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Implementation of the additive technology to the design and manufacturing of vibroisolators with required filtering

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Abstract

The 3D printing technology of selective laser melting is described for the synthesis of a light weight vibro-isolating system. The original design of this system manufactured by casting material is based on a grid-like steel structure that may significantly decrease amplitudes of vibration at several hundred Hz. It is shown that the similar structure which is manufactured by 3D printing has smaller mass while the strength parameters are the same. Mechanical properties of the synthesized material have been studied in comparison with the material cast to ensure the mechanical properties of the printing vibroisolators. Two types of metal powders of stainless steels 07H18N12M2 and 316L are considered. It is obtained that the synthesized material has the tensile strength and yield strength values of 15% and 63% higher than the material cast. The results may be useful for development of space instruments isolation from external vibrations in the certain frequency range.

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1. Introduction

In our days the additive technology (AT) has their application in various fields of science and industry. There are publications devoted to the study of layered technology for the synthesis of heat-resistant materials, see, e.g. [1-4], the stainless steel [5,6] or titanium alloys [7,8]. The advantages of AT over different types of technologies are

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discussed in [9]. However, the practical implementations of AT to designing and fabricating the actual structures still face the problem of predicting the desired properties of the synthesized materials and products.

The example is presented in this paper of application of the AT to make the vibroisolators (VI) to ensure the normal operation of scientific instruments, which are sensitive for vibrations. They were used as the mechanical interface between the instrument and vibrating frame of a spacecraft. The vibroisolation efficiency was obtained about 20dB at the frequency range of 400-700 Hz. The grid-like structure of VI has been originally invented, as a set of thin steel washers interconnected by small masses in a chess-board order.

Before the printing the actual unit the experimental study of synthesized material of steel powders was performed. A number of testing units were printed to choose the printing parameters and another set of testing units was used to study the mechanical parameters of melting material.

2. The methodology of the study

The objects of material quality studies are thin-walled standard plate samples (SS) synthesized from metal powder of stainless steel, and manufactured using selective laser melting (SLM) technology. The SS and vibroisolator sample (VIS) were manufactured on a 3D machine SLM 280HL with 100x100 mm build platform. As a protective environment inert gas nitrogen was used to prevent oxidation and combustion of the metal powder particles. The heat source in the system was infrared fiber laser with a wavelength of 1075 nm and a maximum power of 400 watts.

The metal powders of stainless steels 07H18N12M2 and 316L were used as building material. Based on the high requirements of the metal particles, a necessary step before the growing process was to study the powder particle size and surface morphology. Input control of the metal powder was made by metallographic microscope LP-31.

In the absence of the recommended laser parameters of melting metal powder 07H18N12M2 selection of optimal parameters of the laser source was performed to evaluate the mechanical characteristics of the SS. The study of the strength properties of the samples was performed on a servohydraulic fatigue testing system INSTRON model 8802.

The quality of the synthesized material samples for the presence in the pore structure and lack of fusion between the layers was evaluated by metallographic analysis using an electron microscope Tescan Vega.

3. Experimental results and discussion

Input control of the metal 07H18N12M2 steel powder and 316L was performed before the development of manufacturing technology of VIS and SS. The surface morphology of powder particles is presented in Fig. 1. Also sized powder analysis and chemical analysis were performed (Fig. 2). The investigated powders were produced by gas atomization of the melt. For this technology, as seen in Fig. 1, it is inherent in the formation of small growths on the powder particles, which generally does not affect the process of laying the material onto the build platform and it's further melting. Dimensional analysis of the particles showed that the average diameter of the order of 35 microns, a powder brand 07H18N12M2 were detected particles with size less than 5 microns. The presence of these particles does not have a negative impact on the process of the SLM with a building layer part of 50 microns.