The application of biomass graphene functional fabrics reflects

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Abstract. In the construction and development of modern society, in the face of increasingly high clothing comfort requirements, research scholars in the development of existing fabrics at the same time, more attention to reflect the ecological concept of green comfort. Graphene, as a two-dimensional layered carbon, has strong antibacterial, electrical and mechanical properties. By combining biomass graphene with traditional textile industry, it provides a new idea for the innovation and development of modern textile industry. It can not only guide textiles to develop steadily in the direction of high quality and multi-function. It can also meet the functional needs of social residents such as windproof, thermal adjustability, durability, antistatic and so on. Therefore, on the basis of understanding the current research status of the application of biomass graphene materials, this paper mainly explores how to integrate the biomass graphene and textile industry together, and then uses practical cases to clarify the application value of graphene, in order to accelerate the pace of innovative development of our garment industry.

Keywords: Biomass; Graphene; Natural fiber; Chemical fiber; Nonwoven fabric.

1. Introducion

In the development of modern society, graphene as a new nanomaterial, the thickness of a single layer is only 0.35 decimeter, about 1/10,000 of the diameter of a human hair. From the perspective of practical application, graphene mainly presents the following characteristics: first, excellent mechanical properties, both strength and hardness are very high; Second, strong optical properties, high transparency and stability in practice; Third, excellent electrical conductivity; Fourth, large specific surface area and stability, with strong energy storage performance; Fifth, with excellent antibacterial and bacteriostatic effect. Due to its excellent physical and chemical properties, graphene has gradually become a core topic of research and discussion in the field of textile industry in practice and exploration, and is widely used in the field of functional fibers and intelligent textiles, such as intelligent clothing, far infrared fibers, antibacterial fibers, etc. With the continuous improvement of modern science and technology and the continuous improvement of social and economic level, the preparation process of graphene is becoming more and more simple. This kind of biomass has been widely used in different fields, showing a broader prospect for development.[1-3]

The graphene modified fibers are made by adding graphene to the spinning process to ensure that the resulting textile material is antibacterial and deodorant, thermally-insulated, UV resistant and of high quality. Today, common fiber improvements include the following types: First, polyester fiber. Because polyester fiber production process is relatively simple, with strong wear resistance, elasticity, corrosion resistance and other characteristics, so it is widely used in the field of clothing technology. However, with the continuous improvement of social economy and science and technology, consumer groups' requirements for clothing technology are not limited to durability and comfort and other functions, but also pay more attention to improving the appearance and quality of clothing. Therefore, some researchers have applied graphene in the modification of polyester fiber. Second, polyamide fibers. Polyamide fiber is widely used and effective synthetic fiber. Although it has the characteristics of high elasticity, strong wear resistance and high breaking strength, it also has the problems of poor light resistance and low heat resistance. According to the practical investigation and research, some scholars have carried out optimization innovation with GO, mainly based on melt spinning and in-situ polymerization to prepare GO modified nylon 6 fiber, and finally the nylon pull-up performance has been improved. Some scholars have also applied graphene in polyamide spinning solution to prepare composite nanofibers using electrospinning technology, which can not only improve the thermal stability and electrical conductivity of nanofibers, but also effectively control the fiber diameter. And finally, cellulose fibers. As one of the most common textile raw materials, cellulose fiber has unique properties such as softness, comfort, moisture absorption and so on. Some scholars have added different proportions of graphene to the cellulose textile industry. After making corresponding composite fibers, experiments have proved that the electrical conductivity of fibers is positively correlated with the content of graphene. Some scholars have also studied the bacteriostatic performance of cellulose fibers doped with different graphene contents, and found that with the continuous increase of graphene content, the bacteriostatic performance will gradually increase. When the graphene content reaches 0.285%, the bacteriostatic performance can meet the international standard.[4-6]

Therefore, based on understanding the status quo of technology development in the clothing industry in the new period, this paper mainly verifies the unique advantages of graphene in the clothing industry innovation and development based on the application of biomass graphene functional fabric, so as to improve the level of economic development in the clothing field.

2. Methods

2.1 Natural Fibers

Natural fibers refer to behaviors that occur in the natural environment and can be obtained by natural growth or artificial cultivation, such as silk and cotton. According to natural silk produced and used in recent years, although it contains a large number of polarity groups, graphene does not contain any active groups and is insoluble in water or other organic solvents, which results in graphene having a load on textiles, so natural fibers and fabrics can only be treated in the following ways.[7-9]

First, the coating method. In this method, the fabric is placed in a mixture of graphene and adhesives. Using a "roll-baking" or "roll-baking" process, the graphene is attached to the fabric with the help of adhesives. The process conditions and types of fabric are not affected, and the need for multi-functional treatment can be truly realized.

Secondly, in situ reduction method. This method uses the active groups on the GO lamellar to undergo covalent binding reactions with some fabrics. After obtaining the GO modified fabric, the GO attached to the plant can be in-situ reduced into graphene or reduced GO by chemical reduction or thermal reduction, so as to improve the plant performance.

Again, layer by layer self-assembly method. This method is a technology that makes use of some affinity characteristics between polymer compounds as membrane driving force in the solid or liquid interface to make them spontaneously bond and alternately deposit into multilayer films. Due to the variety of polymer compounds, the driving force of film formation is more complex, such as coordination bond, hydrogen bond force, electrostatic force, etc. According to different driving force, it can be divided into two methods, one is electrostatic adsorption, the other is chemical crosslinking.

Finally, feeding silkworm rearing method. This method is based on the improved graphene method proposed by silk. A Tsinghua scholar sprayed graphene suspension on mulberry leaves eaten by silkworm larvae and then collected cocoon. The common crystals in this treatment are arranged in an orderly manner, which are much stronger and tougher than ordinary silk, and have strong electrical conductivity.

2.2 Chemical Fiber

Chemical fiber refers to the natural polymer compounds or synthetic polymer compounds, in the man-made processing made of fibrous objects, you can get two kinds of fibers, on the one hand refers to the regenerative fiber, on the other hand refers to the synthetic fiber. From the perspective of practical application, the recycled fiber is the raw material of natural cellulose, which is made into solution after a series of chemical treatment, and then flows through the spinneret hole of spinning machine under pressure and solidified into filament strips in coagulation bath. For example, viscose fibers, which have the same chemical composition as natural cellulose, can be treated with graphene and its oxides to form composites using blending silk in addition to in-situ reduction. In essence, blending silk method refers to the process of making chemical fibers, adding an appropriate amount of graphene and its oxides, so as to generate corresponding chemical fibers and effectively improve the application performance of the original polymer.

2.3 Nonwovens

Nonwoven fabric, also known as non-woven fabric, refers to the textile staple fibers or filaments arranged in a directional or random way to form a fiber network structure, which is then reinforced by chemical, thermal bonding, mechanical and other methods. From the perspective of practical application, nonwovens have high production quantity, low application cost and fast production speed, and are widely used in construction, aerospace, medical and other fields. In addition, graphene and its oxide can also be modified by grafting modified layer self-assembly, impregnation, spthorns, etc., so as to achieve multi-functional application treatment of nonwoaves, and expand the application field of this kind of materials. For example, impregnation method is one of the simplest improvements. Some scholars attach graphene oxide to polypropylene nonwovens. After the addition of graphene oxide, the nonwovens have higher oil absorption and improved both mechanical and antistatic properties. Although this method is very simple to operate, nonwovens have no active groups, so the ability to adsorb graphene and its oxides is low, limiting the practical modification effect. In order to further improve the treatment effect of nonwovens and improve the fastness of GO and its binding, some scholars proposed to use graft modified in-situ reduction method. First, the nonwovens were grafted, and then the GO was treated on the nonwovens, and then the GO was reduced to graphene by in-situ reduction method. In this way, the multifunctional treatment of nonwovens could be completed.

3. Result analysis

After clarifying the application of biomass graphene in different textile fabrics, this study prepared the raw materials needed for the experiment, and conducted inspection and analysis according to the national basic safety technical specifications for textiles and sample requirements of chemical fiber knitted underwear through the process steps of grey fabric weaving, density inspection, cloth inspection and repair, soft treatment, dehydration, drying and shaping. Finally, the following research results can be obtained:[10-15]

First, the physical performance test results of the fabric are shown in Table 1 below:

Table 1 Physical properties of fabrics

test item	pH value	Formaldehyde content	Decomposable aromatic amine dy（mg/kg$_{-1}$）	rare delicacy	Colour fastness to dry rubbing/grade	Colour fastness to saliva/grade		Colour fastness to acid and perspiration/grade		Colour fastness to alkali perspiration/grade		Colour fastness to washing/grade	
						change colour	staining	change colour	staining	change colour	staining	change colour	staining
testing result	6.9	Not detected	Not detected	without	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

Based on the analysis of the above table, it can be seen that all indexes of the biomass-graphene fabric studied in this paper meet the Class A standard, which proves that the surface of this kind of textile will not have harmful effects on human body.

Second, the antibacterial performance test results of the fabric are shown in Table 2 below:

Table 2 Results of bacteriostatic properties of fabrics

project	Antibacterial rate of Staphylococcus aureus	Bacteriostasis rate of Escherichia coli	Bacteriostasis rate of Candida albicans
Biomass graphene functional fabric	88.6	86.7	75.6

According to the analysis in Table 2 above, the antibacterial rate of biomass graphene fabric can reach more than 80% against Staphylococcus aureus, more than 70% against Escherichia coli and more than 60% against Candida albicans.

Third, the moisture absorption and quick drying performance test results of the fabric are shown in Table 3 below:

Table 3 Results of moisture absorption and quick drying properties of fabrics

project		Quick drying		hygroscopicity		
		Moisture permeability $[g.(m^2.d)^{-1}]$	Evaporation rate/ $(g.h^{-1})$	Drip diffusion time /s	Wicking height /mm	Water absorption/ %
Biomass graphene functional fabric	Before washing	10300	0.22	1.6	106.3	257
	After washing	10300	0.23	1.3	109.7	309
Contrast sample	Before washing	10000	0.23	6.6	104.0	270
	After washing	10400	0.24	92.6	75.0	286

According to the analysis of the above table, all indexes have reached the standard requirements, which proves that the thermal conductivity of this kind of fabric helps the composite fabric to dry quickly.

Fourthly, the UV protection performance test results of the fabric are shown in Table 4 below:

Table 4 Results of UV protection properties of fabrics

	$T(UVA)_{AV}/\%$	$T(UVB)_{AV}/\%$	$(UPF)_{AV}/\%$	UPF value of sample
Biomass graphene functional fabric	0.95	0.89	112.23	＞50
Contrast sample	12.31	9.94	9.35	9.16

Based on the above analysis, it can be seen that the two-dimensional surface structure of biomass graphene has a strong light reflection efficiency, which is mainly released by absorbing high-energy ultraviolet rays into fluorescence or phosphorescence, so as to achieve effective protection.

Fifth, the antistatic performance test results of the fabric are shown in Table 5 below:

Table 5 Results of antistatic properties of fabrics

project	Half life/%
Biomass graphene functional fabric	0.7
Contrast sample	0.6

According to the above analysis, the half-life of the fabric is 0.7 seconds, which is higher than that of the ordinary fabric of 0.6 seconds. This proves that the addition of graphene can effectively reduce the resistivity of the fiber surface and quickly leak out the generated electrostatic charge, so as to control the friction coefficient and electrostatic charge.

Conclusion

To sum up, as a new material, graphene itself has a very broad development space and application prospects, and has been widely concerned by scientific researchers in various fields. From the perspective of the textile field, graphene and its oxides have antibacterial, anti-ultraviolet, conductive and other properties, so future research scholars should continue to explore graphene and its oxides, and pay attention to the important role of smart textiles and green printing and dyeing.

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