

# Research Status and Development Trend of Polyactic Acid Matrix Composites Applied to 3D Printed Furniture

Qiang Shi

Department of Art, Shanwei Polytechnic College, Shanwei, China  
1014796938@qq.com

**Abstract:** 3D printing technology has become more closely connected with furniture manufacturing industry, with the continuous expansion of industrial 3D printer functions. This paper analyzes and discusses the innovation and development advantages of 3D printed furniture, in view of the principle and materials of 3D printing technology. The application of PLA 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 (PLA). In the discussion of its advantages, the influence of 3D printing on furniture production process, market potential and other aspects were discussed, and the subversive change and future trend brought by this technology to the traditional furniture industry were comprehensively explained. Finally, it shows the view 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, Furniture manufacturing, New manufacturing, Technical principle, Polylactic acid, modified

## 1. 3d Printing Technology and its Application Fields

3D printing technology has been widely used in aerospace, military, construction, industrial production and other fields due to its advantages of low cost, high precision, short molding time and large design space. With the continuous development and progress of 3D printing technology, it will gradually break through the limitations of traditional manufacturing technology and become the most common application technology. Compared with traditional preparation methods, 3D printing technology can meet the above requirements. Using this technology to prepare composite materials can reduce the cost and shorten the printing time [1].

In the current trend of 3D printing technology sweeping the world, 3D printing composite materials have a great development prospect [2]. At present, 3D printing technology has a high manufacturing cost and printing materials are easily limited, and the types of printing materials are mainly polylactic acid materials, nylon materials and resins [3]. Therefore, the research and development of energy-saving and eco-friendly materials plays an important role in the future development of 3D printing technology.

In recent years, 3D printing has gradually appeared in people's vision and been well known by people. 3D printing has the characteristics of rapid prototyping, which is used in the direct manufacturing of some new products. Printing materials are an extremely important and indispensable development condition for the sustainable development of 3D printing technology [4]. It can be said that the development of 3D printing materials determines the application fields of 3D printing to a certain extent [5].

While the research on 3D printing technology in foreign countries is gradually deepening into specific application fields, the research progress of 3D printing technology in China is also accelerating, and the gap between China and the world's advanced level is gradually narrowing [6]. As printing technology matures, in "made in China 2025" planning content, on promoting the development of the new type of intelligent manufacturing technology has the following description - "around the transformation and upgrading of key industries and a new generation of information technology,

intelligent manufacturing, material manufacturing, new materials, biological medicine in areas such as innovation and development of great generality demand, formed a group of manufacturing innovation center" [7]. Indicates the country to strengthen the development of 3D printing technology application advantages and long-term development goals in the future [8].

Many scholars are gradually deepening and improving the research on the effects of 3D printing technology on the industrialization, informatization, industrial transformation and industrial chain structure shaping of furniture manufacturing industry [9]. In general, 3D printing technology has a wide prospect in the future development and shows great potential in the field of furniture manufacturing. These research results have laid a solid theoretical foundation for 3D printing furniture manufacturing application and development research [10].

3D printing has had a significant impact on the furniture manufacturing industry, and is promoting the change of furniture forming characteristics and the transformation of furniture manufacturing mode. Compared with the traditional furniture manufacturing technology, 3D printing simplifies the complex manufacturing process of furniture, which makes the furniture with short iteration period, complex structure, and intelligent, ecological and environmental protection at the same time [11].

## **2. 3d-Printed Furniture and its Materials**

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3D printing has had a significant impact on the furniture manufacturing industry, and is promoting the change of furniture forming characteristics and the transformation of furniture manufacturing mode [14]. Compared with the traditional furniture manufacturing technology, 3D printing simplifies the complex manufacturing process of furniture, which makes the furniture with short iteration period, complex structure, intelligent, ecological and environmental protection at the same time [15].

3D printing uses a wide variety of materials, including rubber, wood, nylon, plastic, aluminum, titanium and paper. With the development of technology, it is now possible to print in heterogeneous materials and mixed materials. The physical characteristics of 3D printers can be divided into liquid, solid and powder, and the raw materials are also different.

## **3. Polylactic Acid Based 3D Printed Furniture Materials**

At present, PLA, as one of the most widely used FDM 3D printing polymer linens, has the advantages of a wide range of sources, renewable, complete biodegradation, excellent mechanical properties and its own shape memory [16]. It has been widely used in industry, civil use, especially in biomedical and other fields. However, due to the weak melt strength of pure PLA, its 3D printed products have severe shrinkage, brittle and easy to break, which limits its application in extrusion and blow molding, and its value is greatly limited [17]. Based on the above technical difficulties, the paper focuses on the research and development of low carbon, energy saving, ecological and environmental friendly 3D printing PLA composite materials, and expands the application of PLA in the field of 3D printed furniture [18].

There are many types of 3D printing technology, among which the fusion deposition 3D printing technology is simple to operate, and has become the most widely known and used technology type. Melt Deposition Molding (FDM) is a 3D printing technology with thermoplastic monofilament as wire extruded by hot nozzle [19]. It has the advantages of simple operation, low cost and high reliability [1]. Generally speaking, there are a wide variety of 3D printing materials used in FDM, among which polylactic acid (PLA) has been highly paid attention by researchers due to its complete biodegradable physical properties.

PLA raw materials are mostly natural plant resources with excellent biodegradability, which can be decomposed into carbon dioxide and water without causing pollution to the surrounding environment [20]. PLA raw materials are a kind of eco-friendly green materials. PLA melts at 180°C -220°C, with a degree of dissolution close to that of a liquid and rapid hardening. When printing, the connection of

each section is good and shiny, and the stacked stripes are thin, which makes the product look better visually.

#### 4. The Development Trend of Pla Based 3D Printing Composites

But at the same time, PLA matrix composites also have the disadvantages of high production cost, high brittleness, poor heat resistance and poor tensile properties, which to a large extent limit their application in 3D printing [21].

In view of PLA's own shortcomings and problems in its application in 3D printing, researchers began to add certain modified substances to PLA to improve the application performance of PLA materials. Among these modified substances, plant fiber has advantages such as light weight, low cost, renewable and a large number of resources on earth. It has become an excellent material for the modification of PLA [22].

Adding a certain amount of plant fibers into the PLA can prepare composite materials that can be used for 3D printing through specific technologies, which can not only reduce the production cost, but also make the 3D-printed furniture products have the mechanism and texture of natural wood. It is a green synthetic material with low carbon, environmental protection; energy saving and low cost [23].

The current 3 d printing with PLA fiber composite materials research is relatively small, there are a lot of shortcomings, the main problem is not only can be used for 3 d printing, has fewer kinds of PLA matrix composites, is rarely on the preparation of a new type of composite materials in the application of 3 d printing, from production to the printing process of composite materials, It didn't form a complete system.

A new PLA matrix composite material was prepared from plant fiber and PLA as raw materials, and applied to 3D printing. Wood powder and PLA composite materials are used as 3D printing wires in FDM 3D printers to expand the application range of eco-friendly biomass composite materials [24].

Starting from the intersection of the development of 3D printing materials and furniture manufacturing, this paper studies the application of 3D printing materials in the furniture manufacturing industry and promotes the large-scale development of 3D printed furniture, which has important practical significance for the future development of the furniture manufacturing industry. PLA composite materials are applied in FDM 3D printing to manufacture indoor furniture, which endows ecological and environmental performance of 3D printed furniture and expands and improves the function of 3D printed furniture products.

By reasonably matching wood powder and PLA, and adding suitable amount of chemical modifier, in improving PLA wood powder biomass based on physical and mechanical properties of composite materials, through the study of the chemical modification of composite materials, for its antibacterial, health care performance, make it become a kind of green ecological environmental protection new materials, applied to the 3 d printing in furniture, It improves the function and environmental protection of 3D printed furniture, and expands the application occasions and functions of 3D printed furniture.

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By adding modifiers to PLA based biomass composites, the environmental performance of PLA based biomass composites is improved and the antibacterial and health care functions of the composites are given, which greatly improves the application range of the composites. At present, there are few reports on this kind of functional 3D printing composites.

The composite material prepared was applied to FDM 3D printer, and the most suitable material ratio method for 3D printed furniture and the ecological and environmental performance of 3D printed furniture were explored.

The base material of PLA wood powder composite material comes from natural plants or agricultural waste, using powder for base material and PLA fiber as raw materials, with silane coupling agent and maleic anhydride grafted poly (lactic acid and chemical modifier for the preparation of compatilizer PLA matrix composites, explore the fiber content on the performance of PLA matrix composites and the influence of the ecological and environmental protection. The PLA matrix composite material with better comprehensive performance was made through comparative analysis,

and it was applied to the 3D printing of indoor furniture manufacturing, and the performance of the printed furniture was tested. Based on composite material to print furniture specimen test of physical and chemical properties, get new PLA matrix composite materials the best combination of 3 d printing process parameters, production process conditions, in order to solve the choice of this problem, reduce the cost and energy consumption, to new PLA matrix composite materials in the application of 3 d printing indoor furniture manufacturing to provide the reference.

This eco-friendly PLA matrix composite material is applied to furniture manufacturers with an annual output value of ten million yuan, which can increase the annual output value by 10-25% and increase the economic benefit of one million yuan for them.

The eco-friendly PLA-based composite material was prepared by adding chemical modifiers into the PLA used in FDM printing technology. Compared with the PLA based material, the VOC emission of the modified PLA composite material was reduced by 34%-60%, the formaldehyde emission was reduced by 13%-35%, and the antibacterial activity was increased by 54-61%.

## 5. Conclusions

Nowadays, 3D printing technology still has a variety of problems, but with the wide application of the technology in various industries, 3D printing technology will continue to improve, becoming mature to meet the needs of society. The wide application of 3D printing technology is an inevitable trend of industry development. The application of 3D printing technology and materials in furniture design and manufacturing conforms to the development trend of The Times. As a potential green material, degradable PLA can be used in furniture production. Modification of PLA can greatly improve the environmental performance of the composites, and the method is simple, effective and cost-effective.

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