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Research Progress in 3D Printing Wood Materials

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Abstract: *3D printing wood materials has been developed rapidly in the furniture manufacturing industry, with the continuous expansion of industrial 3D printer functions. This thesis discusses the innovation and development advantages of 3D printing materials, in view of the principle and technology of 3D printing product. The application of wood-plastic composite materials in the field of 3D printed furniture was explored, which proposed a new direction for the subsequent modification research and market application, according to the properties and modification methods of the biodegradable material polylactic acid. In the discussion of its advantages, the influence of 3D printing on furniture production process, market potential and other aspects were explored, and the prospective change and future trend brought by this technology to the traditional furniture industry were comprehensively explained. Finally, this thesis presents the point that the application of 3D printing in the field of furniture has a great prospect. The future trend of the development of 3D printing furniture is predicted, which provides constructive suggestions for exploring the development of 3D printing technology in the furniture industry.*

Keywords: *3D printing technology, Wood materials, Furniture manufacturing*

1. 3D Printing Technology and Its Origins and Application

3D printing technology is also known as additive manufacturing technology or rapid forming technology in the academic field, which is the general term for a variety of technology forming methods. Different from the traditional material reduction manufacturing and equal material manufacturing and processing methods, the 3D printing technology has a high degree of design freedom, which can quickly manufacture the complex structures that the traditional processing and manufacturing technology are difficult to form by layer by layer superposition.3D printing has the advantages of not relying on mold manufacturing and molding freedom, and its application to composite molding is expected to realize the integrated molding of lightweight complex structural parts.

3D printing technology has been widely used in aerospace, automotive, medical, construction and cultural and creative industries.3D printing technology integrates the advanced technologies of machinery, materials, integrated circuits, CNC and computer, aiming to achieve the rapid manufacturing and molding of 3D parts and shorten the development and manufacturing cycle of parts.3D printing technology slices the 3D model to obtain the two-dimensional section node information of the 3D digital model, and obtains the printing control instruction with the node as the basic unit insertion calculation. The control system identifies the instruction information, guides the printing formation of the printing device on the 2D plane, and finally makes the 3D solid parts layer by layer.

2. 3D Printing Materials and Its Products

While the foreign research on 3D printing technology is gradually deepening into the specific application field, the research progress of Chinese 3D printing technology is also accelerating, which is gradually narrowing the gap with the world's advanced level. With the maturity of printing technology, increasing policy support for its promotion and application. In the Made in China 2025 planning content, about promoting the development of intelligent manufacturing new technology has the following description, around the transformation and upgrading and a new generation of information technology, intelligent manufacturing, additive manufacturing, new materials, biomedicine and other fields of innovation and development of major common demand, form a batch of manufacturing

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innovation center（industrial technology research base）.These specific contents involve the application advantages of 3D printing technology and the future long-term development goals, indicating the national confidence in strengthening the development of 3D printing technology-related industries.

Overall, There are the following institutions that conduct in-depth research and promote the development of 3D printing technology and equipment: the research universities are mainly Tsinghua University, Xi'an Transportation University, Huazhong University of Science and Technology, South China University of Technology, etc., With the gradual promotion of the 3D printing technology, Colleges and universities have also strengthened the research of 3D printing technology; The enterprise is represented by Beijing Longyuan, Beijing Tale Times, AVIC Heavy Laser, Hangzhou Xianlin, Wuhan Jinyun Laser, Shenzhen Guangda, Tianjin Ishen Technology, Hunan Huashu Hi-Tech and other companies with the integration of industry, university and research development; In the specific application fields downstream of the industrial chain, Enterprises with good development model are mainly enterprises such as Shanghai Dream Museum and providing three-dimensional printing products and services. In addition, some 3D printing technology industry alliances and industrial bases in China in recent years are promoting the rapid development of 3D printing technology.

3. The LAYWOOD-D3 Printed Materials

The LAYWOOD-D3 printing material invented in 2012 by German designer Kai Parthy in 2012 broke through the limitations of wood, with the recycled wood crushed and refined, and then mixed with polymer adhesives to make a roll of wood linear materials, and then use FDM melting molding technology, heat and melt the wood wire into glue, and print out various forms of furniture. The temperature of the 3D print head can also be adjusted to print out the annual wheel texture or other pattern of the wood. Compared with traditional wood, the furniture materials using LAYWOOD-D3 printing are not only more efficient, but also lower processing process and difficulty, and better pressure resistance and stronger styling ability.

UC Berkeley is exploring mixing processing waste such as waste wood chips, chicken feathers and seafood into 3D printed materials. In 2014, Jiangsu Jiahe Hi-tech Holding Co. made 3D printed materials from rice stalks. Natural straw and plastic raw materials were mixed with other chemical materials to be made into 3D printing materials, and made into wooden grain vase, wooden grain dining plate, wooden grain chair, tea table and other daily necessities and furniture, which won unprecedented praise in the International Oak and Plastic Exhibition held in Shanghai in 2014.This new furniture material is not only green and affordable.

A French manufacturer used 3D printing to handle the raw wood material, but not using real wood, he tested it with a material called LAYWOOD-D3, in a form between wood and plastic. The researchers found that the print color was affected by different temperature, with light pine colors when the printer modulation low temperature, while the printer is set to high temperature. And when high and low temperatures change due to a "texture", this texture effect makes the product look closer to the natural wood material. Meanwhile, Francois is developing a computer-handling software to better regulate the printing temperature to create the desired texture effect.

Luo Kai, Zhao Hui and others from Northeast Forestry University have used wood and plastic composite materials in selective laser sintering molding technology. Current printing materials are mainly concentrated on polymers such as PLA and ABS, with no research and application for universal thermoplastic polymer/wood powder composites. Swedish researchers are developing a 3D printing technology with cellulose, the most rich organic polymer on earth, exists in the cell walls of green plants and many different kinds of algae, because the current construction use of wood and wood products, caused a great negative impact on the natural environment, researchers hope to use this technology for printing houses, thus changing the face of the construction industry.

4. The Development Trend of Wood Based 3d Printing Materials

Fibrous material is a kind of green biomass material represented by wood fiber and crop straw. Therefore, actively carrying out 3D printing research of cellulose materials broadens the types of 3D printing materials and provides a new way for the diversified utilization of cellulose materials. The combination of the two is expected to become a new trend of research of advanced materials in the field of intelligent manufacturing. To apply the cellulose material to 3D printing, the first thing to be solved is that the cellulose material itself cannot melt or dissolve in conventional solvents and

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incompatibility with existing 3D printing devices.

To solve these problems, it can be started from the development of new solvents, modification of cellulose materials, composite printing of cellulose materials and other materials, research and development of a 3D printer that can be suitable for cellulose materials.

Wood fiber and biodegradable polymer polylactic acid are reasonably optimized and integrated configuration to prepare green and completely degradable composite materials, wood fiber as reinforcement material can be foot, footpath, branches and other corner materials for wood processing, polylactic acid as the base material. From the perspective of cost benefit, all kinds of wood processing residues can be used; from the perspective of material performance, the mass production of fully degradable biomass composites and the extensive use in all walks of life will somewhat reduce the environmental pressure on the production of oil-based plastics, and also help to effectively control and reduce the environmental pollution caused by waste incineration, and improve the utilization value of wood residues while increasing the national economic production value.

At the same time, the degradable polylactic acid also has high price, poor mechanical performance and low thermal stability, so the use of wood materials to enhance the degradable polymer can play a role in killing multiple birds with one stone.

Wood is usually the most commonly used material in furniture, but the structure, form, and function are limited due to the hardness, and linear shape of the wood. The problem of wood application in 3D printing has been partially studied. The process of mixing wood powder with PLA through FDM injection printing has been developed abroad and used for the actual manufacturing of wood furniture. Wood and plastic composite composites have become a kind of environmentally friendly composite materials booming at home and abroad in recent years, mainly used in building materials, furniture, logistics and packaging and other industries. Although at present, the 3D printed wood products are not comparable to Xiang wood in quality or cost, the 3D printed wood material has unique aesthetic and environmental value.

Wood and plastic composite composites have become a kind of environmentally friendly composite materials booming at home and abroad in recent years, mainly used in building materials, furniture, logistics and packaging and other industries. However, the variety of 3D printing materials is still very limited, becoming the bottleneck of the development of the 3D printing industry. Therefore, the development of 3D printing materials with rich resources, low cost, and non-toxic safety has become a hot topic at home and abroad. The current research on 3D printed wood-plastic composites is not much reported for further research. The following is detailed overview of 3D printing technology, FDM process principle and current status and progress of materials and wood and plastic composites. Taking flexible wood powder as the reinforcing material, the test results showed that after the modification of EPDM-gMAH（EPDM grafted maleic anhydride）, it compensated for the flexibility of the TPU/WF composite and improved the interface adhesion. When the wood powder content was 30% （mass score）, the tensile performance increased significantly and the fracture elongation increased by about 100.14%.

Wood powder and corn straw modified polyolefin-based wood plastic composite 3D printing material-wood plastic composite material has become a class of environmental-friendly composite materials booming at home and abroad in recent years, mainly used for building materials, furniture, logistics packaging and other industries. Few research on 3D printed wood-plastic composite, pending further research. Therefore, it is also very important to choose a suitable polymer as the matrix of composite material. Biomass composite material is a new kind of environmental protection composite material obtained with biomass fiber materials such as wood, bamboo and crop straw, which has developed rapidly in a short time with its advantages of high quality and short price. Biomass composite material has the dual advantages of the two main components of biomass material and plastic matrix, such as high mechanical strength, durability and good processing performance, which can be widely used in construction, furniture, automobile and other fields.

The polymer used is polylactic acid, which is produced by biological fermentation by natural renewable resources like plant corn, wheat, starch and grain straw. The lactic acid is polymerized by certain chemical methods. It can be decomposed into small molecular substances in the natural environment and finally into pollution-free water and carbon dioxide. It has good biocompatibility, but polylactic acid materials as linear polymerization products, its relative molecular weight distribution is too wide and leading to obvious defects, such as large mechanical brittle, poor impact resistance and other problems, cannot meet the daily application requirements, but these shortcomings can be

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improved through some chemical modification means.

5. Conclusion and Outlook

At present, the production process of polylactic acid is mainly divided into direct one-step synthesis method and indirect two-step synthesis method. The direct synthesis method mainly adopts dehydration agent and catalyst, which dehydrates and shrinks between lactic acid or lactic acid oligomers under appropriate conditions, and forms polylactic acid with high molecular weight. This method is efficient and simple, under the catalyst, the hydroxy and carboxyl groups in the lactic acid molecular structure are heat and dehydrated by adjusting the temperature, but other products such as propylene ester, water and oligomer are present during the reaction, making the separation of polylactic acid becomes difficult.

3D printing technology provides a good opportunity for the diversified application of some cheap and extensive biomass resources (such as lignocellulose materials), and gives them higher value, which is another new way for the industrialization development and renewable utilization of biomass-based materials. The application of 3D printing is not limited to daily furniture, thanks to its flexible manufacturing characteristics, but also used in the restoration and reproduction scenes of classical, cultural relics and technological furniture. For damaged ancient furniture, the missing parts can be used to glue the missing parts after polishing, spraying and making old parts to other intact parts, which plays a positive role in both archaeological and historical research.

Reverse engineering combined with 3D printing technology is a powerful means to replicate classical furniture. The specific approach is to form a data point cloud by optical scanning of classical furniture isolated products. The engineer can repair the point cloud into a surface and then model it for 3D printing and production. After surface treatment, almost identical classical furniture is obtained, which plays a positive role in promoting the promotion of high-end products to ordinary consumers. A small branch of the field of furniture is the classical furniture model, whose model size is reduced according to the physical ratio, the material is solid wood, part of plastic material.3D printing can be used as a printing material. The classical furniture model made of solid wood is not only the privilege of some woodworking lovers. Every consumer can have 3D printer to make it. Although the market is relatively small, the survey sales volume is still considerable, so the 3D printing of the furniture model also has the ideal market potential.

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