

СЕКЦІЯ «ТЕХНОЛОГІЯ МАШИНОБУДУВАННЯ»

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QUALITY CONTROL METHODS FOR ADDITIVE MANUFACTURING PRODUCTS

The quality of the surface of a product is understood as the state of its surface layer as a result of the influence of one or more technological methods that are sequentially applied. The most important characteristic of the quality of the surface of additive manufacturing products is roughness, which significantly affects the operational properties. The data on the values of the surface roughness of additive manufacturing products obtained by different authors have a significant spread, associated with the influence on this indicator of many factors - the method and accuracy of measurement, the measuring instrument used, the physical features of the implementation of the additive manufacturing process in different installations, the presence and type of post-processing, etc. Table 1 shows the generalized values of the surface roughness of products for some methods of additive growth and after post-processing.

Table 1 – Surface roughness of additively manufactured products

Additive manufacturing process	Surface roughness of additively manufactured products (without post-processing) R_a , mc	Surface roughness after post-treatment (best results) R_a , mc
SLA	2÷40	0,64
SLS	5÷35	0,8
FDM	9÷40	0,3
LOM	6÷27	–

Structural factors are important indicators of the quality of additive manufacturing products, in particular the quality of the surface layer. For example, typical defects observed in products made of metal materials (SLS, SLM) include the absence of fusion (delamination), shrinkage porosity, gas porosity, microcracks, thermal stresses, warping and “bulging”. Typical defects of polymer and composite products manufactured by additive manufacturing can be low interlayer adhesion, warping, absence of a layer, the presence of microcracks, the formation of micro- and macroporosity. The most promising methods of non-destructive testing of additive manufacturing products, which allow detecting both surface and internal

defects of the structure and even measuring geometric parameters with high accuracy, are ultrasonic imaging, neutron tomography, X-ray computed tomography, etc. The X-ray computed tomography method is based on estimating the density of the material by the intensity of radiation passing through the object and hitting the detector. The method makes it possible to create a three-dimensional model of the scanned object, with the subsequent obtaining of any of its sections. Based on the three-dimensional image during X-ray examination, it is possible to obtain the exact dimensions of both the internal and external surfaces of the additive manufacturing of products, determine the geometry of the internal surfaces and channels, and obtain a three-dimensional picture of the location of defects - voids, pores, cracks, inclusions, etc.

A special role in product quality control is assigned to non-destructive methods of control (monitoring) in real time, included directly in the technological process of layer-by-layer growth of products. The most effective method of monitoring, active control of a number of additive manufacturing technologies (SLS, SLM) is the method of infrared thermography, which allows you to visualize the temperature distribution on the surface of the product layer by layer and, as a result, provides control of the history of product formation by layer-by-layer growth, as well as the dynamics of processes for the purpose of product quality management. The main research tool in the thermography method is an infrared camera, which operates on the principle of registering near-infrared radiation (i.e. electromagnetic radiation with a wavelength of $0.9\div 14\text{ }\mu\text{m}$) in the laser processing zone. Information on the dynamics of the product surface temperature throughout the entire thermal cycle of laser processing is of great practical interest, since the lack of operational control in selective laser melting is one of the main obstacles to its widespread industrial application. Infrared cameras, built into the general scheme of additive manufacturing installations, provide continuous temperature measurement in local areas during the additive layer-by-layer growth process, control of thermal fields inside each layer, as well as detection of various defects of system integrity, in particular pores, microcracks and geometry violations. Thus, the infrared thermography method allows you to control the dynamics of sintering processes of dispersed media, the features of melting and solidification of melts (SLS, SLM, FDM), provides detection and prevention of the formation of the most dangerous defects of products during the layer-by-layer growth process. Based on infrared thermography data, it is possible to predict the features of microstructure formation, which ultimately determine the functional properties of products.

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