Application of 3D printing technology in the manufacture of automotive cooling plastic molds

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Abstract: With the rapid development of 3D printing technology, it is gradually applied in the fields of laboratories, enterprises, homes, etc., when the surface of automotive cooling plastic molds is processed, it has the advantages that other molding methods are incomparable, the prototype materials required in the manufacturing process and the performance is also gradually improving, and the application range of mold production and processing will become larger and larger. In the future, the traditional processing methods of the mold industry will be integrated with 3D printing technology. This paper starts from the development of 3D printing principle and technology, analyzes the status quo of 3D printing technology, and focuses on the application of 3D printing technology in rapid sample development, complex mold manufacturing, lightweight product manufacturing, creative product customization, etc. in automotive cooling plastic mold manufacturing. . The application of 3D printing technology to automotive cooling plastic mold manufacturing not only accelerates the design and manufacturing speed of plastic molds, but also overcomes the warping deformation caused by uneven cooling of conventional plastic molds, and can greatly shorten the cooling cycle and increase production efficiency.

1. Introduction

3D printing technology began in the mid-to-late 1990s and is an important branch of rapid prototyping technology, also known as “additive manufacturing” [1, 2]. Charles Hull developed and produced the first 3D printer in 1986. In 2005, ZCorp successfully developed the world's first color 3D printer [3, 4]. In recent years, the 3D printing industry has quickly entered people's attention, causing widespread concern and gradually spreading in the fields of laboratories, enterprises, and households.

Automotive cooling plastic molds are the foundation of the development of the automobile industry and occupy a very important position in the national economy. They are one of the important means to measure the manufacturing level of a country [5]. The cooling mode of the plastic mold directly affects the quality and production efficiency of the mold. The traditional plastic mold cooling water channel is linear. The water channel processing is a conventional method using drilling, and the restriction of the plastic parts ejection system affects the water channel. The distribution, size and quantity of the plastic parts do not reach uniform and rapid cooling, which reduces the injection efficiency and the quality of the mold. The use of 3D printers to process and produce automotive-cooled plastic molds can almost completely ignore the complexity of their structure and shape, especially when machining curved surfaces, which has advantages over other forming methods. Moreover, with the rapid development of 3D printing equipment and technology, the prototype materials and performance required in the manufacturing process are gradually improving, and the application range in the production and processing of automotive cooling plastic molds will become larger and larger [6].

This paper starts from the development of 3D printing principle and technology, analyzes the current status of 3D printing technology, and focuses on the application of 3D printing technology in the manufacture of automotive cooling plastic molds. Applying 3D printing technology to automotive cooling plastic mold manufacturing can not only speed up the design and manufacturing

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speed of plastic molds, but also overcome the warping deformation caused by uneven cooling of conventional plastic molds, and can greatly shorten the cooling cycle and increase production efficiency.

2. Application of 3D printing technology in the manufacture of automotive cooling plastic molds

2.1 3D printing technology

A 3D printer works like an inkjet printer, it can be divided into binder printing, melt wax printing and molten plastic coating (FDM), laser-sintering (SLS), photo-curing resin (SLA), and laser melting (SLM) can also be considered as special cases of three-dimensional printing if the print head is replaced with a laser head, so the term generalized three-dimensional printing encompasses most incremental stacks [7].Three-dimensional printing is completely different from the cutting method for removing excess material from the blank, and is also different from the process of forming a forced material by means of die forging, stamping, casting and injection, and is an "incremental" forming technique. The specific forming process is based on the three-dimensional CAD model. After the format conversion, the parts are layered and sliced to obtain the two-dimensional contour shape of each layer section.

According to these contour shapes, a layer of binder or hot-melt material is selectively sprayed with a jet source, or a layer of liquid photosensitive resin is selectively cured with a laser beam, or a powder layer of a layer is sintered to form each two-dimensional planar contour shape of the layer section is then superimposed into three-dimensional parts [8].

3D printing technology will be one of the important ways to promote the upgrading of the manufacturing industry, including [9]:

1) Short production cycle: 3 D printing technology can simplify some of the processes in the traditional manufacturing industry. The design process and its modification process can be completed in the computer, significantly improving work efficiency.

2) High manufacturing precision: The model structure after 3D printing technology is more reasonable, and its shape accuracy, dimensional accuracy and positional accuracy are higher, which is unmatched by traditional manufacturing methods.

3) Direct manufacturing of complex models: Using 3D printers to process and produce molds, almost no need to consider the complexity of its structure and shape, especially when machining curved surfaces, it has the advantage that other forming methods are difficult to compare.

The 3D printing process can be divided into three steps [10], as shown in Figure 1.

1) 3D modeling: 3D modeling software such as UG or Pro/E is used to determine the 3D digital model of the product. The dimensional accuracy and shape accuracy of the 3D model must be guaranteed during the modeling process. The quality of the subsequent printed products depends on the quality of 3D model.

2) 3D model stratification: The automatic stratification software in the printer stratifies the 3D model along the direction parallel to the XOY plane, and each layer records the two-dimensional data information of the product. Therefore, the number of layers is more, the dimensional accuracy and shape accuracy of the product are higher, but the printing speed is relatively slower and the production efficiency is lower.

3) 3D printing: Using the printer's own reading program, the data information in each layer is identified, and the original powder material or sheet material is bonded to each other, through the cumulative combination between the layers, and finally Form a product.

In summary, the process of 3D printing is the final product shape formed by the cumulative stacking of two-dimensional layered adhesive materials.

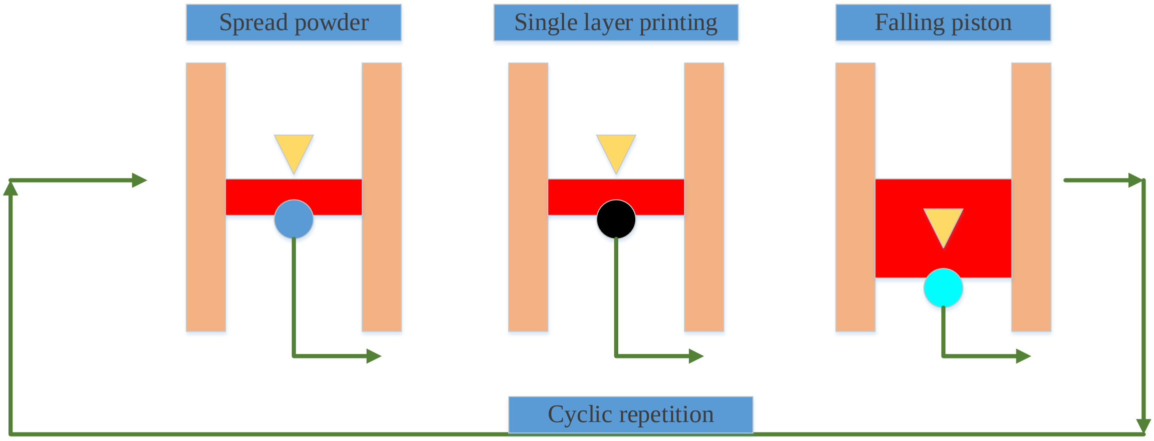

Figure 1.The main steps of the 3D printer

2.2 Application of 3D printing technology in the manufacture of automotive cooling plastic molds

The traditional automotive cooling plastic mold design and manufacturing process is mainly based on CAD software design, assembly and commissioning according to the designed components. This process is time-consuming and costly, and if the design is defective, it will cause great losses. With the gradual maturity of 3D printing technology, the reverse engineering concept changes the processing mode of traditional automotive cooling plastic molds, and by using its significant advantages in complex structural models, it can solve the difficult problem of processing complex plastics in automotive cooling plastic mold processing. The use of 3D printing technology has reduced the design process in the process of manufacturing automotive cooling plastic molds, and improved the time for product replacement. The 3D printing automotive cooling plastic mold is shown in Figure 2.

Figure 2.3D printing car cooling plastic mold

The maturity of 3D printing technology has accelerated the design and manufacturing process of automotive cooling plastic molds. The process shown in Figure 3 optimizes the process of designing and manufacturing automotive cooling plastic molds and improves the efficiency of automotive cooling plastic mold manufacturing.

3. Conclusion

The traditional man-cooled plastic mold manufacturing process requires a lot of manpower and material resources to produce a qualified mold, and the production cycle is longer. The cooling technology of automotive plastic molds is developed on the basis of 3D printing technology. 3D printing technology has built a bridge between linear cooling and conformal cooling, turning the dream of cooling waterway in the automotive plastic mold industry into reality. The application of 3D printing technology and cooling technology in automotive plastic molds has improved the cooling efficiency of automotive plastic molds, shortened the molding cycle and improved the quality of plastic parts.

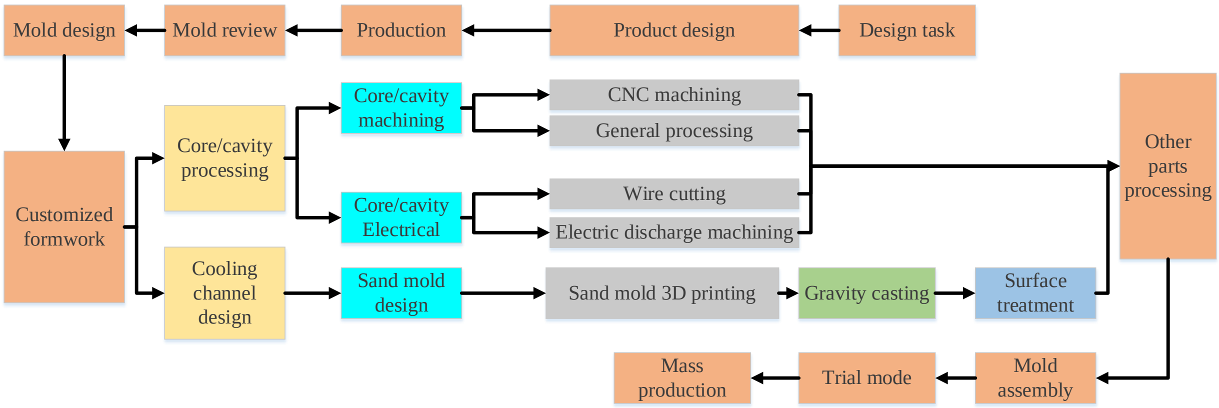

Figure 3.3D printing mold manufacturing flow chart

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