

# Effect of Bended Ratio and Twist Factor on the Mechanical Properties of Nano Silver Antibacterial Polyester Yarns

Dawei Shang<sup>1</sup>, Yuqing Zhang<sup>2</sup>

<sup>1</sup> Qingdao Product Quality Supervision and Testing Research Center, Qingdao, 266071, P. R. China

<sup>2</sup> Qingdao University, No 308 Ningxia Road, Qingdao, 266071, P. R. China

**Abstract:** To discuss the effect caused by twist factor of pure nano silver antibacterial polyester fiber and blending ratio of nano silver antibacterial polyester combed cotton fiber on yarn strength and elongation, nano silver antibacterial polyester was spun purely in different twist factor and in different blending ratio with combed cotton fiber, strength and elongation test and analyses were carried out on the yarns. The result shows that breaking strength and breaking elongation rate of the blended yarn are the lowest when the blending ratio of nano silver antibacterial polyester combed cotton is 41.2/58.8 or 43/57, In the process of production, the blending ratio within the scope of (41.2-43)/(58.5-57) should be avoided as far as possible. Critical twist of pure nano silver antibacterial polyester yarn is about 400.7.

**Keywords** Nano silver antibacterial polyester, Blended ratio, Twist factor, Strength and elongation

## INTRODUCTION

Twist factor and blending ratio of blended yarn are two most important parameters in the design of yarn structure.[Song, et. al., 2017] Regardless of economic principle, the optimal blended ratio corresponds the best comprehensive properties when two or several fibers are assembled into the blended yarns. [Wang, et. al., 2018] A pure spun yarn fiber single label must also have the critical twist factor. [Yang, et. al., 2005] When raw materials and equipment and other process conditions were determined, twist factor and blended ratio were the key to influence the quality of the yarns. [Li, et. al., 2009]

The purpose of this paper is to study the effect of twist factor on the nano silver antibacterial polyester fiber pure yarn and blended ratio on nano silver antibacterial polyester fiber and combed cotton blended yarn strong stretching performance (breaking strength, elongation at break). The influence of for nano silver antibacterial polyester yarn series can provide the guidance to product development.

## MATERIALS AND METHODS

### Preparation of Yarn Samples

Nano silver antibacterial polyester yarns were produced by China petrochemical group Co., LTD, specification is 1.67 dtex×38 mm, and combed slivers were provided by Qingdao spinning united holding group Co., Ltd.

According to the conventional combed cotton spinning process. Cotton assorting 2.2 grade, and quality 31 mm in length, 1.7 dtex fineness of raw cotton.

The nano silver antibacterial polyester fibers are used and the SEM images of cross-section and longitudinal section of the fibers are shown in Figs.1 and 2, respectively.

### Mixed Spinning Method

Using the cotton spinning system, with nano silver antibacterial polyester fiber and combed cotton fiber as raw materials for the spinning, nano silver antibacterial polyester fiber and combed cotton article label pure spun yarn, the nano silver anti-bacterial polyester sliver and combed sliver again on 10/90, 30/70, 30/70, 70/30, 90/10 of the blending ratio, blending yarn. [Xu, 2018]

Blended yarn spinning process, the nano silver anti-bacterial polyester fiber pre article and then blended with combed sliver to design more than three merger hybrid method, fully guarantee the validity of the blended yarn and blended ratio.

### Spinning Process and Yarn Count

Nano silver antibacterial pure polyester yarn.

Nano silver antibacterial polyester fiber→DSBL-01 type digital carding machine →FA304 drawing frame →FA496 roving frame →DSSp-01 type a digital frame.

Nano silver antibacterial polyester combed cotton blended yarn.

Nano silver nti-bacterial polyester fiber pre-drawn & combed cotton→FA304 drawing frame→FA496-12 drawing frame→DSSp-01A digital spinning frame

Considering the comparability, the test results of experiment with the eye, with ingot, made yarn twist

factor, such as spinning, 18 tex count, twist factor of 330.

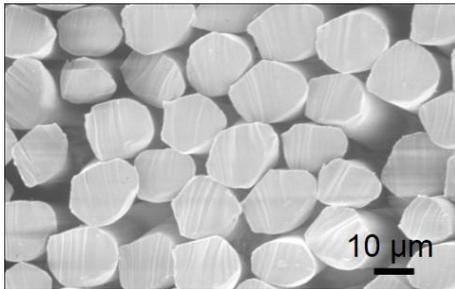


Figure 1: Cross-sectional SEM image of the nano silver antibacterial polyester fibers.

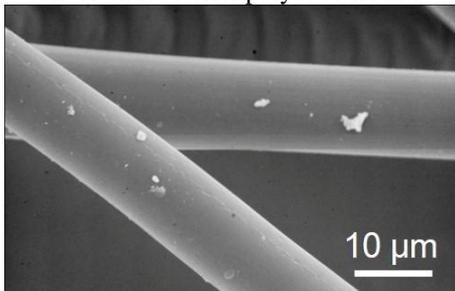


Figure 2: Longitudinal section SEM image of the nano silver antibacterial polyester fibers.

**Spinning Process and Yarn Count**

Nano silver antibacterial pure polyester yarn.

Nano silver antibacterial polyester fiber→DSBL-01 type digital carding machine →FA304 drawing frame →FA496 roving frame →DSSp-01 type a digital frame.

Nano silver antibacterial polyester combed cotton blended yarn.

Nano silver nti-bacterial polyester fiber pre-drawin & combed cotton→FA304 drawing frame→FA496-12 drawing frame→DSSp-01A digital spinning frame.

Considering the comparability, the test results of experiment with the eye, with ingot, made yarn twist factor, such as spinning, 18 tex count, twist factor of 330.

**Performance Test**

With reference to the GB/T3916-19976 textiles, package yarn and single yarn breaking strength and elongation of the determination of standard, adopt YG061F type electronic yarn strength instrument, the spinning experiment of five different blended ratio of blended yarn, nano silver antibacterial polyester fiber and combed cotton fiber pure yarn on tensile properties, breaking strength and elongation at break) test.

Instrument parameter settings are as follows. The tensile fracture speed is 500 mm/min, clamping spacing of the specimen is 500 mm, and the tension is 25 cN. Each yarn sample was experimented for 30 times, and the average was obtained for statistical analysis. The experiments were carried out at a temperature of 20 °C and relative humidity of 65%.

**RESULTS AND DISCUSSION**

Blending ratio on nano silver antibacterial polyester combed cotton blended yarn strong stretching performance impact.

Nano silver antibacterial polyester and combed cotton spinning pure yarn and blended ratio of nano silver antibacterial polyester combed cotton blended yarn tensile properties test results are shown in Table 1.

Table 1: Nano silver antibacterial polyester combed cotton blended yarn tensile properties test results

blending ratio	breaking force(cN)	breaking strength (cN tex <sup>-1</sup> )	Elongation at break(%)
0/100	419.1	23.282	5.70
10/90	365.8	20.321	4.91
30/70	313.7	17.427	4.69
50/50	303.4	16.855	4.30
70/30	244.8	18.599	4.77
90/10	456.5	25.361	5.82
100/0	605.6	33.643	6.76

According to Table 1, the scatter diagram can be drawn using the experimental data of nano silver antibacterial polyester combed cotton blended yarn blending ratio and yarn breaking strength, elongation at break. The relationship between the content (blended ratio) of nano silver antibacterial polyester fiber and tensile breaking strength and elongation at break can be obtained, as shown in Figs. 3(a) and (b), respectively.

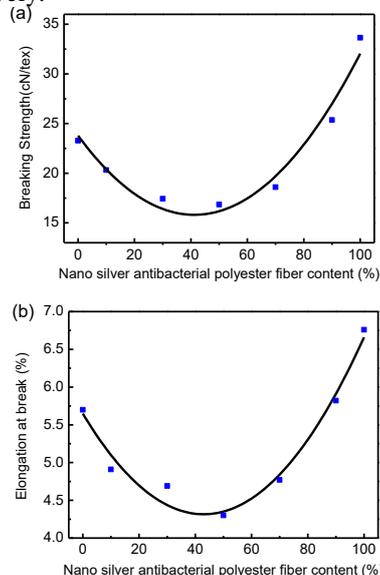


Figure 3: Breaking strength (a) and elongation at break (b) for the nano silver antibacterial polyester combed cotton yarn.

It can be seen from Fig. 3(a) that nano silver antibacterial polyester combed cotton blended yarn breaking strength and the change rule of the bicomponent fiber blended yarn breaking strength. Pure cotton combed yarn breaking strength is higher, with the nano silver antibacterial ratio of blended polyester content increases gradually, the blended yarn breaking strength decreases gradually, the nano silver antibacterial polyester fiber content is 41.2% (blended ratio 41.2/58.8) at a minimum; Then as its content (blended ratio) is gradually increasing until the nano silver anti-bacterial polyester combed cotton blended peak than 100/0.

From Fig. 3(b) it can be calculated that nano silver antibacterial polyester fiber content of 43.0% (43/57 blending ratio) has the lowest blended yarn elongation at break. On both sides blending ratio of 43/57, the elongation at break of antibacterial polyester content gradually reduces and then gradually increases. Combed pure cotton yarn elongation at break is lower than that of the pure nano silver antibacterial polyester yarn elongation at break.

Considering two quality index, breaking strength and elongation at break of nano silver antibacterial polyester combed cotton blended yarn blending ratio

Table 2: Different twist coefficient of nano silver antibacterial polyester yarn breaking strength test results

Twist multiplier	240	260	280	300	320	340	360	380	400
Breaking strength (cN tex <sup>-1</sup> )	29.38	29.91	31.52	31.20	33.27	33.73	32.95	34.18	33.99

According to the experimental data in Table 2, get the twist factor of nano silver antibacterial polyester yarn breaking strength of the fitting regression curve is shown in Fig. 4.

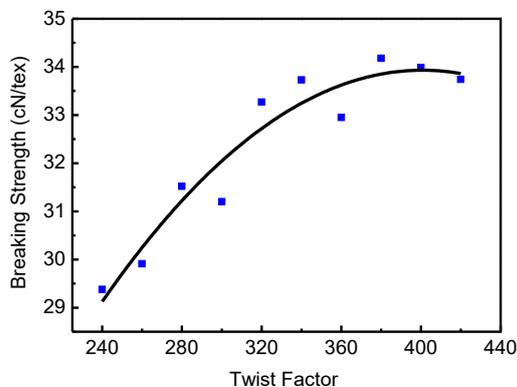


Figure 4: Influence of twist factor on the nano silver antibacterial terylene pure yarn breaking strength.

It can be seen from Fig. 4 that the effect of twist factor on the fracture strength of nano silver antibacterial polyester yarn is very obvious. It gradually increased with the increase of twist coefficient of its breaking strength, reaches the critical value and then declines gradually. On the

in (41.2-43)/(58.8-57) area within the scope of blending ratio on nano silver antibacterial polyester combed cotton blended yarn strong stretching performance is bad, should try to avoid in the process of production the area within the scope of the blended ratio design.

**Twist factor of the influence of nanometer silver antibacterial terylene pure yarn breaking strength**

Different varieties of staple yarn has different critical twist factor. The size of the twist factor directly affects the yarn appearance characteristics, quality performance and the cost of production.

To explore twist coefficient of nano silver antibacterial terylene pure yarn breaking strength, the influence of the above test of nano silver antibacterial polyester roving quantitative (5.0 g /10 m, twist factor 65), on the DSSp-01 type a digital frame, twist factor since the 240-420 interval changes, such as step 20 system with spun twist coefficient of 10 different nano silver antibacterial polyester 18.5 tex cop a number. The tensile properties were tested, and the measured data of tensile fracture strength are shown in Table 2.

twist coefficient X with pure yarn breaking strength Y do regression analysis, have to a quadratic regression equation:  $Y = 1.8589 \times 10^{-4} X^2 + 0.14899 + 4.076 X$ , the correlation coefficient  $R^2 = 0.90315$ .

Through the above equation it can be obtained when  $X = 400.7$ , Y has the greatest value. Thus we can get the critical twist factor of nano silver antibacterial terylene pure yarn was 400.7, and the blended yarn has the maximum fracture strength of 33.9 cN/tex.

**CONCLUSION**

Blending ratio on nano silver antibacterial polyester combed cotton blended yarn strong stretching performance significantly, as the increase of the nano silver anti-bacterial polyester fibre blended yarn tensile breaking strength and elongation at break are present, increase with the decrease of the first and the blending ratio on the blended yarn breaking strength and elongation at break is almost at the same time; Breaking strength and elongation at break when the blending ratio 41.2/58.8 and 43/57, respectively, at a minimum. Think in terms of yarn strength and performance, should avoid as far as

possible in the process of production (41.2-43)/(58.8-57) the critical blending ratio of the range area.

Nano silver antibacterial terylene pure yarn twist factor - the relationship between fracture strength in line with the conic, the critical twist factor near the 400.7 area, can be used in the process of actual production, in order to achieve the best performance and production efficiency.

Nano silver antibacterial polyester combed cotton blended yarn blending ratio design, from the end of the yarn requirements and production cost is taken into consideration to choose the appropriate blending ratio. If you want to fully reflect the characteristics of cotton, the optional is to use a content lower than the critical blending ratio. If you want to fully reflect the nature of the nano silver antibacterial polyester, the optional is to use the content higher than the critical blending ratio.

#### REFERENCES

- Li, Y., Xing, M.J., Zhang, Y., et al., The manufacture and performance test of antibacterial PET/Chitosan fibre blended yarn. *Shandong Textile Science & Technology*, (4), pp. 17-19, 2009.
- Li, Y., Zhang, H., Tian, W., et al., Test and dralon fine pronle acrvlic analyses of yarn strength and elongation. *Cotton Textile Technology*, 42(6), pp. 36-39, 2014.
- Liu, Y., Liu, S.G., Jiang, H., Relativity analyses of yarn twist factor and yarn strength. *Cotton Textile Technology*, 36(8), pp. 15-18, 2008.
- Song, L., Luo, L., Song, J., Zhang, H., Li, X., Cheng, S., Wang, F. (2017). Enhanced photodegradation activity of hydrogen-terminated Si nanowires arrays with different-oriented crystal phases. *Catalysts*, 7(12), 371.
- Tang, W. H., Cotton ring spinning yarn technology route. *Journal of Textile Research*, 8, pp. 8-11, 1991.
- Wang R., Yang C., K. Fang, Y. Cai, L. Hao, Removing the residual cellulase by graphene oxide to recycle the biopolishing effluent for dyeing cotton fabrics, *J Environ Manage* 207 (2018) 423-431.
- Xu P., Research and application of near-infrared spectroscopy in rapid detection of water pollution, *Desalination and Water Treatment*, 122(2018)1-4.
- Yang ,S. T., Modern spinning technology. China Textile Press, pp. 114-121, 2004.
- Yang, Q.B., Zhang, Y.Q., Yu, W.D., Influence of the twist factor and blended ratio on the soybean protein yarn strength, *Journal of Textile Research*, 26(1), pp. 76-77, 2005.
- Yao, M., Science of Textile Material. Beijing China Textile & Apparel Press, 5, p. 238, 2009.
- Yu, Ch., Chang, Y., Shen, P., Theoretic elongation expression for blended yarn composed of dual component fibers and its experimental testing. *Journal of Donghua University*, 28, pp. 18-20, 2002.
- Yu, C. W., Spinning technological design and quality control. China Textile Press, pp. 2-59, 2005.
- Zhang, Y.Q., Yang, Q.B, Zhao, T.Y., Test and analyses of pure and blended Shengma yarn mechanics property. *Cotton Textile Technology*, 36(10), pp. 21-23, 2008.