# DEVELOPMENT OF ELECTRON-BEAM EQUIPMENT AND TECHNOLOGY OF LAYER WELDING OF THE WIRE IN THE CONDITIONS OF ADDITIVE TECHNOLOGIES

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Currently, more and more often, a wide range of additive technologies (or 3D printing technologies) are used to solve problems of obtaining metal products of complex shape with anisotropic properties. If it is necessary to print thick-walled parts with less accuracy (a few millimeters) and greater productivity, the method of dimensional electron beam surfacing with wire is promising. In the period from 2015 to the present, the modular installation of electron beam fusion of powders and surfacing with wire was created and constantly modernized at NI TPU. At its core is a vacuum chamber with an electron-beam gun with a plasma emitter and modular manipulators, providing the possibility of layer-by-layer alloying of powders (EBM) or dimensional deposition with wire. The software provides the possibility of modular replacement and synchronized control of all installation organs, according to the task, using digital G - codes. Printing was carried out at an accelerating voltage of 30 kV and a beam current of 15 to 20 mA (depending on the distance from the substrate), thus, the input power varied from 450 to 600 watts. The focused beam (diameter 150 μm) moved in a circular scan 4 mm in diameter. The frequency of the beam on the scan of 1000 Hz. The wire was fed to the sweep area, and the sample geometry was achieved by moving the table along three axes. The distance between the tracks (hatching distance) was 4 mm, and the layer height was 0.8 mm, the movement in the horizontal plane was zigzag. The sample construction scheme is shown in Figure 1.

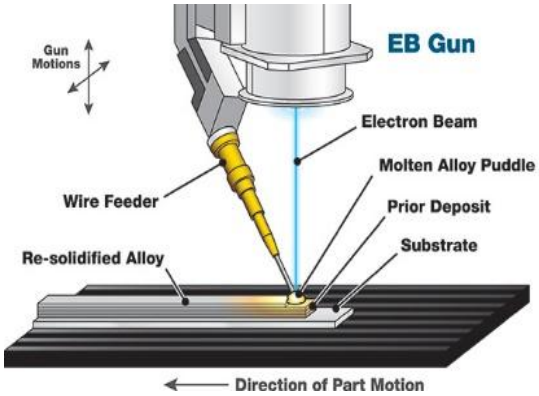


Fig.1.


Fig.2

During the work, samples from wires of titanium alloy Ti-6Al-4V and steel AISI 304 were printed on an electron-beam 3D-printer. To study porosity and mechanical properties, a continuous sample of titanium alloy in the form of a cube and from steel in the form of a rectangle was obtained, fig.2. The study of the quality of the formed samples on the subject of porosity and structural heterogeneity, and hence the mechanical properties was carried out in the work of non-destructive testing methods using computed tomography and methods of mechanical testing and metallography. It is shown that the regulation of the modes of radiation exposure and modes of wire feeding and beam scanning allows obtaining titanium and steel products with high microstructural uniformity and satisfactory mechanical properties, but the problem of reducing macro porosity requires new approaches to optimize microstructural uniformity and porosity.