N3-P-009202

MACRO- AND MICROSTRUCTURE OF THE SUPERALLOY COMPONENTS FORMED BY ELECTRON BEAM ADDITIVE MANUFACTURING*

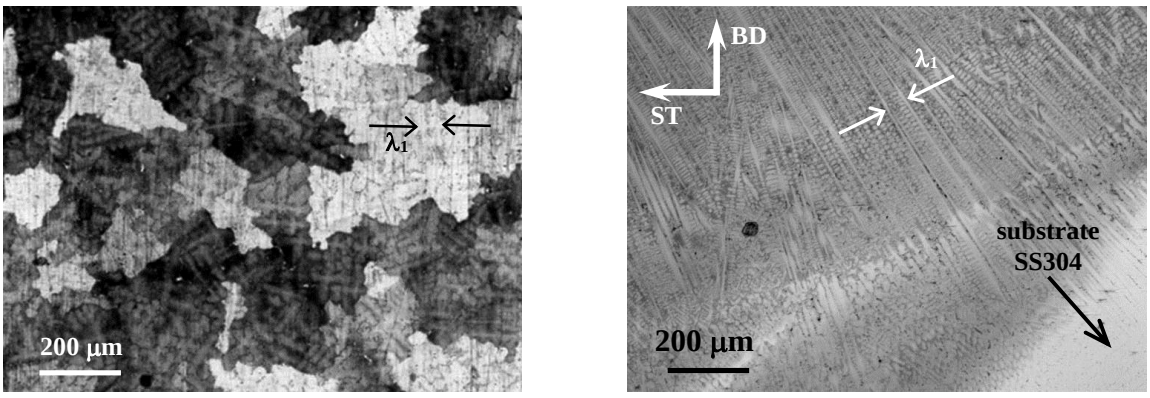
S.Y. NIKONOV, S.V. FORTUNA, D.A. GURIANOV

Institute of Strength Physics and Materials Science SB RAS, Tomsk, Russia

Additive manufacturing processes are characterized by very high temperature gradients and crystallization rates. These conditions lead to the formation of microstructural elements of a smaller size than in conventional casting processes, a multiple or more times. As applied to nickel-based superalloys, this opens up potential opportunities for developing methods for forming parts of the hot path of gas turbine plants with improved performance [1]. However, the high cracking susceptibility of PH superalloys is a problem for additive products.

In the present work, additive products of a simplified form in the form of vertical walls from the second generation superalloy ZhS32 [2] were fabricated by means of electron beam additive manufacturing (EBAM). The influence of heat input [3] and the printing strategy on the given geometry of additive products, on the formation of macrodefects in the material of products, as well as on the sizes and morphology of microstructure elements was studied. The studies were carried out by means of optical and scanning electron microscopy.

As an example, Figure 1 shows images of the microstructure of superalloy ZhS32 in the initial (cast) state, as well as the material of an additive product formed from bars of the same alloy on a substrate of austenitic steel SS316. It is clearly seen that the microstructure of the material of the additive product is represented by colonies of dendrites. In this case, the axes of the first-order dendrites are predominantly oriented along the direction of additive growth of the product (building direction - BD in Figure 1b) with an inclination of approximately 30 degrees towards the 3D printing trajectory (scanning trajectory - ST in Figure 1b). Note that the average distance between the axes of the first-order dendrites λ_1 in the material of the additive product is about 33 μm, and in the cast state about 75 μm.



(a) (b)

Fig. 1. Microstructure of nickel-based superalloy ZhS32 in the as-cast state (a) and microstructure of material of product obtained by wire-feed EBAM (b)

REFERENCES

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* The investigation was supported by the Russian Science Foundation grant No. 22-22-00891, https://rscf.ru/en/project/22-22-00891/.