Research on 3D printing materials used in environmental art design

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Abstract: Based on the innovation of science and technology in China, 3D printing has achieved good application effects in many fields and engineering. Environmental art design is an important part of the current social development. The reasonable use of 3D printing technology to print materials is an important technical means to carry out green concept, energy saving and emission reduction and environmental protection. In view of this, this article mainly analyzes 3D printing technology, studies the status of environmental art design, and explores the application of 3D printing materials to provide good reference for related engineering and design activities.

1. Introduction
Environmental art design is a new development industry in recent years. It gathers multi-disciplinary knowledge and it is a comprehensive specialty, which mainly involves art, sculpture, and model making, garden design and home art, and some materials. Especially in the development process of modern society, the role of environmental art design is becoming more and more prominent. In building interior environment and garden landscape design. With the help of 3D printing technology, environmentally friendly and recyclable materials can be produced, which fully reflects the characteristics of green, environmental protection, beautiful and practical. However, because environmental art design requires materials with good compressibility and resilience, when using 3D printing materials, it should pay attention to their toughness and viscosity to ensure that environmental art design is scientific and reasonable.

2. Overview of printing technology
3D printing technology is a new type of modern technology, which can effectively reduce the production cost of various materials, and achieve rapid prototyping to shorten the production time. In the actual application, the corresponding 3D scanner can be used to scan the things to be printed in detail. It can use relevant computer design software to make a three-dimensional model consistent with the real thing. Then it can divide the model into sections with different layers, and fill in appropriate glue materials such as liquids and powders. Finally, it can use mechanical equipment to operate and the printing becomes the same physical material as the model. Under normal circumstances, 3D printing technology can be used for raw materials such as metal, plastic and glass. It can melt it into liquid or powder for better printing operation [1].
This new technology is different from general material processing technology. First of all, in the past, material processing means cutting or polishing the overall shape of the raw material, and then welding and assembling the parts, and the product has been completed. The 3D printing technology is based on a computer data model, and the material is produced in the form of synthesis and processing, mainly by using the original blank and mold to increase or decrease the material that can flexibly adjust the size. In contrast, 3D printing technology has the advantages of high material production efficiency, short development time, fast processing speed and low production cost. It currently plays a good role in the fields of industry, aerospace, and art design.

3. Development of environmental art design

Environmental art design is the product of social innovation, especially in the current era. Due to the rapid economic development, people change the concept of enjoying life, pay attention to the quality of living environment, so environmental art design has been widely concerned by the society. In the process of continuous development, environmental art design involves architectural interior environment design, architectural design, landscape design and green space design, etc. It includes professional knowledge of decorative aesthetics, model making, ergonomics and architectural structure engineering technology. [2] Continuous progress in the frontier science of materials promotes the material application of environmental art design to change greatly. In order to ensure that it meets the practical requirements of engineering, 3D printing technology can be used to improve the material performance and promote environmental art design to be more safe, reliable and economical. Therefore, in the practice of environmental art design, the main focus of environmental art design practice is to start exploring the in-depth application of 3D printing materials to effectively improve the overall effect of environmental art design [3]. The current entry of 3D printing technology into the field of environmental art design has promoted greater innovation, improved traditional design concepts and methods, and promoted various environmental designs to better meet the requirements of the new era, and meet the aesthetic requirements and development concepts of modern society.

4. Analysis on the application of 3D printing materials to environmental art design

4.1. Raw material analysis of 3D printing materials

Model making is a key link in the use of 3D printing materials in environmental art design. Only by making good use of raw materials can appropriate models be made to ensure that 3D printing materials have good use value. At present, the use of 3D printing materials to make environmental technology design models can be applied to architecture, construction construction, home and sculpture, etc., to help designers master the theme and better reflect the results of engineering practice. But for some environmental art design modeling, it requires a certain degree of compressibility and variability, such as sofas in home decoration, garden plant landscape[4]. Therefore, the relevant personnel should pay attention to the prepolymer and active monomer of 3D printing material to ensure that the material has good flexibility and viscosity. At present, the 3D printing materials used in environmental art design in China are prepolymer and active monomer, which can be shown in table 1.

| Prepolymer                                      | Active monomer                                |
|------------------------------------------------|-----------------------------------------------|
| Aliphatic polyurethane acrylate                 | Ethoxyethyl acrylate                          |
| Epoxy acrylates                                 | Tripropanediol diacrylate                     |
| Polyester acrylate                              | Di propylene glycol diacrylate                |
| E44, E51 of bisphenol A epoxy resin             | Trimethylolpropane dilute acid                |
| Mono- and di- and multi-functional oxygen heterocyclic butane | Ethylene oxide 1.2 trihydroxyglycidyl ether |
| Epoxy polybutadiene                             | Neoprene diacrylate                           |
| Hyperbranched polyester acrylate                | 3.4 epoxy ring-based formates                 |
4.2. A study on the viscosity properties of 3D printing materials

Based on the research of forming mechanism, the viscosity performance of prepolymer as a raw material for 3D printing materials is analyzed. According to the type of prepolymer, it can be divided into two major photocuring system prepolymers. They are free radical and sunlight ion. The experimental research on 3D printing materials is mainly to fix the types and contents of active monomers, photoinitiators and various additives, and then adjust the prepolymer to determine the viscosity of the material samples made. For active monomer raw materials, it needs to fix the content and type of prepolymer and photoinitiator, change the type of active monomer, and measure the viscosity of various material samples [5]. The viscosity measurement results of the two can be shown in table 2. It can be found that the types of prepolymer and active monomer will affect the viscosity of 3D printing materials. To further verify, the photoinitiator and various auxiliaries, active monomer types and contents of the fixed materials are used to determine the viscosity of the experimental samples of 3D printing materials by increasing the content of V400 prepolymer. The amount of active monomer is gradually increased for the simple curing material, and the viscosity of the material is measured. The results of the two are shown in figure 1. It can be seen that its viscosity is positively correlated with the content of prepolymer. However, when its content increases from 10% to 50%, the viscosity of the material grows slowly, indicating that the prepolymer in the 3D printed material gradually increases, which can increase the contact between molecules to a large extent, thus leading to the increase of the flow resistance, which will lead to the increase of the flow resistance of the whole material system. When the amount of active monomer increases, the viscosity of the material is inversely correlated. When the dosage is at least 10%, the viscosity of the material can reach 82.8 MPa·s. When the dosage reaches 40%, the decreasing trend of the material viscosity increases slowly.

Table 2. Effects of the types of prepolymer and active monomer on the viscosity of materials

| Type of prepolymer | Viscosity (mPa·s) | Active monomer type | Viscosity (mPa·s) |
|-------------------|------------------|---------------------|------------------|
| V100              | 22               | EOEOEA              | 15               |
| V400              | 30               | HDDA                | 18               |
| EB270             | 44               | TPGDA               | 26               |
| EB815             | 50               | NPGDA               | 25               |
| E44               | 170              | DPGDA               | 34               |
| E51               | 160              | TTA—21              | 45               |
| MOX               | 65               | TTA—26              | 40               |

Figure 1. Relationship between the amount of prepolymer and active monomer and the viscosity of the material
4.3. Flexibility of 3D printing materials

The application of 3D printed materials in environmental art design should ensure that they have good flexibility. In the actual research, through the analysis of the prepolymer and active monomer raw materials, it can explore the rational application of 3D printing materials in environmental art design path. It is found that different kinds of prepolymer will have a certain influence on the flexibility of 3D printing materials. For example, after the 3D printing material is fixed, other internal components are not changed, the type of the prepolymer is adjusted, and then the flexibility of the produced material is measured. For the production of 3D printing materials made of reactive monomer materials, different types of raw materials are selected, and the flexibility of the materials after production can have certain differences. The flexibility measurement results of 3D printing materials produced by prepolymer and active monomers are shown in table 3. It is found that differences in the prepolymer used in 3D printing materials will lead to differences in the flexibility of flexo materials. At the same time, V400 and E44 resin materials made of 3D printing materials have the best flexibility, but their overall performance is relatively general. Using different kinds of active monomers to prepare materials, the flexibility of the difference is also great, and in the acrylic ester active monomer raw materials, the single functional group acrylic resin flexibility is better.

| Type of prepolymer | Flexibility (mm) | Active monomer | Flexibility (mm) |
|--------------------|------------------|----------------|------------------|
| V100               | 3.5              | EOEOEA         | 2.5              |
| V400               | 2.8              | HDDA           | 2.8              |
| EB270              | 5.9              | TPGDA          | 4.5              |
| EB815              | 7.7              | NPGDA          | 4.5              |
| E44                | 2.2              | TMPTA          | 5.8              |
| E51                | 3.5              | DPGDA          | 4                |
| MOX                | 3.7              | TTA—21         | 1.6              |

5. Application of 3D printing materials in environmental art design

Combined with the advantages of 3D printing technology and the development status of environmental art design and the impact of raw materials on the performance of 3D printing materials, application of 3D printing materials in the future requires attention to the viscosity and flexibility. The aliphatic epoxy resin E44 and E51 are used as the main materials to achieve the maximum viscosity. This is because there is a positive correlation between the amount of prepolymer and the viscosity of the material. The higher the content of prepolymer, the higher the viscosity will be through the increase of the intermolecular force. For active monomer 3D printing materials, it is necessary to understand the increase in the number of monomer functional groups. Since different types of reactive monomers have different effects on the viscosity of the material, the increase in the amount of 3D printing materials will cause the viscosity to decrease. The balance of the amount weaken the influence of the dilution effect. In the development process of environmental art design, the use of 3D printing materials will become more and more common. In order to ensure its better viscosity and flexibility, V400 and E44 resin materials should be used to improve the effect of environmental art design. As an important development trend of 3D printing materials, it has great promotion value and market prospect.

6. Conclusion

To sum up, in the current science and technology progress under the situation of development theory and related research, environmental art design in the process of application of 3D printing materials can play a bigger role and function, fully guarantee of interior decoration and landscape design with good deformability and compressibility and adapt to the development of science and technology, the optimization and upgrading of traditional environmental art design industry. It can promote toward the direction of the green environmental protection, efficient and development.
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