INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF THE $AlSi_{10}Mg$ ALLOY OBTAINED BY SELECTIVE LASER FUSION

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The purpose of these studies is to study the effect of the geometry of the construction of samples relative to the $AlSi_{10}Mg$ alloy substrate on their structure, defects and mechanical properties.

Using additive technology, selective laser melting (SLM) of powder obtained from the alloy of the specified composition was used to grow two cylindrical samples with different orientations of the cylinder axis relative to the substrate – horizontal and vertical. At the macro level, the structure is represented by tracks formed by the melt pool, having a semicircular shape in longitudinal sections (parallel to the growth direction) and oval – in cross sections (perpendicular to the growth direction). From the microstructure data obtained by the SEM method using EBSD analysis, it follows that at the micro level, the SLM samples have a hierarchical structure consisting of grains ~6 μm in size and ultrafine cells, the size of which is an order of magnitude smaller ~0.5 μm. The defectiveness and density of the samples depend on the location of the samples relative to the substrate. In the vertical sample ρ = 96%, in the horizontal ρ = 99%. According to EN 1706:2010, the hardness of the $AlSi_{10}Mg$ alloy is 50HB in the cast state and increases to 75HB after T6 heat treatment. Thus, the alloy cast using the SLM technology is significantly harder than not only the cast analogue, but also the alloy after heat treatment by 2.4 and 1.6 times, respectively. The values of $\sigma_в$ and $\sigma_{0.2}$ of the horizontal and vertical samples are almost identical, and with increasing temperature, a natural decrease in both parameters is observed (Fig. 1). If we do not take into account a small difference in the strength characteristics of the two samples, we can say that with an increase in temperature from 20 to 500°C, $\sigma_в$ decreased by ~5.5 times, i. e. on average from 408 to 74 MPa, and $\sigma_{0.2}$ – by 4.5 times. Therefore, the strength properties of SLM samples do not depend on the geometry of the construction, but are determined only by the phase composition and structure, which are almost identical. According to GOST 1583-93, the $AlSi_{10}Mg$ (AK9ch) alloy without heat treatment has the following mechanical properties $\sigma_в$ = 196 MPa, δ = 1.5. It follows from the data that the strength properties of SLM samples are 2 times higher than the standard properties of an alloy of this composition.

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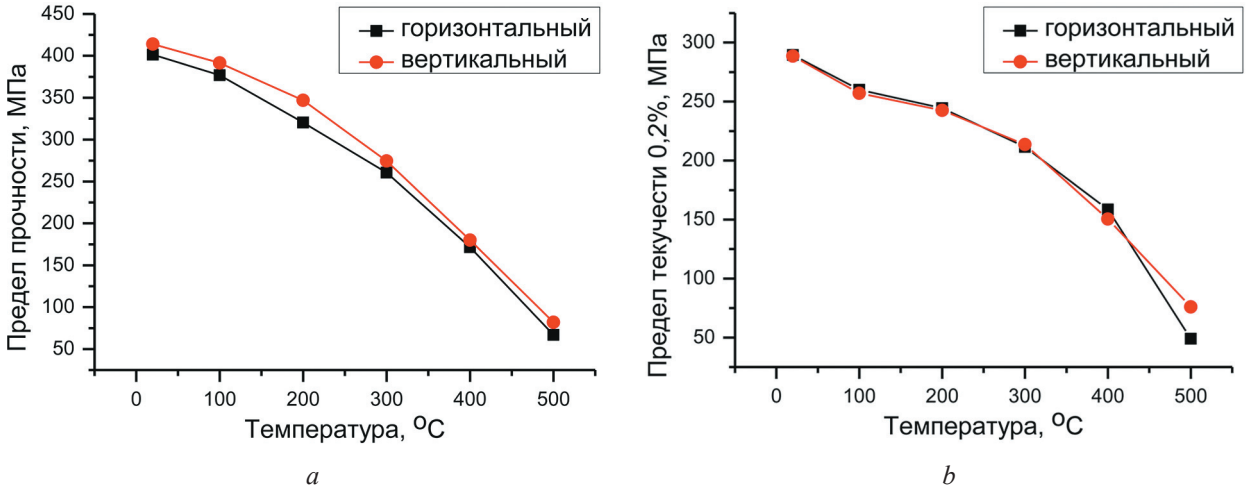

a *b*

Fig. 1. Temperature dependence of mechanical properties of SLM samples:
a – tensile strength, *b* – yield strength