SINTERING OF COMPOSITE POWDER ON THE SUBSTRATE, CONTROLLED BY ELECTRONIC BEAM

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In additive technology the creation of the product using electron beam energy is possible in many ways. In one case the electron beam runs along the previously poured powder layer. In the second case, the powder is poured into the molten bath, initially formed by the electron beam in the substrate or in the previously deposited layer. Synthesis of the composite from the mixture of titanium and carbide powders under these conditions is practically impossible to realize due to the large difference in the melting temperatures of the components, their different molar masses, and the problems of the solid particle wetting by the melt. Therefore, we assume that the powder used for layer-by-layer product growth is a Ti-TiC composite, which precludes named problems. However, it is necessary to make choice of processing conditions which ensures uniformity of sintering and a predicted shrinkage value.

During small item growing, the process is essentially nonstationary; therefore, it is required to set the mode of beam movement and energy distribution explicitly.

For a thermally thin plate and thin surface layer of the substrate we neglect the temperature distribution over the depth. We suppose that the shrinkage and the kinetic parameters in the porosity variation law depend from hydrodynamics. The thermal part of the problem includes a two-dimensional heat equation. The thermal conductivity equation takes into account the heat loss from the surface according to the Stefan-Boltzmann law and the effective heat loss into the substrate.

The porosity variation leads to change in the thermophysical properties and the shrinkage of the powder layer. The specific heat and thermal conductivity of the poured particles are calculated by the rule of the mixture, depending on the fraction of titanium carbide. The thermal conductivity of the powder layer depends on the porosity. The thickness of the powder layer varies according to the kinetic law.

Figure 1 shows the change in the thickness of the stacking over time layer for different scanning modes.

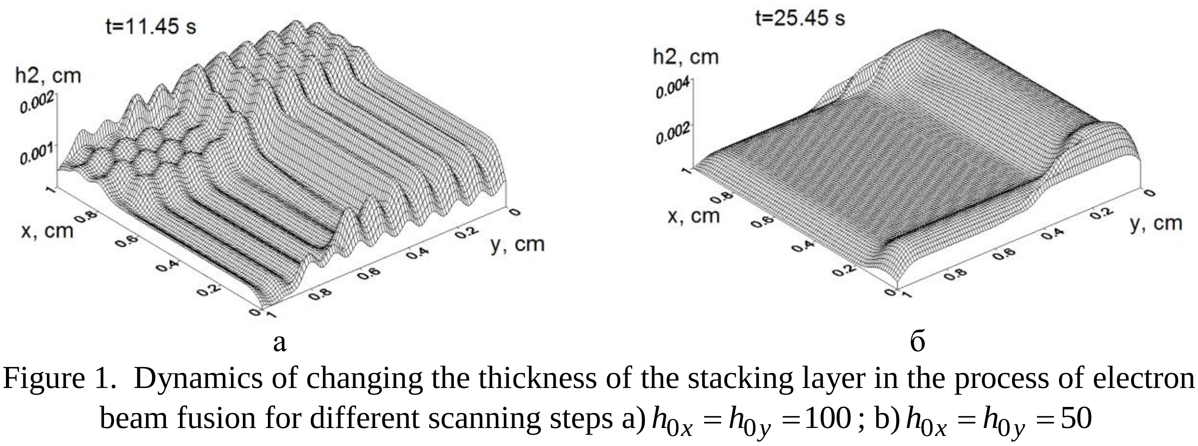

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Figure 1. Dynamics of changing the thickness of the stacking layer in the process of electron beam fusion for different scanning steps a) $h_{0x} = h_{0y} = 100$; b) $h_{0x} = h_{0y} = 50$

Mathematical modeling allows studying nonequilibrium phenomena accompanying the synthesis of composite powders and the layer-by-layer formation of products as well as the laws of the formation of properties at the synthesis and fusion regimes changing.

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