The analysis of the wax foundry models fabrication process for the CPX3000 device

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Abstract

The paper presents possibilities of creating wax founding models by means of CPX3000 device. The device is used for Rapid Prototyping of models made of foundry wax in an incremental process. The paper also presents problems connected with choosing technological parameters for incremental shaping which influence the accuracy of created models. Issues connected with post-processing are also described. This process is of great importance for obtaining geometrically correct models. The analysis of parameters of cleaning models from supporting material is also presented. At present CPX3000 printer is the first used in Poland device by 3D Systems firm for creating wax models. The printer is at The Faculty of Mechanical Engineering at Rzeszów University of Technology.

Key words: Rapid Prototyping, wax models, gears, 3D-CAD

1. Introduction

Rapid Prototyping incremental systems are used more and more often in manufacturing foundry components. RP systems can be applied for direct or indirect fabrication of foundry models as well as for indirect fabrication of foundry moulds [1-15]. In the process of precision founding, the foundry models are most frequently made of wax. That is why some manufacturers of RP devices offer machines for incremental shaping of foundry waxes or materials with parameters similar to wax. The ProJet CPX3000 3D printer by 3D Systems is a device allowing for fabrication of wax prototypes. These prototypes can be indirectly used as foundry models in lost-wax process engineering. On the basis of the prototypes, it is possible to fabricate ceramic foundry moulds applied for founding mainly machines' parts but also plaster moulds applied for making founded jewellery parts [16].

The CPX3000 printer makes it possible to print models of two types of definition – standard one HD (328x328x700 DPI – layer thickness of 36 µm) and high one XHD (656x656x1600 DPI – layer thickness of 16 µm).

2. Preparing data for the process

2.1. 3D-CAD Model

The first stage of making a foundry model is creating a 3D-CAD model (fig. 1). The CAD model can be supplemented by gate system allowing e.g. for connection with model system. The CAD model must be recorded in STL or SLC format so that it can be read by CPX3000 device software [12–14].
2.2. Programming space

The CPX3000 printer makes it possible to print models of two kinds of definition HD and XHD. In case of HD printout the working space has the following dimensions: 298×185×203 mm and in case of XHD printout the space diminishes to dimensions of 127×178×152 mm. Additionally for high definition, a barrier defining borders of HDX area appears together with the model (fig. 2). Unfortunately it causes unnecessary use of a great quantity of material.

3. Fabrication of a prototype

3.1. Preparing the device

Preparing the device for printing covers the following activities:
- turning the printer on,
- loading the modelling material (wax) and supporting material to the device storage bin,
- heating the device to working temperature,
- preparing data by means of the device software,
- starting the printing process.

3.2. Preparing data

The software allows for entering STL or SLC file into virtual working space and for defining position of models to be printed and arranging them in the working space. Programming options make it possible to read the printing time and material used up for making the models (fig. 3).

3.3. Printing the model

After finishing the program processing of models, the data for printing is sent to the printer and the printing process is started. Directly before printing, the cleaning of heads is carried out and
the cleaning products are removed to a waste container. Printing proceeds in a closed chamber which can be opened after finishing the process (fig. 4).

3.4. Cleaning the model

After finishing the printing process it is necessary to pull a working platform out of the printer and then detach models from the platform. It can be done by cooling the platform together with models and breaking them out of the platform or by heating the platform which causes melting the supporting construction and makes it easy to detach the models. Figure 5 shows a model of gear with supports detached from the platform.

The following stage of post-processing is melting and dissolving the supporting structures. The melting temperature of the modelling material (RealWax VisiJet CPX200) equals about 62 °C and the supporting material (VisiJet S200 Wax Support Material) is 42 °C. Thanks to that it is possible to melt the supports and separate them from the actual model.

The melting process of the supports takes place in a mixture of liquids: propylene glycol and propanol mixed by a proportion of 1:1. The models with the supports are sunk into that liquid and placed in a heating chamber keeping a constant temperature (fig. 6). After about 3 hours the supports are separated from the model and dissolved.

4. Conclusion

Fabricating wax founding models using incremental Rapid Prototyping devices allows for significant acceleration of the process of making a prototype of founding mould and a cast itself.

In the Rapid Prototyping process of creating wax models, the accuracy of workmanship depends in the first stage on the parameters of the process prescribed in the software of the printing device. It is necessary to pay special attention to adjusting the quality of the printout to a definite prototype taking into consideration significant use of material needed for the printout of models in XHD and a long time of making them.

The process of separating the supporting structures from the model has also got a vital influence on the prototype accuracy. Theoretically speaking, the supporting material should separate from the model without residues. In practice after finishing the process of dissolving and melting the supports, some remaining of the supporting material is often left on the model. It can be removed heating the model once again however it is necessary to be careful to keep the constant temperature of the process on the level of 42±1°C. Exceeding the temperature may cause permanent deformation of the wax prototype.
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References


Analiza parametrów procesu wytwarzania woskowych modeli odlewniczych z zastosowaniem urządzenia CPX3000

Streszczenie

Artykuł przedstawia możliwości wytwarzania woskowych modeli odlewniczych z zastosowaniem maszyny CPX3000. Urządzenia CPX3000 służy do szybkiego prototypowania modeli z wosku odlewniczego wytwarzanych w procesie przyrostowym. W artykule przedstawione są problemy związane z doborem parametrów technologicznych procesu kształtowania przyrostowego mające wpływ na dokładność wykonywanych modeli. Opisane są również zagadnienia związane z postprocessingiem. Proces ten ma zasadnicze znaczenie dla uzyskania modeli poprawnych geometrycznie. Przedstawiono analizę parametrów oczyszczania modeli z materiału podporowego w aspekcie teoretycznym i praktycznym.