Application of additive technologies in the process of technological preparation of aviation products

To cite this article: N A Lunev et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 412 012094

View the article online for updates and enhancements.
Application of additive technologies in the process of technological preparation of aviation products

N A Lunev¹, A V Shapkin³, R N Kashapov¹,², D V Kurylev³, L N Kashapov¹ and N F Kashapov¹
¹ Engineering Institute, Kazan Federal University, Kazan, 420008, Russia
² Laboratory of Radiation Physics, Kazan Physical-Technical Institute of the Kazan Scientific Center of the Russian Academy of Sciences, Kazan, 420029, Russia
³ Techproject-Service LLC

kashramiln@gmail.com

Annotation. Preparation of production and development of new science-intensive products is a complex and time-consuming process, including the creation of product models for carrying out a series of experimental studies to refine computational models, and then manufacturing the necessary technological equipment. The use of digital production technologies can reduce the laboriousness of this process. This work researches on decrease in time of development of details of the gas-turbine engine with use of digital manufacture concepts and additive technologies are given.

Technological equipment plays an important role in the technological preparation of new parts production. It largely determines the economic and technical parameters of the part production, including cost and competitiveness of the product on the market.

The main technology of manufacturing tooling is machining from monolithic billets using CNC equipment. And so this version of production is almost completely optimized and does not have a significant resource to reduce labor intensity and cost.

Modern production is characterized by a relatively fast change of products. It is possible to fabricate the forming parts of the tooling in a shorter period by selective laser melting [1, 2, 3, 4].

Additive technologies are a part of modern methods of creating new products, machines, technologies, products that are used at the stage of testing the design and construction of the product or at the stage of preparing the product for production [6].

One of the promising areas of additive technologies application is the production of technological equipment for development parts for casting on investment models (Fig. 1).
Selective laser melting is the most common method of manufacturing metal parts. The method allows producing parts with greater productivity; however, it is limited in the choice of material. Selective laser melting introduces certain requirements for the design of the part (Fig. 2).

The technology of laser melting of powder materials consists in a layer-by-layer sintering of a powder (polymer, metal) by a laser beam directed by a scanning system. Details grown by selective laser melting have a high roughness (Fig. 3). Therefore, after manufacturing the part on a 3D printer, it is necessary to mechanically process the parts.

After machining the parts, measurements were taken on the 3D scanner ATOS III Triple Scan XL and using special templates (Fig. 4).
Fig. 4 Measuring the details of grown mold
After the manufacture of all parts, mold was assembled and tested in real production conditions (Fig. 5).

Fig. 5 Molds made by using additive technologies

The following results were achieved during the work:
The duration of work on the manufacture of technological equipment didn’t exceed 2-2.5 months;
The use of additive technologies has reduced the weight of the structure and increased the utilization factor of materials in several times;
Various mesh structures and internal channels and cavities have been used in the mold design, which are impossible or difficult to obtain with conventional machining;
The resulting molds are made from fewer parts and with fewer technological operations, which have reduced the number of mating surfaces and increased accuracy.
The design process was tested and the additive technology of manufacturing reusable tooling was used, which allowed using traditional LWP technology and shortening the cycle of production preparation in real production conditions.
This work was funded by the subsidy allocated to Kazan Federal University for the state assignment in the sphere of scientific activities (11.1300.2017/4.6).

References
[1] Kashapov R N, Kashapov L N, Kashapov N F 2017 Analysis and development of methods for obtaining metallic powders for selective laser melting IOP Conference Series: Materials Science and Engineering Vol 240 Is 1 012071
[2] Kashapov R N, Kashapov L N, Kashapov N F 2015 *The research of anodic microdischarges in plasma-electrolyte processing* IOP Conference Series: Materials Science and Engineering Vol 86 Is 1 012019

[3] Kashapov L N, Kashapov N F, Kashapov R N 2013 *Research of the impact acidity of electrolytic cathode on the course of the plasma-electrolytic process* Journal of Physics: Conference Series. Vol 479 Is 1 012011

[4] Zlenko M A, Nagaitsev M V, Dovbysh V M 2015 *Additive technologies in mechanical engineering* M. SSC RF FGUP "NAMI" 220 p

[5] Kablov E N, Evgenov A G, Ospennikova O G, Semenov B I, Semenov A B, Korolev V A 2016 *Metallic powder compositions of the heat-resistant EP648 alloy produced by FSUE VIAM in the technologies of selective laser melting, laser gas-powder overlaying and high-precision casting of polymers filled with metal powders* News of higher educational institutions. Mechanical engineering No 9 (678) pp 62-80

[6] Nyamekye P, Leino M, Piili H, Salminen A 2015 *Overview of Sustainability Studies of CNC Machining and LAM of Stainless Steel* Physics Procedia No 78 pp 367-76