

Application and Development of Antibacterial Wood-Based Panels in Composite Flooring

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Abstract: The floor is indispensable for people's normal daily lives, and the floor is also the object with the highest contact rate in life. With the rapid development of the panel customized home industry, in addition to environmental protection, people have increasingly high requirements for the safety of the materials used. It is necessary to meet the needs of people for floors with the concepts of cleaning, sterilization and health, and to apply antibacterial technology reasonably and efficiently to the floors required for daily life. In modern life, the floor is an important basic component. The existing materials, whether in color or texture, show a variety of aspects, which can achieve a close combination of functionality and artistry, and promote the increase of floor consumption. With the development of society and economy, people's requirements for indoor health are transferring from the safety and environmental protection of raw materials to the height of antibacterial. The trend of applying antibacterial technology on the floor has been formed after the antibacterial technology has been realized in the fields of floor, household appliances, and daily necessities. The floor with antibacterial function not only contains all the characteristics of the traditional floor, but also has the health function of inhibiting and killing the growth and reproduction of harmful bacteria. Antibacterial flooring will have huge potential demand and broad development prospects in the future. The prosperity of the flooring market has also promoted a significant increase in wood consumption. This study discusses the development trend of wood-based panels in antibacterial properties and their applications in flooring. Some suggestions are also provided.

Keywords: Antibacterial Materials, Wood-Based Panels, Antibacterial Floor, Composite Floor, Application

1. Introduction

The sudden outbreak of the COVID-19 epidemic not only threatened people's health and safety, but also caused people's concern about the living environment. The average time of modern people is spent working and living indoors. More research has shown that many daily objects that people frequently contact in life carry a variety of harmful pathogenic bacteria. It can be seen that the indoor floor, floor and decorative materials are the main vectors of bacteria and microorganisms that affect human health in the indoor environment, and their common parts are also prone to cross

infection [1-3].

At present, people's requirements for indoor health have risen from the safety and environmental protection of raw materials to the height of antibacterial. The trend of applying antibacterial technology on the floor has been formed after the antibacterial technology has been realized in the fields of floor, paint, household appliances, daily necessities and so on [2-4]. The floor with antibacterial function only contains all the characteristics of the traditional floor, and also has the health function of inhibiting and killing the growth and reproduction of harmful bacteria. Antibacterial flooring will have huge potential demand and broad development

prospects in the future. In the current modern floor production and manufacturing, the application of wood-based panels has significant advantages. It can better meet the requirements of modern floor production and manufacturing, and can significantly reduce the consumption of traditional forestry resources, which has an important impact on China's overall economic and social development [5-7]. In this paper, the development trend of antibacterial properties of wood-based panels and their application in flooring are briefly analyzed and some suggestions are put forward.

2. Wood-Based Panels

2.1. Basic Concepts

Wood-based panels are made of wood or other non-wood plants as raw materials, which are separated into various unit materials by certain mechanical processing, and then glued with or without adhesives and other additives. It mainly includes plywood, particleboard (chipboard) and fiberboard, with more than 100 kinds of extended products and deep-processing products.

2.2. Application

In practical applications, wood-based panels are widely used in modern floor production and manufacturing. As a standard industrial board, wood-based panel has brought revolutionary changes to the interior decoration. It not only saves wood raw materials, but also overcomes the shortcomings of natural wood, such as moisture deformation and cracks, thus bringing convenience to the industrial production of interior decoration. Relying on wood-based panels can significantly reduce the dependence of flooring enterprises on traditional forestry resources. Moreover, the actual application rate of wood-based panels is significantly higher than that of ordinary wood, and the texture, color and texture of wood-based panels are also more in line with the basic requirements of modern flooring with high grade, which is of great significance for improving the utilization rate of production materials [8].

2.3. Advantages and Disadvantages of Wooden Composite Floor

2.3.1. Advantages

With the maturity of technology application, the actual application range of wood-based panels is further expanded, which can be used in all links of modern floor production and manufacturing, and the actual procurement cost is significantly reduced. This can better meet the basic production and manufacturing needs of different types of modern flooring enterprises, and better reflect the industrial value of wood-based panels. Relying on the use of wood-based panels, the proportion of traditional forestry resources in modern floor production and manufacturing can be gradually reduced. This is of great significance to the protection of forest resources and the maintenance of natural ecological balance. At the same time, the

ingredients can be adjusted according to the actual needs of wood-based panel texture to ensure a better combination of quality, color, etc. with the actual needs of floor production [9].

2.3.2. Disadvantages

On the whole, wood-based panels have been widely used. However, there are still some difficulties in the production of high-quality wood-based panels. For example, the relevant ingredients and technical operations are too complex. This affects the production and manufacturing of wood-based panels, is not conducive to the production of small and medium-sized enterprises, and to a certain extent increases the cost. In the process of producing wood-based panels, some adhesive additives will be used. Under the influence of temperature and other conditions, volatilization will occur. This may affect people's health to some extent.

3. Antibacterial Floor

3.1. Development Source of Antibacterial Floor

The development source of antibacterial flooring is the concept of antibacterial building materials, which was first proposed and developed by Japan. At the end of the eighties, TOTO and INAX, the Japanese building ceramics companies, developed two types of inorganic antibacterial ceramics - photocatalysis antibacterial ceramics and silver-containing antibacterial ceramics, forming an antibacterial industry. The antibacterial floor originated from the outbreak of EHEC in Germany in 2011. In order to effectively operate the epidemic prevention and control mechanism, the government requires hospitals, sanatoriums and other places to prevent bacterial infection and infection in accordance with the sanitary standards in the regulations of the Infection Protection Law. At the same time, tables, chairs and other floors in close contact with doctors and patients are also set in the sanitary standards. Therefore, the German flooring brand Kusch+co subdivided the original flooring categories and replaced the traditional materials with antibacterial materials that reached the hygiene certification to produce flooring. Among them, Hola, who won the "Red Dot Award", ARN, who won the "German design award", and Trio, who "may be the first curved leg chair in the world", all entered the medical space with antibacterial products. Therefore, the development trend of floor antibacterial has been formed [10-11].

Antibacterial floor and interior decoration materials are functional materials with antibacterial effect selected on the basis of meeting the functional and quality requirements of the original floor and interior decoration components. By inhibiting the propagation of bacteria on the surface of the material or killing the bacteria on the surface of the material, the product has self-cleaning antibacterial function, achieving the purpose of long-term sanitation and safety self-cleaning. Its antibacterial performance is achieved by adding antibacterial agents to the surface or raw materials of floor and interior decoration parts.

3.2. Types and Characteristics of Antibacterial Agents

Antibacterial agents are the core of antibacterial materials. The functions of antibacterial agents include bacteriostasis and sterilization, in which bacteriostasis is to prevent or inhibit the growth and reproduction of microorganisms, and sterilization is the process of killing microbial vegetative bodies and propagules. At present, antibacterial agents can be roughly divided into organic antibacterial agents, inorganic antibacterial agents, macromolecular antibacterial agents and natural antibacterial agents [12-14].

3.2.1. Natural Antibacterial Agent

The use of natural antibacterial agents has a long history. As early as thousands of years ago, people have extracted antibiotics from natural plants. Natural antibacterial agents, such as chitosan and chitin, are biodegradable and can achieve antibacterial function. However, due to its high extraction cost, short service life, easy carbonization, decomposition and other problems, natural antibacterial agents have not been produced on a large scale in the market.

3.2.2. Organic Antibacterial Agent

It has rich sources, strong operability and good stability in storage. Organic antibacterial agents have been used by people for a long time. Like formalin, it is an organic antibacterial agent that is widely used in the early stage. However, the development of organic antibacterial agents is also limited by their heat resistance, easy decomposition and strong toxicity.

3.2.3. Inorganic Antibacterial Agent

Inorganic antibacterial agents include metal ion type. Under the background of the vigorous development of nanotechnology, the common ones are silver ion antibacterial agents and copper ion antibacterial agents; There are also photocatalytic semiconductor materials, represented by titanium dioxide antibacterial agent. Compared with organic antibacterial agents, inorganic antibacterial agents can achieve higher antibacterial rate and more stable properties when they play a role.

3.2.4. Polymer Antibacterial Agent

Polymers with antibacterial properties were synthesized by combining the characteristics of organic antibacterial agents and natural macromolecular antibacterial agents. The advantage of polymer antibacterial agent is that it can resist bacteria for a long time, and its stable nature can also ensure that it will not volatilize, let alone invade human skin; It can improve the efficiency and pertinence of antibacterial, and can be used for a longer time without the problem of toxic residue. Its disadvantages are that it is easy to dissociate at high temperature and poor compatibility. The development prospect of macromolecular antibacterial agent is considerable, and it is still in its infancy, and it is difficult to use it in a large scale.

4. Antibacterial Wood-Based Panel

As an important decorative and structural material,

wood-based panels are widely used in interior decoration. Wood is the most common substrate of wood-based panels. Wood is the product of the growth of trees. Trees are living organisms, composed of cells. The cell wall of wood is mainly composed of cellulose, hemicellulose and lignin. Therefore, wood is susceptible to mildew, discoloration and decay due to the erosion of insects, microorganisms, such as mold, discoloring bacteria and decaying bacteria, resulting in soft wood, color change and easy peeling. Therefore, it is necessary to carry out antibacterial treatment on wood materials.

Antibacterial performance refers to the ability of artificial board to inhibit the propagation and growth of bacteria. It has high requirements for antibacterial performance of artificial board used indoors, especially in close contact with people. Bacterial damage to the plate itself is small, mainly bringing risks to environmental safety and human health.

4.1. Characteristic

At present, the anti-mildew/anti-bacterial materials are mostly made to have antibacterial properties by adding antibacterial agents. The antibacterial wood-based panels have certain antibacterial properties after being processed or modified by antibacterial agents or surface processing during or after production. Enhance the antibacterial property of wood surface with antibacterial agent. Through special anti-mold/antibacterial treatment on the core and finish, it can effectively inhibit the growth of bacteria and mold, play a role in sterilization and mites removal. This kind of plate can improve the ability of products to adapt to different environments, ensure that the floor products will not turn yellow and black due to mildew, protect the beauty of household products and the comfort and health of the environment, thus extending the service life of the floor [13].

4.2. Processing Method

Taking antibacterial wood-based panels as an example, the most common method is to use nano-titanium dioxide and silver ions as antibacterial agents to achieve antibacterial effect by modifying thin wood or adding inorganic metal pulp with antibacterial function on the surface of adhesive or impregnated paper to make decorative wood-based panels. Although nano-silver has good antibacterial performance, it is unstable and easy to be converted into silver oxide, and its antibacterial effect cannot be maintained at a high level for a long time.

Long et al. found that the impregnated paper and veneer added with nano-titanium dioxide have good antibacterial properties, and when the amount of titanium dioxide is 1%, the antibacterial effect is the best, and it can play a good inhibitory role on *Staphylococcus aureus* and *Escherichia coli*. Du et al. studied the different impregnation methods of modified melamine formaldehyde resin impregnated with different amounts of antibacterial agents, and concluded that the most economical and effective impregnation method is to impregnate the front of the veneer with modified melamine

formaldehyde resin containing a certain amount of antibacterial agent, while the back is impregnated with modified melamine formaldehyde resin without antibacterial agent, and the impregnation amount of the front and back sides of the veneer should be the same. Liu found that the antibacterial ability of the antibacterial decorative panel is positively correlated with the amount of antibacterial agent added. The antibacterial ability of the decorative panel will increase with the amount of antibacterial agent added, and can play a good role in inhibiting some bacteria on the surface of the decorative panel [13-15].

4.3. Application in Composite Flooring

At present, anti-mold/anti-bacterial wood-based panels are mainly used in hard floor products such as solid wood or solid wood composite flooring, cabinet wooden countertops, and customized wardrobe. Custom wardrobe is a place where clothes are often stored, and the space is relatively closed, so it is also a place where bacteria are easy to grow. At present, the antibacterial products of the floor mainly include antibacterial hangers, chairs, etc. In addition, the environment of the bathroom cabinet is also humid all year round, and bacteria are easy to breed. Therefore, at present, antibacterial toilet facilities will also be used for sanitary products on the market, such as antibacterial toilets, toilet cleaning brush and other products.

5. Antibacterial Property Test of Wood-Based Panels

At present, China has not formulated the antibacterial standards and test method standards for the relevant wood-based panels and their products. The general test method standards include the accuracy and scientificity of the test method design, the reasonable control of the operation error, and the error size caused by the test itself. The rationality and correctness of the test method plays an important role in the development of the entire antibacterial material industry. The antibacterial performance of wood-based panels is measured by the growth of bacteria on the test piece. The antibacterial rate of the test piece is the difference between the growth of bacteria on the blank control test piece and the growth of bacteria on the test piece and the percentage of the growth on the blank control test piece. Antibacterial wood-based panels are divided into 0 strong antibacterial grade and 1 antibacterial grade. 0 is the plate with antibacterial rate of more than 99%, and 1 is the plate with antibacterial rate of less than 99% but more than or equal to 90%.

Antibacterial function includes anti-bacterial and anti-mold performance. Due to the different structure and taxonomic characteristics of bacteria and mold, the recognized detection methods at home and abroad for the detection of antibacterial function are classified as two types of methods.

5.1. Antibacterial Test Method

Due to the different performance of antibacterial products,

the evaluation methods of antibacterial function are also different. The most appropriate evaluation method shall be selected for different products according to their own characteristics and actual use environment. In consideration of the reproducibility of the evaluation method, the microorganisms used for the evaluation of antimicrobial resistance are generally *Escherichia coli* and *Staphylococcus aureus* according to taxonomy.

5.2. Evaluation Method of Resistance to Fungus

Fungi and bacteria are different. When they grow on the plate, they have the differentiation of vegetative mycelium and aerial mycelium. Therefore, when testing the sterilization, the plate count cannot be directly carried out with the bacterial liquid, but only the growth of their mycelium can be observed through microscopic inspection, so as to judge the inhibition or killing effect on bacteria.

5.3. Plate Detection Method

The detection method has the following steps: Make mixed spore suspension. Transfer the tested molds into test tubes for 14-28 days, and then separate sterile water to make spore suspension of certain concentration. Make a plate, heat the agar culture medium and pour it into a plate. After cooling and solidification, put the sample to be tested on the surface of the culture medium, and coat a certain amount of nutrient mixed spore suspension on the surface of the culture medium and sample, and then culture for a certain time. Test the growth of surface hypha.

6. Development of Antibacterial Wood-Based Composite Flooring

In order to ensure the safety and quality of antibacterial wood-based panels more effectively, accelerate the pace of wood-based panel production and quality standard system construction in China, and improve the detection and analysis ability of different wood-based panel products has become a top priority. Three suggestions are put forward for the development of antibacterial wood-based panels:

Accelerate the construction of quality standard system for antibacterial wood-based panel products. The production process of antibacterial wood-based panel is different, but its application and effect are the same. Therefore, based on the principle of simplification, the construction of different product testing methods and quality evaluation standards should be accelerated and improved as soon as possible, and the testing standard system of antibacterial wood-based panel should be improved.

Accelerate the domestic transformation of international advanced standards. Make full use of the information collected by various information systems at home and abroad, translate and publish foreign technical regulations and standards, strengthen the development and research of detection technology for different uses of antibacterial wood-based panels in China, reasonably and effectively

adopt international advanced standards, and realize the rapid transformation of these standards based on the health limit regulations and detection standards of the European Union, the United States, Japan and other developed countries.

To establish a safety evaluation system for antibacterial components of antibacterial wood-based panels. At present, China lacks sufficient research and evaluation on the use safety of antibacterial wood-based panels, especially the relevant technical methods for the safety evaluation of important hazardous substances in household flooring and food packaging materials, and has not yet established a safety evaluation system for hazardous substances in such products. For active and intelligent antibacterial ingredients, adhesives, ion exchange resins, nano-additives and other additives, there is a lack of basic safety evaluation technical methods and standards. To evaluate the quality of products, the formulation of such standards is an urgent and imperative task.

7. Conclusion

As discussed above, the floor is indispensable for people's normal daily living and living, and the floor is also the object with the highest contact rate in life. With the rapid development of the panel customized home industry, in addition to environmental protection, people have increasingly high requirements for the safety of the materials used. In recent years, the market demand for artificial panels with certain moisture-proof and antibacterial functions is increasing. Therefore, vigorously develop and produce moisture-proof and mildew-proof products, reduce the deformation and expansion of wooden household products and the breeding of bacteria and mold, meet the use requirements of wooden household products in special places, and protect the health of consumers while ensuring that the storage is not contaminated by bacteria and mold, which will become a new demand of consumers and product development trend. In this study, the development trend of antibacterial properties of wood-based panels and their application in flooring were discussed and some suggestions were provided. It can be stated that with the in-depth research and development of moisture-proof and antibacterial materials by researchers, moisture-proof and antibacterial materials will certainly benefit human society better.

Author Contributions

The Manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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