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Nano-material Preparation Technology in Anti-skid and Anti-bacterial Ballet Shoes

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Abstract: As people pay more and more attention to human health, dance movement is also accepted by more people and plays an important role in modern life. Ballet shoes are the foundation of ballet dancers and also important equipment. Only by wearing non-slip dancing shoes can you actively demonstrate your dancing talent. Therefore, the research on the preparation of dancing shoes and anti-slip and antibacterial is based on the safety and health of dancers. The development of nanotechnology is accepted by the world. In this paper, a fast sol-gel method is used to organize nanomaterials to improve the antibacterial durability of dancing shoes. Through the antibacterial performance test, the best preparation process of antibacterial fabrics was explored. Through the experimental exploration of this article, compared with ordinary materials, the average burst strength of nano-materials is reduced by 8.86%. Therefore, nanomaterials still have a certain value in ballet shoes.

1. Introduction

In recent years, with the exploration and research of nanomaterials, people have found that nanomaterials have good chemical stability. With people's exploration and research on nanomaterials, they are also widely used in the field of anti-skid. Due to the good properties of nanotechnology, it is applied to the soles of sports and dance sports shoes, knee pads and lumbar intervertebral discs. Nanomaterials are a new type of functional polymer compounds, which have various special physical and chemical properties, such as high surface energy and strong antibacterial properties. Nanomaterials can form a dense protective layer on the surface of the shoe, thereby preventing harmful substances and various toxic gases.

Ballet is a form of dance performance with strong artistic expression. It uses music, art and many other factors to show characters and plots. Ballet has entered us as an art form. Ballet shoes are made up of small squares. It must not only show elegance and fashion, but also be flexible, changeable, and flexible to meet the various needs of different groups of people. The "ballet" in dance moves can not only show elegant texture and graceful posture, but also has a unique personality. In daily life, people can learn about different nationalities, regional cultural differences, historical traditions and other aspects of each country through body language; besides work and study, we can also feel their unique style and temperament, have a deeper understanding of ballet.

With people's in-depth understanding and appreciation of ballet, the production of ballet shoes has also aroused the interest of ballet lovers. The application of nanomaterials to the production of ballet shoes is a new attempt. Therefore, it is meaningful to study such topics. There are many theoretical results on the preparation of nanomaterials and their application in ballet shoes. For example, PiYang uses FT-IR, XRD, Raman, etc. to characterize nanomaterials [1]. Yang Yingying said that bacterial infections threaten human health [2]. LiuJunli believes that the modified MMT/ZnO/GQDs nanocomposite material is made by a water bath process, and montmorillonite (MMT) is used as the carrier of zinc oxide (ZnO)/graphene composite quantum dots to effectively prevent the agglomeration of nanoparticles and the recombination of electrons and holes of ZnO quantum dots on the surface [3]. ZhangJingtao synthesized a gold (Au/TiO2) modified nanocomposite material made of titanium oxide with surface plasmon effect through precipitation, acidification and calcination. It is characterized by its antibacterial properties and tested [4]. GuanRenquan said that MoS2 is one of the typical transition metal sulfides. It has a narrow energy band gap and has broad application prospects in catalysis and lubrication [5]. CaiHai studied the mechanical properties of aluminum nitride on polyethylene nanocomposites [6]. Therefore, nanomaterials have many functions, and the antibacterial properties of ballet shoes can be designed from nanomaterials.

The innovation of this article is to study the properties and characteristics of nanomaterials, and then propose the role of nanomaterials in ballet shoes. Therefore, hypotheses are put forward and experiments are designed. Through the common sense of ballet shoes, the preparation of nanomaterials that may be applied to them, and the UV spectrum test, explore the relationship between the fluorescence intensity of P-TA and hydrogen peroxide and the formation of hydroxyl radicals. Moreover, this article also carried out the AAS analysis method to compare the reaction measured by the absorption spectra of silver ions. The relevant results of the experiment tell us that nanomaterials have a strong antibacterial effect, so the antibacterial effect of ballet shoes can start from the material, adding nano elements to achieve the antibacterial effect.

2. Application and Performance of Nano Material Preparation Technology in Anti-Slip and Anti-Bacterial Ballet Shoes

2.1. Antibacterial and Anti-Slip Effects of Nanomaterials

Studies have shown that when the size of the same substance is reduced to the nanometer level, the surface environment of the substance will also change significantly. The catalytic effect has also undergone great changes. Nanocomposites have many excellent properties that other materials do not have. Its nano-scale structure provides more possibilities for further modification and modification of materials, and better ductility. With the rapid development of biotechnology and inorganic chemistry, it also provides more and better technical and basic support for the synthesis and application of nanomaterials, and further promotes the application of new nanocomposite materials [7-8]. The special properties of nanocomposites include the following aspects:

Humans can make nanomaterials in many ways. The chemical vapor deposition process refers to a process in which different gas molecules react with each other to form the desired compound on the surface of the substrate. The nanomaterials produced by chemical vapor deposition have high purity and uniform particle size distribution. In fact, the chemical vapor deposition process makes it possible to produce the necessary nanomaterials on a large scale. Plasma sputtering refers to the use of radio frequency electricity to ionize inert gas, atomize it from the target, and then drop it onto the coated substrate. The plasma spraying process has the advantages of simple equipment, fast film formation, close connection between the substrate and the coating, and uniform layer thickness [9-10]. The sol-gel process involves using metal alkoxides as precursors under liquid phase conditions, and forming a sol in solution after the reaction. The solvent is combined and dried to obtain nanomaterials. Using the sol-gel method, purer nanomaterials can be produced under mild conditions. The hydrothermal method is the most commonly used synthesis method. The temperature of the hydrothermal reaction is generally not high, which is conducive to the synthesis of low melting point compounds [11-12].

(1) Classification, properties and sterilization mechanism of antibacterial agents

The antibacterial material mainly plays an antibacterial effect is an antibacterial agent. Natural antibacterial agents are mainly obtained from extracts of organisms (such as chitosan, hinokitiol, mugwort, etc.). Inorganic antibacterial agents are divided into two categories according to their antibacterial action mechanism. Natural antibacterial agents are chemically unstable and have limited antibacterial activity. Organic antibacterial agents are easy to decompose. The decomposition products are toxic and have a short shelf life. These shortcomings limit their applications. Inorganic antibacterial agents are not easy to produce drug resistance, and have the characteristics of good stability, broad antibacterial spectrum and long-lasting antibacterial effect. Among inorganic antibacterial agents, silver antibacterial materials have the best antibacterial properties, the most in-depth research, and the most widely used [13-14].

(2) Application of carbon-based nanomaterials in the field of antibacterial

Graphite is composed of layers of carbon atoms. Scientists use certain methods to exfoliate layers of carbon atoms to create a single-layer structure of carbon atoms, known as graphene. Structurally, the honeycomb structure of graphene oxide is a flat hexagonal layered structure composed of carbon atoms arranged next to each other. The electrons in carbon atoms combine to form an infinite electronic lattice. Graphene oxide can encapsulate pathogens. The splitting of the graphene layer destroys the cell membrane of pathogens [15-16].

(3) Performance evaluation of antibacterial agents

Antibacterial agents have the function of inhibiting or slowing down the growth and reproduction of fungi, bacteria and molds. The antibacterial effect is mainly reflected by the MIC value. Inject a certain amount of test bacteria into the sterilized liquid medium, add different quality antibacterial agents, and vibrate for a period of time at an appropriate temperature to observe whether the bacteria grow [17-18].

The lower the MIC, the better the antibacterial effect. Antibacterial agents are selective; that is, the same antibacterial agent has a strong inhibitory ability against certain types of bacteria, while its inhibitory ability against other types of bacteria is weak, or even has no antibacterial effect. We hope that the prepared antibacterial agent has a broad antibacterial spectrum. Compared with organic antibacterial agents with unstable chemical properties, poor heat resistance, and poor UV resistance, antibacterial agents containing metal ions generally have better durability. The antibacterial shelf life is closely related to the existence, combination and location of antibacterial agents. The better the slow-release performance of the antibacterial agent, the more durable the antibacterial agent and the longer the service life. Excellent heat resistance is one of the conditions that many materials must meet in the production, and the processing and use of antibacterial agents puts forward particularly high requirements for heat resistance. The active ingredients of inorganic antibacterial agents can still maintain excellent antibacterial properties under high temperature conditions, while organic antibacterial agents generally have antibacterial activity under low temperature conditions. Products made of processed antimicrobial agents are closely related to life, which requires the safety of antimicrobial agents. Some antibacterial agents are volatile, irritate the skin, cause genetic mutations, etc. Therefore, antibacterial agents must be safe [19-20].

(4) Antibacterial properties of metal nanomaterials

At present, the main antibacterial metals are silver, copper, zinc, iron, cobalt, nickel and other metals. So far, nano silver has the best antibacterial properties. The morphological characteristics of nano-silver have an indirect effect on the antibacterial performance, the most important of which is the release of silver ions. Therefore, the antibacterial activity of nano-silver can control the release of silver ions by controlling the oxidation, the size of the nanoparticles and the type of coating.

Silver-based antibacterial agents are selective and toxic antibacterial agents. Studies have shown that a small amount of silver ions has no obvious harmful effects on cells in human tissues. The antibacterial properties of nano silver antibacterial active ingredients are far superior to traditional antibacterial properties.

It is believed that the silver ions produced by the dissolution of silver nanoparticles and the silver ions released in the body are the products of the reaction of silver nanoparticles with H2O2. The possible mechanism of its response is:

$$2Ag + H_2O_2 + 2H \rightarrow 2Ag + H_2O \tag{1}$$

In eukaryotic cells, this reaction may occur in the mitochondria, where there is an important H+. Similarly, a similar mechanism may appear in bacterial cell membranes where proton motility occurs. Another possible mechanism for the oxidation and dissolution of silver nanoparticles can be expressed as:

$$4Ag + H_2O + O_2 \rightarrow 4Ag + 40H \tag{2}$$

Silver ions are known to have antibacterial properties. Therefore, the ions released from silver nanoparticles are at least part of the reason for their antibacterial properties.

(5) Nano antibacterial material of TiO light touch media series

The photocatalytic antibacterial agent TiO 2 has high antibacterial activity after being treated by the dispersion method. Studies have shown that the instant effect of the medicament after the nano-TiO is mixed and calcined is good, and it can instantly disinfect the body.

Studies have shown that wearing shoes for a long time has poor air permeability and the sweat on the feet is not easy to evaporate. For a long time, people have been trying to find a good method of antibacterial and deodorization, such as: studying the factors that affect the comfort and hygiene of finished shoes, changing the upper and lining, and changing the shape and structure of the shoes. But the effect after production is not very satisfactory. Spray volatile substances (camphor, borneol, tea, etc.) on the sole to remove the peculiar smell in the shoe cavity.

Adsorbent materials (activated carbon, etc.) can produce strong adsorption force due to the high surface energy and large area of these materials to absorb the peculiar smell in the shoe cavity. Antiperspirant, the use of this type of substance can shrink the sweat glands to achieve the purpose of deodorizing the shoe cavity. Used as an odor suppressant for insoles and shoes.

(6) Nano composite coating

When the nano-modification method is adopted, the modification effect of the nano-particles is very good when the amount is small, which can give the composite coating more excellent performance. In the field of coatings, the most commonly used modified nano-materials are nano-SiO2, TiO2, CaCO3, Al2O3 and ZnO. Utilizing the high surface energy of nanomaterials can increase the possibility of bonding, crosslinking and compounding with the components of the coating, thereby reducing the coating performance of all aspects. The nanocomposite emulsion finally significantly improves the strength and scratch resistance of the acrylic coating , Shielding, gloss, adhesion, high and low temperature resistance and transparency.

2.2. Ballet and Ballet Shoes Production

The sports training of ballet is performed in a natural, relaxing and enjoyable way in a single moment. It is not just simply imitating human body movements. At the same time, it can also make people feel that what art brings is the fusion of spirit and material, continuous innovation and development, and perfect integration, resulting in beauty and the enjoyment of beauty. The emotional experience, etc., needs to be the most authentic through the actors. Therefore, any excellent ballet work is shown to the audience by the dancers with their own unique and superb technical means. In modern ballet, because of its unique beauty, it is valued by many people who appreciate art.

The shoes that ballet dancers wear when dancing are similar to ordinary soft-soled sneakers. It's just that the front part of the fabric is glued layer by layer with special glue to solidify it into a hard head. There is a small flat area at the front end (some wood and metal); the sole has a rubber sole, and the outer side of the sole has a leather sole. The ballerina can stand up using a splint and use the level of her little toes to fix her center of gravity. The studs are different from ordinary sports shoes with soft soles. The front part of the fabric is glued layer by layer with special glue to solidify it into a hard toe cap. There is a small flat surface at the front end, and the sole has a shoe plate. The rubber is the leather bag bottom. When a ballerina gets up, she uses a splint and uses the small area of her toe to fix her center of gravity.

The composition of shoes and the composition of materials are shown in Figure 1:

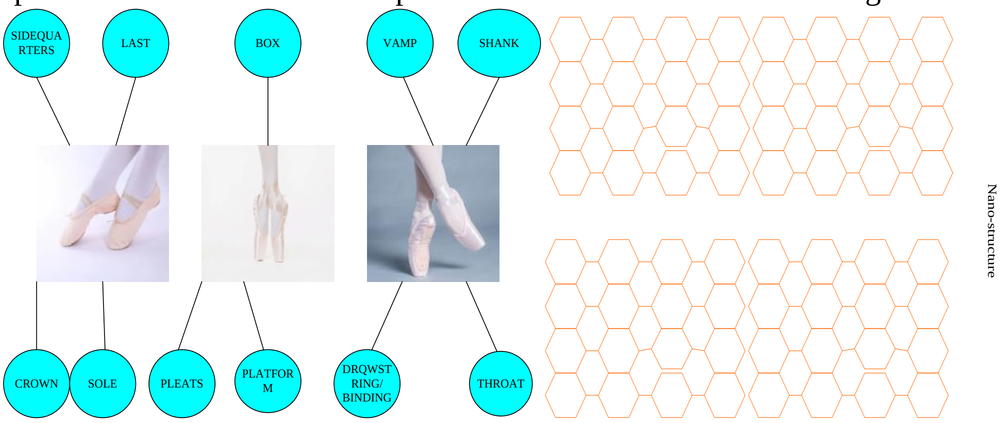

Figure 1. Composition of ballet shoes and nanomaterial structure

LAST (shoe last), making models of dancing shoes. BOX (toe cap), help the actor stand on the tip of the toes. VAMP (shoe upper) refers to the part from the front FLATFORM to the tightening belt. The throat of the shoe, viewed from above, is the part that allows the foot to be raised and flattened to expose the instep. DRQWSTRING / BINDING, by tightening the shoelaces, the toes can better adapt to the shape of the foot. PLATFORM (horizontal), at the end of the toe. The actors rely on this plane to stand on tiptoes. PLIES (folds), located on the lower front of the shoe. The dancing shoes are pleated here and embedded in the sole. SIDE HAND, a piece of dancing shoe on the side of the shoe, sewn on the heel. The sole, leather outsole is used for traction. The sole is sewn to the upper. UPPER (shoe bone), this is the "backbone" of the entire pair of shoes. Below the sole line is the bottom plate of the shoe, which serves to support the arch of the foot. This part is usually divided into two types, soft and hard, to meet the needs of different foot types.

The service life of ballet shoes usually depends on the level of support provided by the inner bones of the shoes. With the long-term use of toe technology, the bones in the shoes gradually lose their elasticity and support. During this period, the shoes need to be replaced to ensure the safety of the feet.

Girls' ballet shoes are divided into three categories: the former are soft shoes, and soft shoes are also divided into two categories: full-soled and split shoes. There are also many types of soft shoes, mainly leather, satin and canvas. The leather is stronger; the canvas feels comfortable and breathable. The second category is half toe. Since soft shoes do not have a hard sole, do not stand on your toes. The third category is everyone's favorite pointe shoes, which are also worn by dancers in ballet performances.

From the upper material to the sole to the toe, special materials are used to wrap them layer by layer to make them wear-resistant and flexible. The fabric of the shoes is also made of more comfortable and soft fabrics, which make the ballet shoes wear-resistant, fit and comfortable when dancing.

2.3. Wearability Test of Antibacterial Fabric

Taking into account the throat, humidity and smell of shoes, many measures have been taken at home and abroad. Some aim to improve the breathability of shoes, and prevent the odor of the feet by destroying the living environment to kill bacteria, and some are in the shoes. The midsole and insoles use high hygroscopic material, and antibacterial, antibacterial and bactericidal drugs are used to prevent foot odor. At present, the main domestic use is the organic antibacterial fungicide A-bromocinnamaldehyde, spices and octadecanoic acid. Experiments have proved that bromocinnamaldehyde has a good antibacterial and bactericidal effect, but one in a thousand people are allergic to bromine and use octadecanoic acid to reduce the secretion of foot sweat glands and prevent foot odor. The antibacterial agents used in Japan and the United Kingdom are all antibacterial agents treated with Ag^{+}, which can inhibit the growth of bacteria in a large amount. We believe that the key to solving the peculiar smell of shoes is: not only antibacterial and sterilization, but also durability, function and value ratio can be accepted by the market, suitable for large-scale industrial production, and easy to operate.

In ballet, the role of shoes is to provide them with comfort, nature, and at the same time have a certain anti-slip function. If the ankle joint, back swing pelvis and lower limb muscles are injured in ballet exercises, ballet uplift can be used to remedy it. In ballet, there are many movements that require the body's back to be compressed by sweat or limbs and then expand and stretch to form a complete continuous movement process, so there are great requirements in terms of soft opening.

Kreb's 30% anti-slip is immersed in 1% ester water to produce special liquid bubbles in the water, and then this liquid is injected into the rubber. Because it can prevent bacteria and molds from destroying the leather surface structure, internal structure and external environmental factors. When 60%-100% anti-cancer agent is added, it can effectively prevent the intrusion of sand and dust and prevent microbial contamination. 30% Kreb anti-skid refers to a kind of liquid bubble, when it is immersed to 50%, a certain anti-skid effect is achieved. The ester water forms a special fluid film in the water. Since zinc is easily decomposed, it is easy to produce iron oxide, lead and other elements. Therefore, when zinc comes into contact with the human body, it can easily cause tendinitis or muscle pain. If the softness requirements are high, too much force or too little force should not be used, so as not to damage the sole and seal. The abrasion resistance of the soft belt can cause problems such as a large number of slippage and damage to the elastic membrane on the skin.

Add dispersant to improve the uniformity of the colloid and increase flexibility by stirring or soaking. At the same time, it can also change the effect of fibrous surfactant on the substrate, thereby reducing the shrinkage deformation capacity and the reduction of elastic modulus caused by the nature of the material itself.

2.4. Preparation Technology of Nanomaterials

Nano-material manufacturing technology is to uniformly mix, disperse and stir materials with a particle size of less than 1m and unique structures and properties in a ball mill room to produce a surfactant-based reaction material. Arc polymerization is a simple and easy method. This method is relatively simple, efficient and reliable to solve the synthesis problem. However, this method requires a lot of labor and must control large reaction conditions to achieve the desired effect. In addition, there are other technologies such as surface finishing, Ultrasonic treatment and other technologies to produce nano-scale materials or metal oxide films.

There are two main methods for preparing nanomaterials, namely, surface chemical method and physical co-precipitation method. Surface chemistry: Use metal ions or atoms in organic compounds to directly react with the matrix to produce new elements. This method is currently one of the most widely used, simple, fast and efficient synthetic methods. Physical co-precipitation is also called solvent extraction water treatment technology, which involves proper separation, purification and dissolution of substances to remove certain pollutants and special components that are difficult to dissolve in wastewater.

There are three main types of nano-antibacterial agents we have come into contact with: zinc oxide (ZnO), titanium dioxide (TiO2) and composite silver ions (Ag+). These three kinds of antibacterial effects are better, long-lasting and strong support. ZnO can be directly used as a medium or mixed with alcohol. Although TiO2 is more stable than ZnO and TiO2 is resistant to Ag, it is recommended to use -N-TiO2.

The Ag-N-TiO2 nano sol uses pure cotton pin dancing shoes as the carrier substrate, and is produced through a rapid sol-gel process, so that the subsequent freezing process occurs directly on the dancing shoes. Wrap the dancing shoes on the trolley at a pressure of 2 kg/cm ^{2}to remove excess gel. The Ag-N-TiO2 photocatalytic antibacterial mechanism is as follows:

Photogenerated hole reaction:

$$H_2O + h^+ \rightarrow \bullet OH + H^+ \tag{3}$$

$$OH^- + \mathrm{h}^+ \rightarrow \cdot OH \tag{4}$$

Photo-generated electron reaction:

$$O_2 + \mathrm{e}^- \rightarrow \cdot O^{2-} \Rightarrow H_2O + \cdot O_2 \rightarrow \cdot OOH + OH^- \tag{5}$$

$$2 \cdot OOH \rightarrow O_2 + H_2O_2 \Rightarrow H_2O_2 + E^- \rightarrow \cdot OH + OH^- \Rightarrow H_2O_2 + O_2{}^{2-} \rightarrow \cdot OH + OH^- \tag{6}$$

In dark conditions, nano-TiO2 has almost no bactericidal effect, but the prepared photocatalytic antibiotic Ag-N-TiO2 still has an excellent bactericidal effect, thanks to the antibacterial effect of doped silver ions. The antibacterial mechanism of silver ions under dark conditions is mainly contact sterilization.

Ultraviolet-visible diffuse reflection absorption can characterize the absorption of ultraviolet and visible light by photocatalytic antibacterial agents. The formula for calculating the prohibited bandwidth is as follows:

$$E_f = 1240 / \beta \tag{7}$$

In the formula: β is the corresponding wavelength; E_f is the effective band gap width.

The interaction between rubber and filler is calculated using the Park and Lorenze equations:

$$\frac{R_a}{R_b} = xf^{-c} + y \tag{8}$$

a and b refer to vulcanizates with and without fillers respectively, c is the weight fraction of fillers in the vulcanizates, and x and y are constants.

Soak the cured sample in toluene at 25℃ for 48 hours to reach equilibrium swelling, then remove the sample and dry the toluene. The amount of toluene absorbed per gram of rubber is calculated by the formula:

$$R = \frac{Q_t - Q_e}{Q_1 \times \partial} \tag{9}$$

Q_t is the weight when swollen, Q_e is the weight after drying, Q_1 is the weight at the beginning, and ∂ is the weight fraction of rubber in the rubber composite.

3. Preparation Experiment of Nanomaterials in Ballet Shoes

3.1. Experimental Raw Materials and Nanomaterials

(1) Prepare and produce antibacterial samples and nanomaterials antibacterial samples according to the antibacterial experiment plan:

Add antibacterial nanomaterials to prepare a midsole squeegee to make a special-shaped sponge: first, add the antibacterial composite nanomaterials to the general dispersion of the squeegee midsole (water-soluble) in the grinder, and then prepare the squeegee and scrape it on the midsole. Each pair of midsole fabric contains 2 grams of nanomaterials, which are then glued to the sponge blank without deodorant.

The sponge material is added with antibacterial nanomaterials to prepare molded sponge: the antibacterial composite material is added to the molded sponge material and mixed, each pair of wool contains 3g, and the blank is reduced to 4 pairs of vulcanized midsole fabrics to make the bottom of the molded vulcanized sponge.

Make a regular-shaped deodorant sponge: directly mix α-bromocinnamaldehyde into the molded sponge, and each pair contains 2g of α-bromocinnamaldehyde.

(2) Experimental reagents

Butyl titanate, urea, silver nitrate, absolute ethanol, nitric acid, anhydrous disodium hydrogen phosphate, sodium hydroxide, 75% alcohol disinfectant.

(3) Experimental equipment

Magnetic stirrer, constant pressure dropping funnel, electric heating blast drying box, UV-visible spectrophotometer, digital camera, eddy current vibrator, washing fastness tester, pneumatic trolley, electronic dance shoe power machine, digital Air permeability meter, digital whiteness meter, dance shoe style meter, pH meter.

3.2. Material Preparation

Under ice bath conditions, 70.0ml sodium borohydride was added to 20.0ml silver nitrate solution and magnetically stirred for 10 minutes. Add 0.04 g of sodium citrate and stir for another 25 minutes. A light green solution is obtained. Centrifuge at 10,000 rpm for 5 minutes. Store the solution in a refrigerator at 4 ℃ for later use.

Weigh 70.0 mg polyvinylpyrrolidone, dissolve it in 180.0 ml GO solution, and stir for 25 minutes. Centrifuge at 10,000 rpm for 18 minutes and at 7,500 rpm for 10 minutes. The precipitate was dissolved in 1800 ml of water. A brown solution with a concentration of 2 mg/ml was obtained. Take 30.0 liters of the above solution and add 1400 milliliters of silver nanoparticles. Let the ultrasound work for 4 minutes and overnight.

3.3. Experimental Method

Add 3000ml of freshly prepared LB medium to each of the three culture flasks, and add a certain amount of newly prepared GO, Ag, GQD or GQD-Ag to make the final concentration of material Es 10 μg/ml. Incubate for 12 hours with shaking at 25,160 rpm. Calculate OD, repeat 3 times, take the average and calculate the error bars.

The survival rate of bacteria is calculated as follows:

$$E = \frac{\exp Number}{\text{con } Number} \times 100\% \tag{10}$$

Among them, E represents the survival rate of bacteria, $\exp Number$ represents the number of colonies in the experimental group, and $\text{con } Number$ represents the number of colonies in the control group.

According to the requirements of each experiment, prepare 4×(n+2) carefully sterilized 200ml conical flasks, where n is the type of sample to be tested, including standard samples. For each sample to be tested, 4 conical flasks are prepared in parallel. Put the flasks into 4 flasks marked with standard symbols. Each flask contains 0.75 grams of sterilized, pretreated and chopped white cotton dancing shoes and a certain amount of antibacterial agent or antibacterial tissue and take out 3 in each vial without sample was added as a blank value control, and finally 60ml of PBS buffer with a concentration of 0.03mol/l was put into each bottle of 100ml test tube, and sealed with Parafilm in time. The concentration of viable bacteria in the flask before and after each sample is contacted and shaken is calculated using formula (11) after 24 hours:

$$N = c \times s \tag{11}$$

In the formula: N is the concentration of viable bacteria, c is the average number of colonies; s is the dilution factor.

Take 30 mg of the prepared GO and 30 mg of dopamine hydrochloride and add them to 150 ml of Tris buffer, and sonicate the mixed solution for 5 minutes. The mixed solution was placed in a 60 ℃ water bath and stirred for 24 hours. When the reaction time has passed, add 5 ml of AgNO3 solution prepared at 10 mg/ml, and add 30 mg of dopamine hydrochloride to ensure that Ag + is reduced to nano-Ag. The reaction solution was centrifuged and washed several times and placed in a refrigerator at -20℃ for several hours. The frozen sample was taken out and dried in a freeze dryer for 48 hours. Store the prepared sample in a sealed bag for later use.

Inoculate 100 μl of the bacterial suspension into an Erlenmeyer flask, which contains different doses of Ag-PDA-RGO dispersion. The final volume in Erlenmeyer is 10 mL. Incubate the Erlenmeyer flask in a shaking incubator at 37.2℃ and 100 rpm for 1 hour. The control sample was prepared by a similar procedure, and there was no Ag-PDA-GERD for standard comparison. Take a 100 μl aliquot of the bacterial suspension, distribute the dilution on the agar plate, incubate at 37℃ for 24 hours, and count the colonies the next day. The total number of bacteria in the bacterial suspension obtained at each concentration was cultured in an Erlenmeyer flask for 1 hour, and then 100 μL was distributed on the agar plate at the same dilution ratio, and the number of bacteria increased after 24 hours. Use formula (12)

$$X = \frac{a_1 - a_2}{a_1} \times 100\% \qquad (12)$$

In the formula, a_1 and a_2 respectively represent the number of bacterial colonies in the blank sample and the sample with the antibacterial agent added.

4. Results and Discussion

4.1. UV Spectrum Absorption of Tetramethylbenzidine Reagent

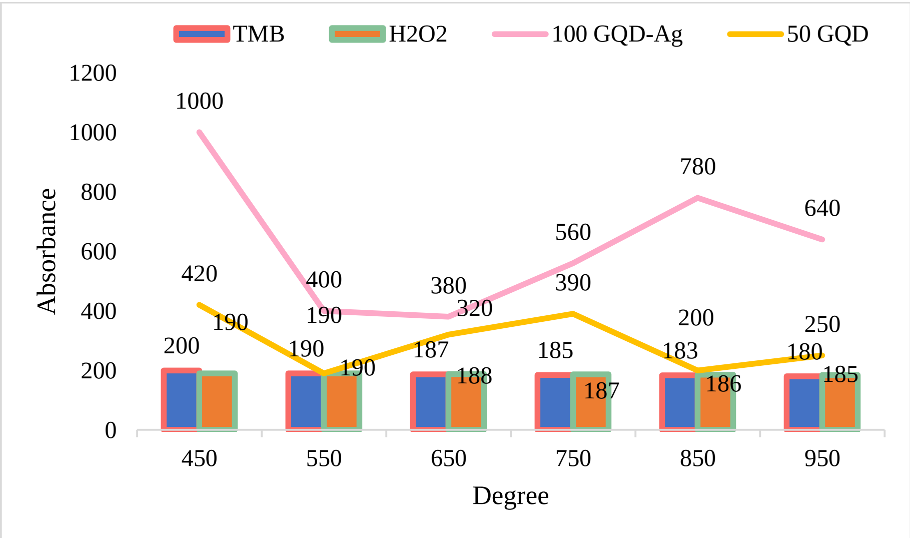

Figure 2. UV absorption of TMB

As shown in Figure 2, TMB single hydrogen peroxide and the mixed solution showed no UV absorption after the color reaction time. However, if GQD or GQD-Ag is present in the solution, the UV absorption of the solution will be obvious. As the material concentration increases, whether it is a solution containing GQD or GQD-Ag, the UV absorption gradually increases.

4.2. The Relationship between the Fluorescence Intensity of p-Ta And Hydrogen Peroxide and the Formation of Hydroxyl Radicals

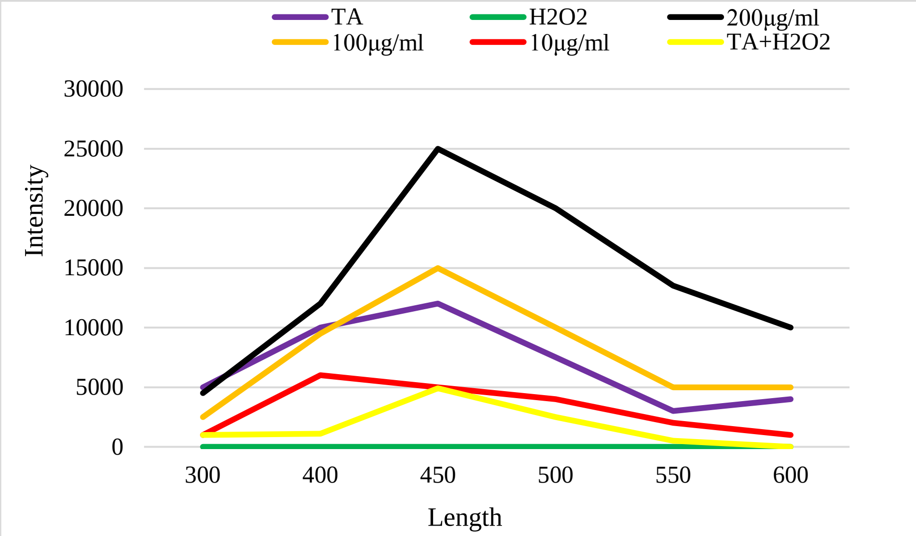

Figure 3. The Relationship between the Fluorescence Intensity of P-TA and Hydrogen Peroxide and the Formation of Hydroxyl Radicals

As shown in Figure 3, P-TA and hydrogen peroxide alone do not fluoresce. When p-TA is mixed with hydrogen peroxide, the solution will produce weak fluorescence, indicating that hydrogen peroxide is partially decomposed to form hydroxyl radicals under normal conditions. As the concentration of GQD-Ag increases, the fluorescence intensity gradually increases. This shows that GQD-Ag can catalyze the decomposition of hydrogen peroxide and generate hydroxyl radicals.

4.3. UV-Visible Diffuse Reflectance Absorption Spectrum Analysis

The doping of silver element can introduce defects in the surface lattice of nano-TiO2, forming photo-generated electrons. And the ratio of its different concentrations, the absorbed ultraviolet spectrum is different.

Table 1. The absorption sideband and forbidden band width of the prepared series of photocatalytic antibacterial agents

Sample type	60 ℃ heat treatment		125 ℃ heat treatment	
	λ/nm	Eg/eV	λ/nm	Eg/eV
Q1	360	3.34	366	3.28
Q2	399	3.11	402	3.05
Q3	421	2.91	408	3.01
Q4	429	2.87	421	2.92
Q5	424	2.90	423	2.89

Note: Q1~Q5 means different proportion of photocatalytic antibacterial agent.

It is seen from Table 1 that the band gap of the antimicrobial increases with the silver doping at the same heat treatment temperature. This may be due to the doping of A g ions in the nanoscale TiO2 lattice, reducing the band gap and the energy required for electrons to enter the guide band from the valence band of the impurity level.

4.4. AAS Analysis

The concentration of residual Ag ions in the reaction solution was measured by atomic absorption spectroscopy, and then the amount of nano silver produced was calculated from the amount of silver nitrate added. The results are shown in Table 2. As the reaction time increases and the pH value increases, the silver content in the composite gradually increases. At pH 11, the conversion rate of silver ions reached about 96% after a reaction time of 32 hours. It was found that this method is a very effective green synthesis method for silver nanoparticles. Under the reaction conditions of pH 11, the conversion rate of silver ions is the fastest, which is consistent with the results of UV-Vis spectroscopy.

Table 2. The influence of different pH and reaction time on the content of silver nanoparticles

PH	5-1	5-2	5-32	7-1	7-2	7-32	11-32
Ag concentration	0.512	0.915	0.104	0.645	1.110	1.469	0.82
Conversion rates	26	45	53	34	61	72	96
Ag content	21	30	34	26	39	44	50

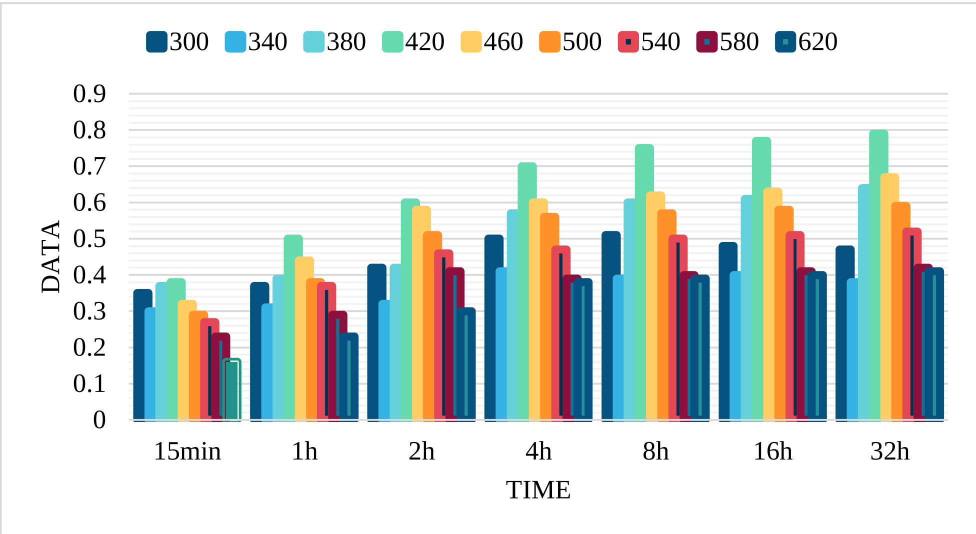

Figure 4. The relationship between the change of pH value and the absorption value of Nano-Silver

In this experiment, the absorption peak decreased with the increase of pH, indicating that the particle size of nano-silver decreased with the increase of pH. It can be seen from Figure 4 that the reaction time is 32 hours, the pH is 7, and the maximum intensity of plasmon resonance absorption is 0.8. These data indicate that as the pH value of the reaction system increases, the content of nano-silver produced increases.

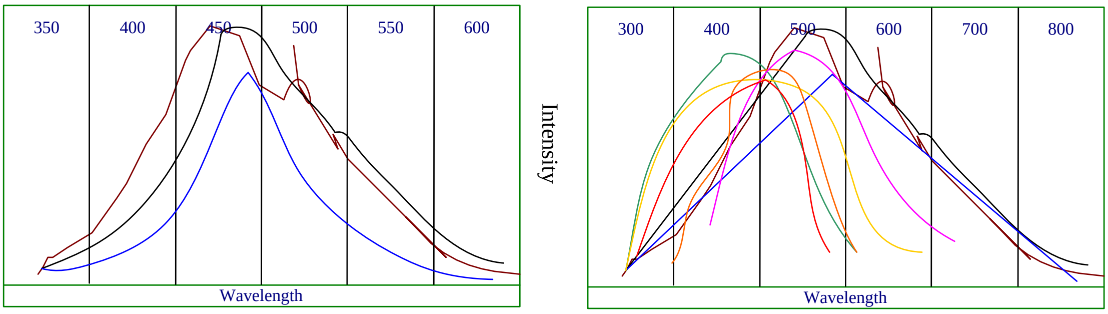

Figure 5. The relationship between sodium hydroxide value and fluorescence intensity

As shown in Figure 5, under the premise that other reaction conditions remain unchanged, GQD is synthesized, purified and dried. The pH value of the solution and the amount of ammonia water can affect the fluorescence intensity of GQD, and ammonia water participates in the entire reaction process.

4.5. Changes in Relative Membrane Potential of Bacteria and Changes in Sterilization Rate

As shown in the left panel of Figure 6, the relative membrane potential of bacteria decreases rapidly as the concentration of ATA increases. Relative membrane potential of the normal group is 36. After treatment with 6 μg/ml ATA for 1 hour, the relative membrane potential dropped to 15. After treatment with 24 μg/ml ATA for 1 hour, the relative membrane potential dropped to 15 and the membrane potential dropped to 6, which was very close to the relative membrane potential of the CCCP positive control.

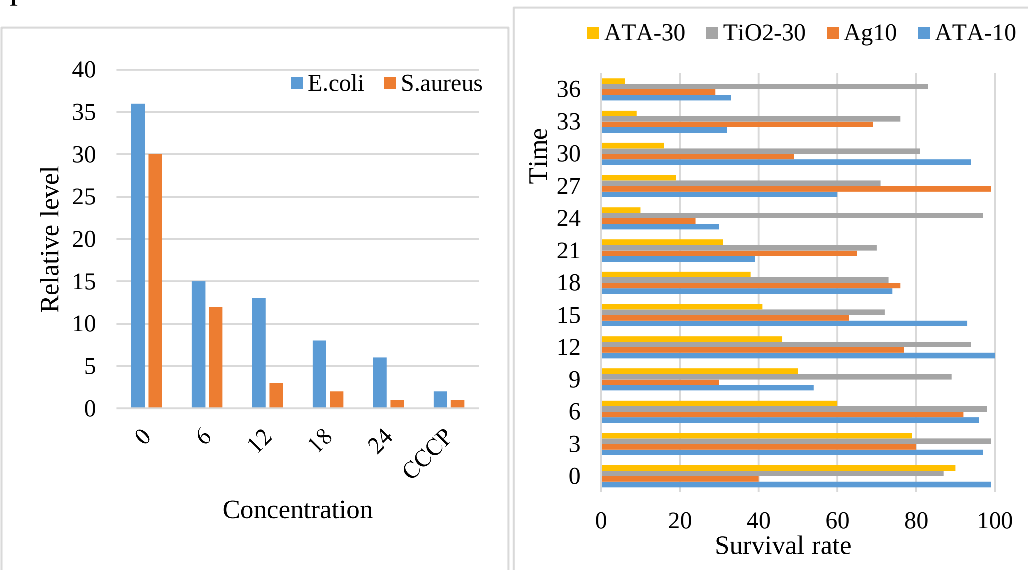

Figure 6. The relationship between the change of the relative membrane potential of bacteria and the antibacterial activity of different concentrations of samples and time

As shown in Figure 6 on the right, the survival rate of the pathogen after 24 hours of treatment with 10 and 30μg/cm2 ATA was 30% and 10%, respectively, and the survival rate only slightly decreased after prolonging the treatment time. Generally speaking, it can be seen that the longer the sterilization rate, the lower the survival rate.

4.6. The Effect of Loading Time of Ballet Shoes Nanomaterials on the Antibacterial Effect of Shoes

It can be seen from Table 3 that when the exposure time is 6 inches, the antibacterial effect of dancing shoes on E. coli is 100% under light and dark conditions. When the exposure time d is 3 minutes, the antibacterial effect of dancing shoes on E. coli is 100% in effect. Light and shady conditions cause antibacterial rates against E. coli 99.40% and 98.5% respectively, and the antibacterial rates are close to 100%. The antibacterial fabrics produced under both exposure times showed excellent antibacterial effects. Therefore, choosing an exposure time of 3 minutes is shorter than the optimal loading time for dancing shoes.

Table 3. The influence of loading time on the antibacterial effect of ballet shoes Nanomaterials

	Under visible light				Under dark conditions		
Load time	Number	Number of colonies	Concentration of viable bacteria	Inhibition rate	Number of colonies	Concentration of viable bacteria	Inhibition rate
3min	1	16	0.018×10^6	99.4	48	0.043×10^6	98.5
	2	24	0.026×10^6		64	0.068×10^6	
6min	1	0	0	100	0	0	100
	2	0	0		0	0	

4.7. Wearability Test Results of Ordinary Fabrics and Nanomaterials

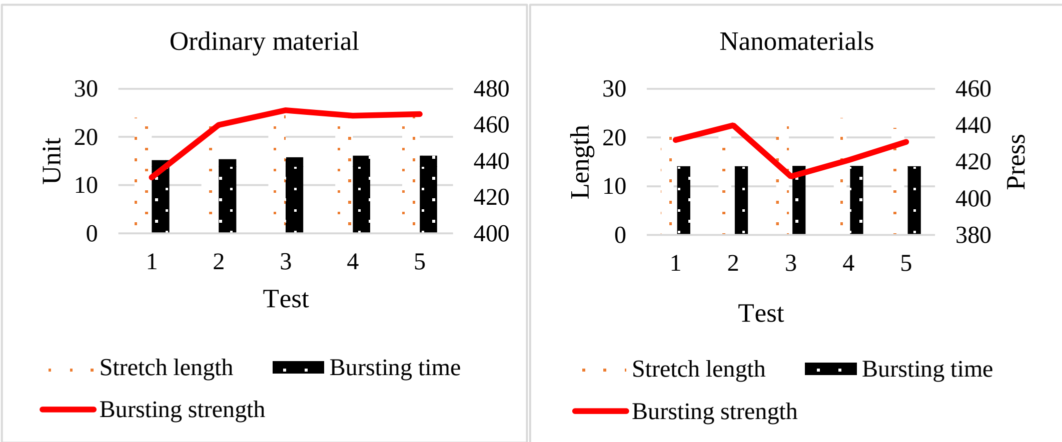

Figure 7. Wearability test of ordinary cloth and nanomaterials

As shown in Figure 7, the nano antibacterial materials and common materials used in ballet shoes have undergone a burst strength test during the optimal preparation process to determine whether the antibacterial treatment will damage the fibers of the material and reduce the strength of the shoe material. According to the test standard, each tissue sample should be tested 5 times, and the blasting strength test results are shown in the figure. According to calculations, the average burst strength of ordinary materials without antibacterial treatment is 463 N, and the average burst strength of nanomaterials after antibacterial treatment is 422 N. Compared with ordinary materials, its average burst strength is reduced by 8.86%. It can be seen that the blasting strength of the specimen before and after the antibacterial treatment has little change.

5. Conclusion

This article mainly discusses the characteristics and categories of nanomaterials and related knowledge of ballet shoes, and analyzes the preparation of nanomaterials. Through a series of nanomaterial preparation experiments and performance tests, this paper draws the following conclusions: the influence of different loading times, different heat treatment times and different heat treatment temperatures on the antibacterial effect of nanomaterials. The material has a high antibacterial rate against E. coli, under visible light and dark conditions. The burst resistance of nanomaterials is lower than that of ordinary ballerinas. The fluorescence intensity of GQD prepared with different concentrations of sodium hydroxide will be different, and the pH value will affect the fluorescence performance of GQD. In addition, nano-silver ions are common and mature, so this article mainly discusses the application of silver-ion nano-materials in ballet shoes, focusing on how nano-silver is made and its ability to absorb ultraviolet spectrum. The whole article of this article focuses more on the antibacterial effect of nanomaterials, and the research on anti-slip is relatively shallow, so it needs to be further strengthened.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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