The Process and Property Characteristic of Electromagnetic Shielding Functional Warp Knitted Composite Fabrics

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Abstract

The scientific progress has improved human life quality, meanwhile today's high-stress lifestyle has resulted in a rising demand for health care and well-being products. The high technology products and innovation make our life more convenient and at the same time the negative effects, such as electrostatic and electromagnetic wave. High electromagnetic wave affects the human body in different ways. Technological innovation and product aesthetics are both important for modern life quality. Companies have invested in research, development and essential household items to improve the lives such as thermal retentivity and antistatic. In this study, PET fiber was used as warp, and PET fiber, bamboo charcoal nylon fiber and stainless steel fiber employed as weft to weave three groups of resilient warp knitted fabrics. Then various examination have been conducted, including electromagnetic shielding effectiveness, tensile strength test, tearing strength test, burst strength test. The results indicate that the electromagnetic shielding effectiveness of bamboo charcoal / stainless steel resilient warp knitted fabrics attained 35 dB and the shielding achieved 99.9 %. The tensile strength of bamboo charcoal / stainless steel resilient warp knitted fabrics (weft) reached 26 MPa.

Introduction

Nowadays the development of consumer electronic products has been focused on high performance, precision and light-weight. High density of circuit element and circuit has greatly reduced the volume. However, the concentration of circuit leads to the increase of interference, especially electromagnetic interference, EMI, electronic noise. The electromagnetic interference and electrostatic discharge interference pose a health hazard to human beings. The home electronic products and electro-communication products become more compact and precise in terms of circuit Wiring. The wide usage of consumer electronic products has resulted in the high exposion of various frequency waves. The rising rate of application of chemical fibre cannot interfere effectively shielding electromagnetic interference and electrostatic discharge [1]. Today's high-stress lifestyle has resulted in a rising demand for health care and well-being products. The researchers and experts are devoted to develop and produce functional textile fibers such as bamboo charcoal and stainless steel fiber. Beside the aesthetic aspects of clothing, consumers pay also their attention to the permeability, sweat absorbent and the touch of clothing materials. Due to the structure of needle loop, knitted fabrics possess a high stretch ability, and the slack structure of gray yarn used fit perfectly body curve and suitable for the movement. Different functional textile products have been developed. Since 1997

many scholars have tried to introduce the metallic fiber to produce electrically conductive textiles. Then they changed the structure and type oftextile to enhance the electromagnetic shielding effectiveness. In fact, in order to create the electromagnetic shielding effectiveness, stainless steel fiber, copper fiber, silver fiber, carbon fiber has been used or taking conductive polymer to produce various fibers, films morphology and to coat with the fiber or textile [2-6]. Comparing to metallic material, the fiber-reinforced composite materials has the strengths like lower price, light weight, design flexibility and easy processing. Different products have been developed to meet the demands of markets [7-14].

In this study, PET fiber, bamboo charcoal nylon fiber and stainless steel fiber were used and crochet machine was employed to weave resilient warp knitted fabrics with electromagnetic shielding effectiveness. The tensile strength test, tearing strength test, burst strength test have been conducted to enhance the functional features of textile. The resilient warp knitted fabrics can be applied in the protection of wrist, girdle to offer the health care function.

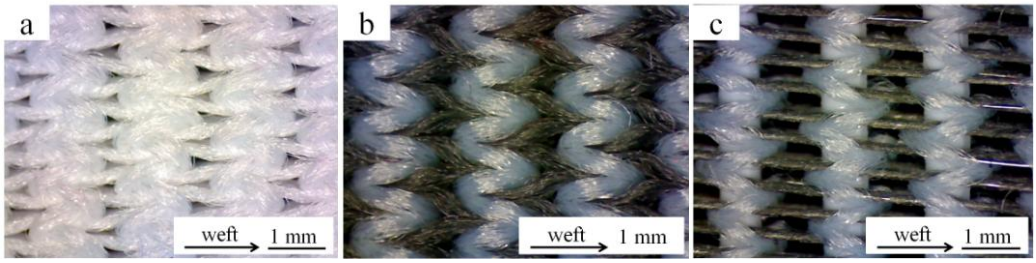
Experiment

Material

PET fiber: fibre fineness: 150 D, 48 f. (made by Far Eastern Co., Ltd.); bamboo charcoal nylon fiber: fibre fineness: 70 D, 36 f, bamboo charcoal content 3 %. (made by Hua Mao Co., Ltd.); stainless steel fiber: diameter: 0.08 mm. (made by Jin Ding Co., Ltd.); rubber thread, number 39. (made by Ta Yi Co., Ltd.)

Method

In this study, PET fiber, bamboo charcoal nylon fiber and stainless steel fiber were used and crochet machine was employed to weave warp knitted fabrics. First group: top and bottom weft PET fiber and PET resilient warp knitted fabrics (Fig. 1a). Second group: bamboo charcoal resilient warp knitted fabrics (Fig. 1b). Third group: weft was twisted with bamboo charcoal and stainless steel warp to produce bamboo charcoal / stainless steel resilient warp knitted fabrics (Fig. 1c). Three groups of resilient warp knitted fabric were then conducted to electromagnetic shielding effectiveness test, tensile strength test, tearing strength test and burst strength test.



Figures.1 (a) PET resilient warp knitted fabrics; (b) Bamboo charcoal resilient warp knitted fabrics; (c) Bamboo charcoal / stainless steel resilient warp knitted fabrics.

Results and discussion

The electromagnetic shielding effectiveness of PET resilient warp knitted fabrics, bamboo charcoal resilient warp knitted fabrics and bamboo charcoal / stainless steel resilient warp knitted fabrics

The results indicate that without metallic fiber, PET resilient warp knitted fabrics and bamboo charcoal resilient warp knitted fabrics have hardly electromagnetic shielding effectiveness (Fig. 2). Adding stainless steel fiber to bamboo charcoal / stainless steel resilient warp knitted fabrics as the weft can create electromagnetic shielding effectiveness. This is because stainless steel fiber has electromagnetic wave removal and reflection functions. In fact, the key is (μ), the rise of μ would increases the intensity of magnetic field. The optimal electromagnetic shielding effectiveness was 35 dB and electromagnetic shielding effectiveness attained 99.9 % which meet the standard for livelihood standard (20 dB).

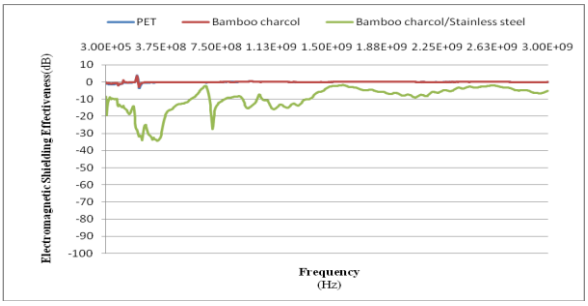


Figure. 2 The electromagnetic shielding effectiveness with the change of weft (PET fiber, bamboo charcoal, bamboo charcoal / stainless steel) in resilient warp knitted fabrics. (warp: PET fiber, rubber thread; weft: bamboo charcoal nylon fiber, PET fiber, stainless steel fiber)

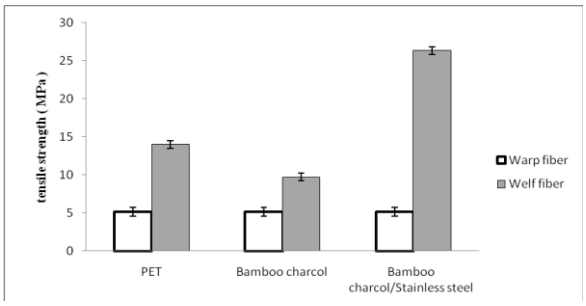


Figure. 3 The tensile strength with the change of weft (PET fiber, bamboo charcoal, bamboo charcoal / stainless steel) in resilient warp knitted fabrics. (warp: PET fiber, rubber thread; weft: bamboo charcoal nylon fiber, PET fiber, stainless steel fiber)

The tensile strength test of PET resilient warp knitted fabrics, bamboo charcoal resilient warp knitted fabrics and bamboo charcoal / stainless steel resilient warp knitted fabrics

The results indicate that PET resilient warp knitted fabrics has a higher tensile strength than bamboo charcoal resilient warp knitted fabrics (Fig. 3). This due to the PET fiber is stronger than bamboo charcoal nylon fiber. The weft change of bamboo charcoal nylon fiber to PET fiber would reduce the tensile strength. When adding the stainless steel fiber in the weft, which has higher strength than PET fiber and bamboo charcoal nylon fiber, therefore bamboo charcoal / stainless steel resilient warp knitted fabrics possess the highest tensile strength (26 MPa). Concerning the tensile strength, there was no significant different among the three groups of resilient warp knitted fabrics. This is because of the force inheritance of PET fiber and rubber thread, and not related to bamboo charcoal nylon fiber and stainless steel fiber.

The tearing strength test of PET resilient warp knitted fabrics, bamboo charcoal resilient warp knitted fabrics and bamboo charcoal / stainless steel resilient warp knitted fabrics

The Fig. 4 shows the tearing strength of three types of resilient warp knitted fabrics. the force inheritance were mainly PET fiber and rubber thread. And because the latter has a high tensile strength which exceeded the limit of machine, therefore, the data was not available.

In terms of weft, the tearing strength of bamboo charcoal resilient warp knitted fabrics is higher than PET resilient warp knitted fabrics and bamboo charcoal resilient warp knitted fabrics. The reason is because of the high content of bamboo charcoal per unit area, and which enhance the tearing strength. The tearing strength of bamboo charcoal / stainless steel resilient warp knitted fabrics is similar to PET resilient warp knitted fabrics. Actually, it is because the smooth surface of stainless steel fiber has decreased the binding force among fibers. The bamboo charcoal resilient warp knitted fabrics has a better tearing strength which is 2.6 MPa.

The burst strength test of PET resilient warp knitted fabrics, bamboo charcoal resilient warp knitted fabrics and bamboo charcoal / stainless steel resilient warp knitted fabrics

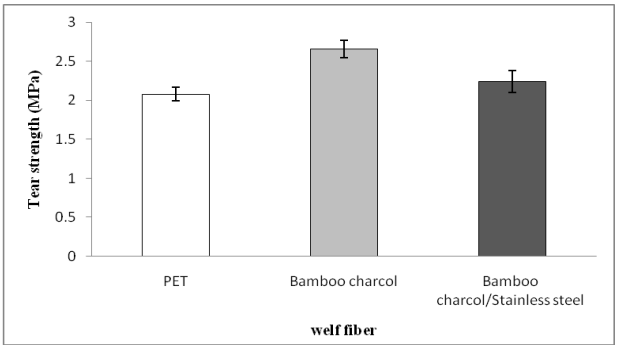


Figure. 4 The tearing strength with the change of

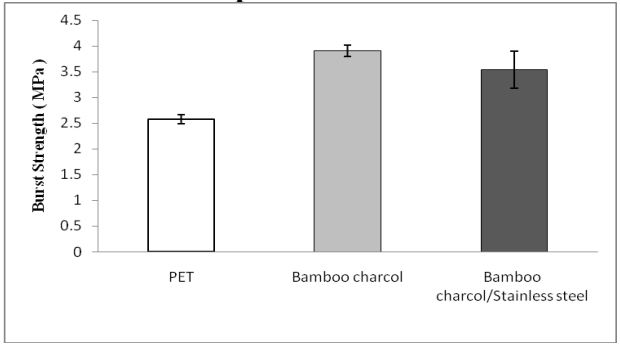


Figure. 5 The burst strength with the change of

weft (PET fiber, bamboo charcoal, bamboo charcoal / stainless steel) in resilient warp knitted fabrics. (warp: PET fiber, rubber thread; weft: bamboo charcoal nylon fiber, PET fiber, stainless steel fiber)

weft (PET fiber, bamboo charcoal, bamboo charcoal / stainless steel) in resilient warp knitted fabrics. (warp: PET fiber, rubber thread; weft: bamboo charcoal nylon fiber, PET fiber, stainless steel fiber)

The burst strength test refers to the durability and rupture index of knitted fabrics under the external pressure variation. According to the Fig. 5, bamboo charcoal resilient warp knitted fabrics has the highest burst strength, following by bamboo charcoal / stainless steel resilient warp knitted fabrics, and the lowest is PET resilient warp knitted fabrics. Concerning the fiber properties, stainless steel fiber has the highest strength, following by PET fiber and bamboo charcoal resilient warp knitted fabrics is the last. The added weft of bamboo charcoal resilient warp knitted fabrics as two units of bamboo charcoal nylon fiber, the content of fiber per unit is higher than PET resilient warp knitted fabrics and bamboo charcoal / stainless steel resilient warp knitted fabrics, therefore it has the highest burst strength 4 MPa.

Conclusion

This research refers to the processing technology and features evaluation of electromagnetic shielding functional composite. The results indicate that the electromagnetic shielding effectiveness of bamboo charcoal / stainless steel resilient warp knitted fabrics attained 35 dB and the shielding achieved 99.9 %, and which meet the standard for livelihood standard (20 dB). Concerning the tensile strength test, bamboo charcoal / stainless steel resilient warp knitted fabrics has the best tensile strength in weft (26 MPa). In terms of warp, PET fiber and rubber thread have similar tensile strength. The bamboo charcoal resilient warp knitted fabrics achieve the optimal results in both tearing strength test and burst strength test, with the data 2.6 MPa and 4 MPa, respectively.

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