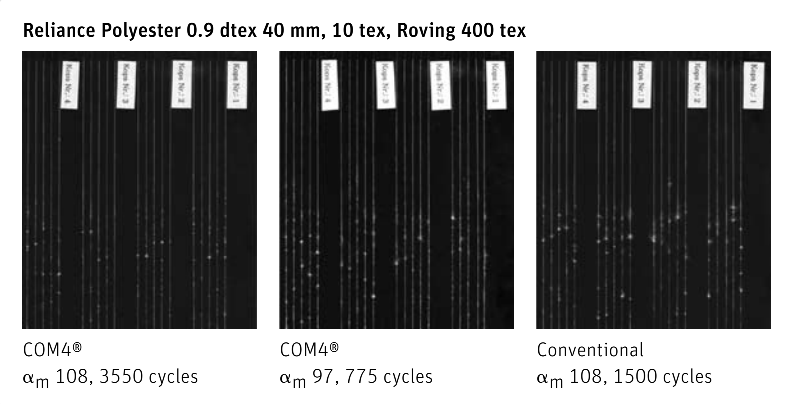


Fig. 25 Abrasion resistance of 100% Micro PES

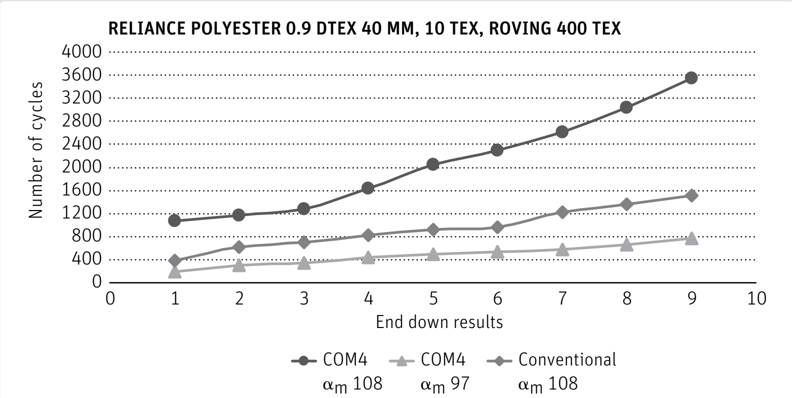
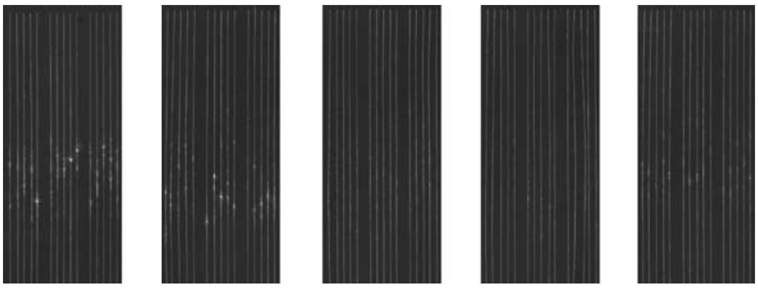


Fig. 26 With the same twist factor COM4® yarn displays a better resistance to abrasion compared to a conventional ring yarn

Compact yarns display a smaller yarn diameter than conventional yarns of the same count. More or less density, i.e. air permeability, can be achieved by means of the final spinning process and the yarn diameter with the same mass per unit area of the knitted fabric. If required, influence can be exercised here by reducing yarn twist in the compact yarn and producing a yarn with more volume by means of reduced twist. There is also potential for developing new articles specifically for end users, both with COM4® and with COM4®twin. However, it must be pointed out that the abrasion resistance of the yarns generally reduces with declining yarn twist, less in the case of finer yarns and more in the case of coarser yarns.

Fig. 25 and Fig. 26 show the relationships between the final spinning process and yarn twist with 100% polyester microfiber.

Abrasion resistance depending on spinning system
Tencel® LF, 0.9 dtex, 34 mm, 15 tex



Ring conventional after 14 cycles | COM4® after 245 cycles | Conventional Siro yarn after 311 cycles | COM4®twin after 330 cycles | Rotor yarn after 49 cycles

Fig. 27 Abrasion resistance of 100% Micro Lyocell

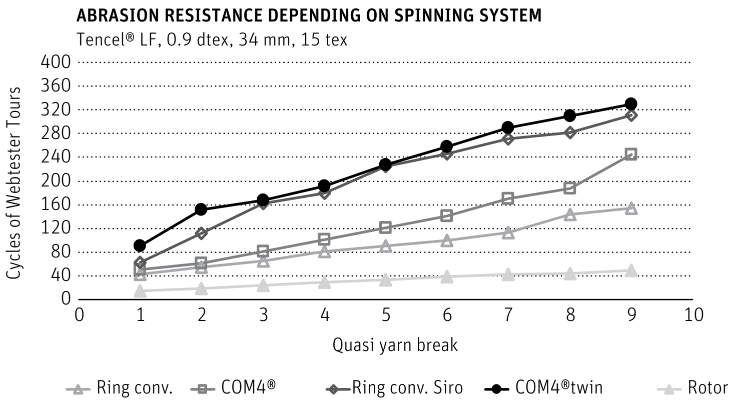
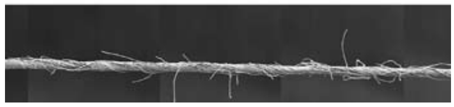


Fig. 28 COM4®twin yarn shows the best abrasion resistance

Tencel® LF, 0.9 dtex, 34 mm, 15 tex

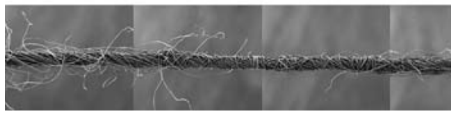
Ring yarn conventional, α_m = 110



Ring yarn COM4®, α_m = 110

Siro yarn conventional, α_m = 110

COM4®twin, α_m = 110



Rotor yarn, α_m = 110

Fig. 29 + 30 The microscope photographs show the different yarn structures

Fig. 27 and Fig. 28 show a comparison between different final spinning processes with 100% Micro Lyocell.

The microscope photographs (Fig. 29 and 30) show the different yarn structures.

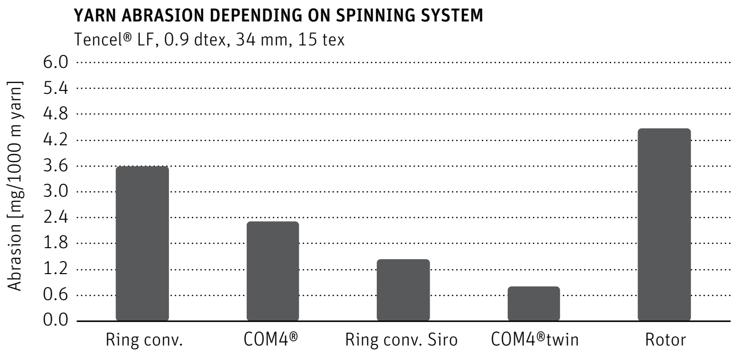
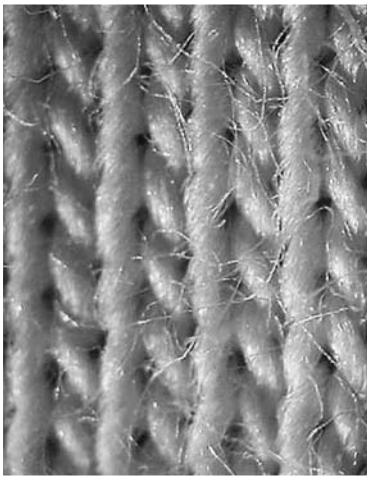


Fig. 31 Yarn abrasion measured in milligram per 1000 m of yarn, comparing COM® with other spinning systems

Knitted fabrics

Perla-A



COM4®

Fig. 32 Hairiness of knitted fabrics, comparing Perla-A and COM4®

ABRASION OF COM4® YARNS

Fiber abrasion can be measured on the yarn. There can also be a direct relationship between high fiber abrasion and fiber fly, depending on yarn loading. Therefore, if high fiber abrasion occurs, this can easily result in higher fiber fly in downstream processing.

Regarding to the abrasion values, the example of Micro Lyocell raw material in COM4® twin displays approx. 4 times less fiber abrasion than conventional ring-spun yarn. The yarn count in all cases is 15 tex and the twist factor α_m 110. The integration of fibers as in a ply yarn means that the fibers are fixed and incorporated in the fiber bundle much more effectively. This results in lower yarn abrasion; yarn abrasion also depends on raw material and yarn count.

HAIRINESS OF COM4® YARNS

Hairiness depends on the following factors:
– fiber length
– yarn twist
– final spinning system
– subsequent treatment of the yarn

High yarn hairiness is usually a disturbing factor. Especially when long fibers stick out from the yarn bundle. Depending on the application, more or less close relationships very often exist between the following characteristic values:
– yarn hairiness
– fiber fly in downstream processing
– fiber abrasion on the yarn bundle
– abrasion resistance of the yarn
– pilling in the knitted fabric

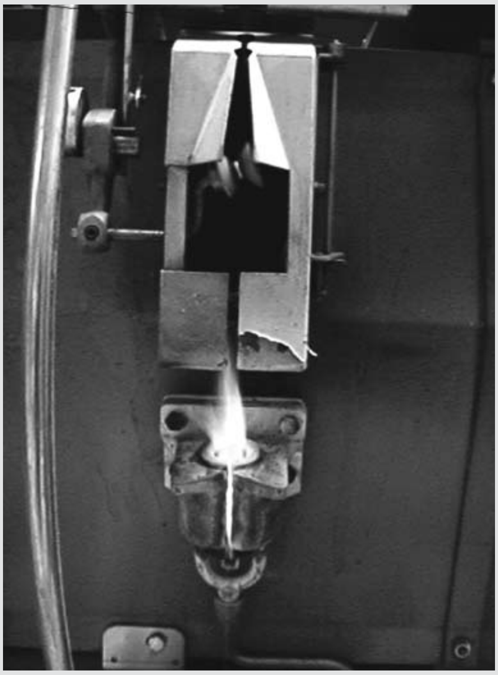
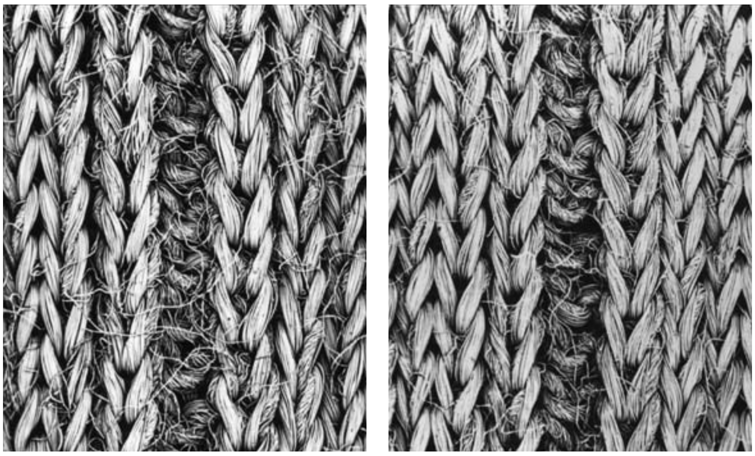


Fig. 33 Yarn singeing unit

Perfect structure



Ring yarn COM4®

Fig. 34 Different knitted fabric appearance of ring and COM4® yarn

For example, high hairiness in combination with relatively heavy yarn loading can result in increased fiber fly. However, relatively low hairiness combined with poor abrasion resistance due to low yarn twist can also result in more fiber fly and higher yarn abrasion. High hairiness also usually proves to result in a higher pilling tendency in the end product.

It has also been shown that low hairiness only has a positive influence on the stated characteristic values when the hair are already integrated and firmly fixed in the yarn bundle during the spinning process. If the yarn bundle is already formed in the spinning process, laying protruding fiber ends on the yarn bundle subsequently by means of air or mechanical force e.g. Perla is not really permanent. The hairs can very quickly become apparent again later in the finished product.

Singeing the yarns in order to obtain the required advantages of low hairiness is technologically possible. It is advisable to avoid this as far as possible for economic and logistical reasons. The final spinning system should rather be required to produce a yarn with low hairiness if necessary. The following profitability analysis can be made if the singeing process is dispensed with.
Supplementary rewinding and singeing result in:
– Production of ash and thus technological problems
– Cotton losses = 5 bis 8 %
– Total costs for 11.8 tex approx. 0,45 USD/kg
– Possible cost reduction 340 to 990 USD per ton

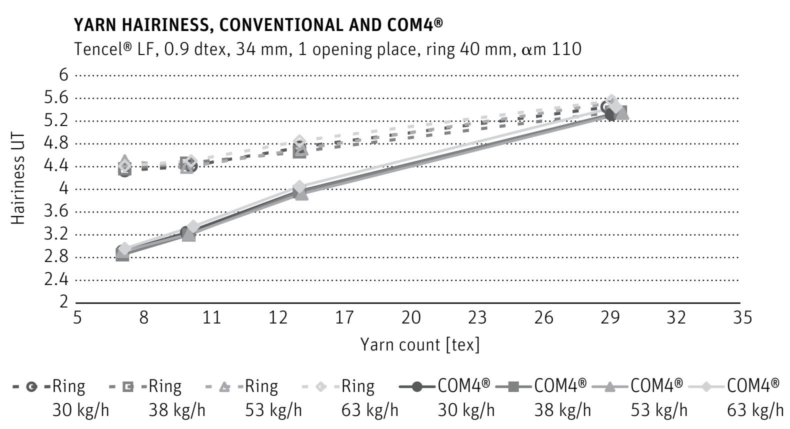


Fig. 35 Yarn hairiness (USTER) subject to yarn count, spinning system and with different card production

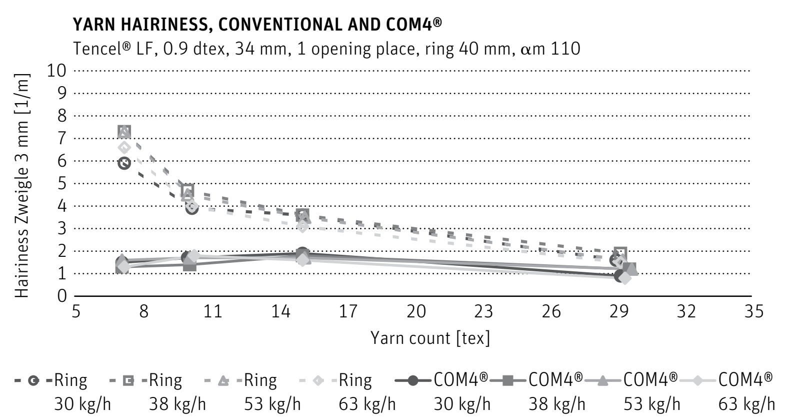


Fig. 36 Yarn hairiness (Zweigle) subject to yarn count, spinning system and with different card production

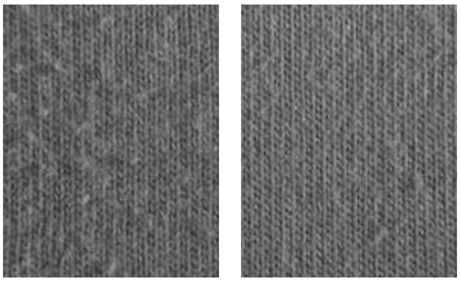
Another important advantage of minimal hairiness can also be a clear loop structure. This advantage is apparent primarily in curl patterns with different yarn colors and large color contrasts. The articles look much finer as a result of the clearly defined loop structure. (Fig. 34)

The massive improvement in hairiness on the COM4® system is illustrated with Micro Lyocell. The hairiness of COM4® yarn measured according to the Uster method is 1.6 points lower than on conventional ring-spun yarn (Fig. 35). The difference in favor of COM4® yarn declines with increasing yarn count, and significant differences are no longer apparent from a yarn count of 30 tex, due to the greater resistance of the fibers to the suction of the air.

Yarn hairiness measured using the Zweigle method is also much lower for the COM4® system, especially for the disturbing long fibers > 3 mm (Fig. 36). The differences also decline in this case as the yarn becomes coarser, and no longer exist from a yarn count of approximately 30 tex on.

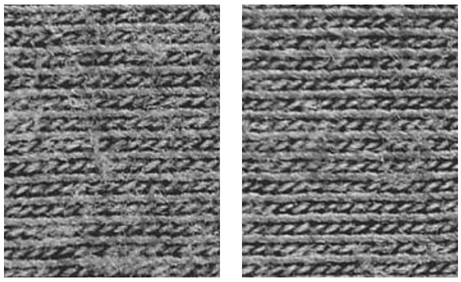
Provided that the given raw material with its short fiber content cannot be changed on cost reason, the only remaining alternative is to choose from the possibilities to set the final spinning machine and from the available final spinning systems.

Less pilling tendency in knitting



Ring yarn COM4®

Better yarn structure for lower pilling tendency knitting



Ring yarn COM4®

Fig. 37 + 38 COM4® yarn tends to less pilling than ring yarn

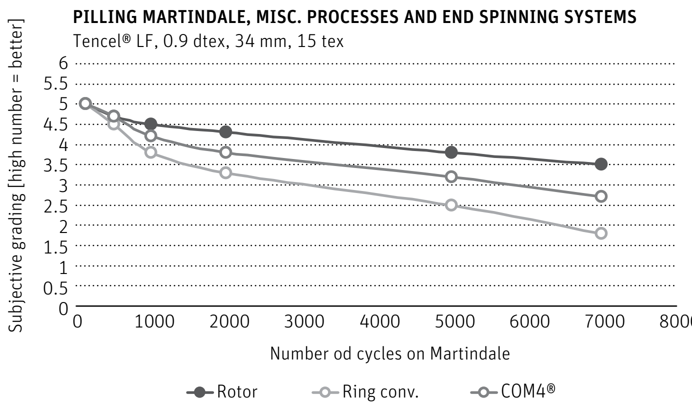


Fig. 39 Pilling resistance subject to spinning system

PILLING COM4® YARNS

Pilling in knitted fabrics is a major problem especially when severe abrasion takes place in use and a raw material has been used, which has a very high pilling tendency due to its fiber properties. Low yarn hairiness while maintaining sufficiently well integrated fibers is a good precondition for preventing pilling when using the knitted fabric. The following illustrations Fig. 37, 38 and 39 show very impressively with the same raw material and the same mechanical loading what advantages can be achieved by using the COM4® system.

Pilling can be quantified by using the Martindale Test as a function of the number of abrasion cycles. The higher the score the better is the rating. The advantages of COM4® yarn compared with conventional ring-spun yarn are clearly apparent in this example when processing Micro Lyocell. Rotor-spun yarn records the best results for the pilling rating.

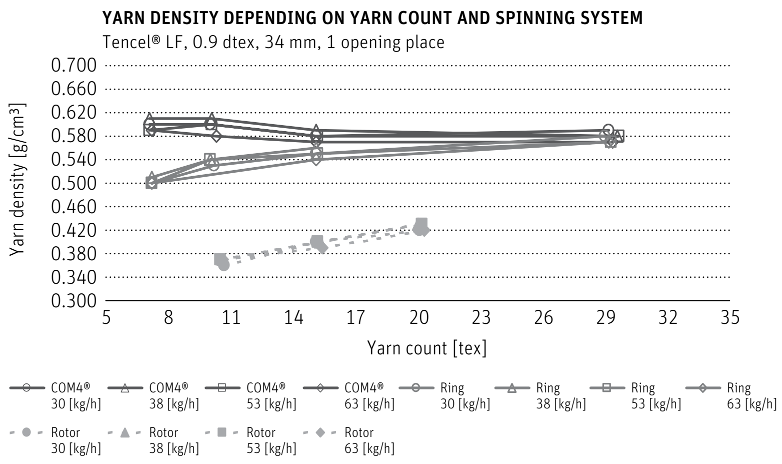


Fig. 40 Yarn density subject to spinning system and different card production

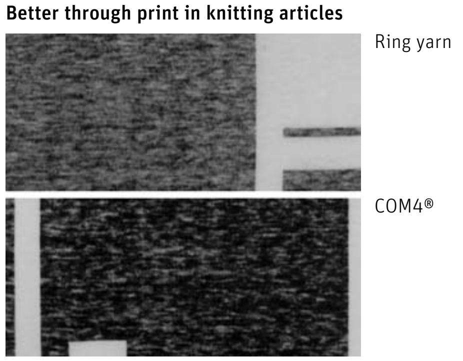


Fig. 41 COM4® yarn tends to have a better dyestuff affinity

FABRIC HANDLE

Soft handle is often required especially in knitted fabrics. Fabric handle can be influenced by the following spinning factors:
– uniform yarn structure
– high yarn density by constant twist
– low twist
– short hairs

Higher yarn density, as in the case of ring-spun yarns, results in a soft handle. If yarn density is very low, yarn volume very high respectively, due to relatively unevenly integrated fibers, the result is a harsh handle.

Due to the higher yarn density on the COM4® system, dye take-up in printing on the knitted fabric was better with the same quantity of dyestuff. The question therefore arises here as to what dyestuff savings can be made while achieving the same printing result, or better contrast while using the same quantity of dyestuffs.

The short hairs in the 1–2 mm range, which are still present in sufficient numbers in the COM4® system, are primarily an advantage for fabric handle. The COM4® system ensures that the disturbing protruding hairs > 3 mm are incorporated in the yarn bundle due to improved fiber integration.

SUMMARY

Altogether following chances and potential arise by using compact yarn in the knitting mill:

- Less dust, fiber fly for less fabric faults
- Reduced needle wear and tear
- Replacement of 2-ply by single with COM4® or COM4®twin
- Extraordinary clear appearance, especially in fancy articles
- Better pilling resistance
- High yarn density on COM4® system help for a soft touch

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