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Short Communication

Study on the warp and weft direction conductivity of anti-radiation knitted fabric

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Measured by electrical experiments involving knitted warp and weft direction conductivity, we concrete analysis on the factors that affect electromagnetic shielding effectiveness of the knitted fabric. The influence factors of preventing electromagnetic radiation fabric shielding performance is associated with the organization structure and related parameters of knitted fabric. These include: organization type, the metal fiber content, the structure of the yarn or fabric, fabric horizontal (or vertical) electrical conductivity. It was found that the knitted fabric horizontal conductivity is different from the vertical conductivity, and the fabric transverse electrical conductivity is better than longitudinal. When knitted fabric electrical conductivity is good at the same condition, the shielding performance of the fabric is good.

Key words: Conductivity, knitted fabric, organization type, shielding effectiveness.

INTRODUCTION

The weave structure of knitted and woven fabric is obviously different. The two different kinds of fabric structure weaved by the same kind of metal fiber can also form a metal gate or metal mesh, and the electromagnetic shielding performance have obvious differences, and the fundamental reason comes down to its own weaving structure (Feng, 1986; Xie, 1996; Zhu et al., 2012).

Knitted fabric is braided by yarn along the lateral or vertical weaving string set of warp/weft, and woven fabric is composed of warp/weft yarns intertwined. If we analyze from the fabric structure, the knitted fabric weft have a yarn formed, and its lateral electrical conductivity is better. The knitted warp is only composed of a series of coil set between the yarn, and its longitudinal conductive performance is made up of string of suites coil resistance. The knitted warp and weft direction conductivity influencing its shielding effectiveness can be achieved by resistance experiments to further study them (Wang, 1986).

EXPERIMENT

Apparatus required

Stainless steel fiber and silver fiber, the knitted fabric, single-sided cloth, rib fabrics, and siping fabric; Laboratory equipment include: special conductive metal fixture, electricity use table DT9205 etc.

Methodology

First, a certain row and columns of fabric pieces were taken along the knitted fabrics weft and warp direction. Thereafter, the fabric

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Table 1. Siping knitted fabric resistance of stainless steel fiber.

Stainless steel fiber siping knitted fabric (resistance)							Average
Lateral (weft) resistance value ($K\Omega$)	50.5	47.5	46.8	46.2	45.7	49.1	47.6
Longitudinal (warp) resistance value ($M\Omega$)	13.5	13.1	12.65	13.7	18	14.3	14.2

Table 2. Siping knitted fabric resistance of stainless steel fiber.

Stainless steel fiber siping knitted fabric (resistance)							Average
Lateral(weft) resistance value ($K\Omega$)	17.6	18.2	19.8	25.5	27	15.6	20.6
Longitudinal (warp) resistance value ($M\Omega$)	0.567	0.595	0.523	0.691	0.642	0.587	0.601

Table 3. Single-sided weft knitted fabric resistance of stainless steel fiber.

Single-sided weft knitted fabric resistance of stainless steel fiber							Average
Lateral(weft) resistance value ($K\Omega$)	27	26	24	29	30	31	27.8
Longitudinal (warp) resistance value ($M\Omega$)	0.5	0.8	0.7	1.3	1.1	0.9	0.88

was placed on both ends of the special fixture, clamping with zigzag bite, and tightly clamped at both ends of the knitted fabric. Finally, the knitted fabrics in the weft direction conductive resistance and warp conductive resistance were measured, averaging multiple measurements.

EXPERIMENTAL RESULTS AND ANALYSIS

This study was aimed at reporting the weft and warp direction conductivities of stainless steel fiber knitted fabric.

Experiment 1: Stainless steel fiber knitted fabric: siping organization; the weft density: 32/5 cm; the warp density: 51/5 cm.

The knitted lateral and longitudinal length: 17.5 × 6 cm; the knitted longitudinal and lateral length: 17.5 × 6 cm; the data results are shown in Table 1.

Experiment 2: stainless steel knitted fabric: siping organization: the lateral density: 32/5 cm; the longitudinal density: 51/5 cm; The knitted transverse and longitudinal length:6 × 6 cm; the data results are shown in Table 2.

The experimental data measured in Tables 1 and 2 are explicit. First, the knitted fabric of siping organization made of stainless steel is conductive fabric, which is the root cause that has the function of preventing electromagnetic radiation. Second, the fabric as conductive metal gate, the horizontal and vertical conductivity have obvious difference. Although the size of the two pieces of fabric is different, it is clear that the lateral resistance is far less than the longitudinal resistance, and the two different direction resistance value is not in an order of magnitude. Therefore, it can be seen that the knitting siping transverse conductivity is better than that of vertical conductivity of the organization. This feature confirms the characteristics of the knitted fabric horizontal weaving yarn namely along the horizontal knitting set into each other. Formed by a yarn knitted horizontally, the resistance is relatively small; between the longitudinal formed by the horizontal coil series, the series of flat coil connection is not quite close together, so resistance is larger, and lateral connectivity weak in fabric, namely cannot form effective metal gate, which is the important factor that affect the fabric shielding effectiveness. Third, the influence of the length of the fabric on the resistance value is not a simple serial or parallel relationship, in terms of the same fabric structure both transverse and longitudinal, the longer the fabric its resistance value will be bigger.

Experiment 3: Single-sided weft plain knitted fabric stainless steel fibers; Fabric size: 6 × 6 cm; the data is shown in Table 3.

Experiment 4: Stainless steel fiber rib organization; fabric size: 6 × 6 cm; the data is shown in Table 4.

When Tables 2 to 4 are viewed together, it can be seen that not only stainless steel fiber knitted fabric of horizontal and vertical conductivity are different, but also the conductivity of the different knitted fabric structures are different. The conclusion further confirmed from the perspective of conductive fabric that knitted fabric of the

Table 4. Rib organization fabric resistance of stainless steel fiber.

Rib organization fabric resistance of stainless steel fiber							**Average**
Lateral(weft) resistance value ($K\Omega$)	4.6	4.5	4.2	4.3	5.0	5.1	4.6
Longitudinal (warp) resistance value ($M\Omega$)	0.442	0.482	0.445	0.437	0.547	0.397	0.458

organization structure is the important factor that affects fabric shielding effectiveness. The knitted fabric resistance with different structure is unstable, so we must take more pieces of sample averaging measurement. Knitted fabric resistance value is the relationship with the structure of the fiber yarn and fabric structure. As for the knitted fabric of lateral resistance,

$$R_{single} = 27.8K\Omega > R_{siping} = 20.6K\Omega > R_{rib} = 4.6K\Omega \, .$$

As for the knitted fabric longitudinal resistance,

$$R_{single} = 0.88M\Omega > R_{siping} = 0.601M\Omega > R_{rib} = 0.458M\Omega \, ,$$

If knitted fabrics weaved by the same kind of fiber have different organizational structures, both in transverse electrical conductivity and longitudinal conductivity, then single-sided fabrics are weaker than siping fabric, siping weaker than rib, which are determined by the absolute content of metal fiber formed fabrics and which have close relationship with the fabric to form effective metal gate. Each coil is a small metal grid. A completely closed coil is the key that the knitted fabric forms an effective closed loop.

Conclusion

From fabric horizontal and vertical conductivity experiment we can draw some conclusion. Firstly, the transverse conductivity of ordinary stainless steel fiber knitted fabric is better than that of vertical electrical conductivity. As knitted fabric has better electrical conductivity at the same condition, the shielding performance of the fabric is better; the closer fabric knit between the coil set, the more fabric interwoven point contacting area between, the better electrical conductivity. Secondly, for the same fiber, different organization structures imply that the knitted fabric has different conductivity. The conductivity of the metal fiber is better, and knitted fabric of vertical and horizontal conductivity are also better; the smaller the difference between them, the better in shielding properties also.

Thirdly, the knitted fabric conductivity is associated with the type of fiber as well as with the fiber structure. The greater the absolute content of the metal fiber, the better the fabric conductivity, the better shielding effectiveness; the electrical conductivity of the metal fiber filament is better than that of short fibers.

In a word, to improve the electromagnetic shielding effectiveness and the knitted fabric metal fibre to continuous distribution, mutual conduction is an important factor. In order to further improve the shielding effectiveness of blended fabric, on the one hand, by improving the fabric tightness, increase in the density of the fabric articles as well as the stainless steel staple fiber with ordinary fibre mixing are ways to implement.

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