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EFFECTS OF DEFORMATION OF THE HIGH-TEMPERATURE SYNTHESIS PRODUCT ON THE GRAIN SIZE OF THE Ni_3Al INTERMETALLIC COMPOUND SYNTHESIZED UNDER PRESSURE

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Improving the strength properties of Ni_3Al intermetallic compounds in a wide temperature range is a current task when developing a new generation of heat-resistant intermetallic alloys. One of the key parameters determining the level of intermetallic compound operational properties is the grain size. It is theoretically shown that for ordered intermetallic compounds, which are characterized by low ductility under tension as a result of destruction along the grain boundaries, there is a critical grain size below which an increase in the crack resistance of the polycrystal occurs (the stress intensity coefficient K_{Ic} increases, the plasticity of the intermetallic compound increases) [1]. The significance of the problem is determined by the increased brittleness of the intermetallic compound, whose content in modern nickel superalloys reaches 89% [2]. Therefore, the use of known methods of plastic deformation for intermetallic compound grain refinement to increase its strength properties is very limited, but it is possible under the conditions of a volumetric exothermic reaction of the intermetallic compound in a powder mixture of nickel and aluminum [3-4]. It is known that the thermal effect of the bulk exothermic reaction of the Ni_3Al intermetallic compound formation in a powder mixture of nickel with aluminum reaches $9.7 \pm 1.9 \cdot 10^6$ J / kg with a self-heating of synthesis product to temperatures above 2000 K. The formation of grain nuclei in the synthesized intermetallic compound occurs in non-equilibrium thermodynamic conditions at the peak of the high-temperature synthesis product heating with grain growth at the stage of the intermetallic synthesis product crystallization. The retention of the grain structure in a highly dispersed state is possible under the conditions of synchronization of the bulk exothermic reaction and force compaction (deformation) processes of the high-temperature synthesis product (Fig. 1).

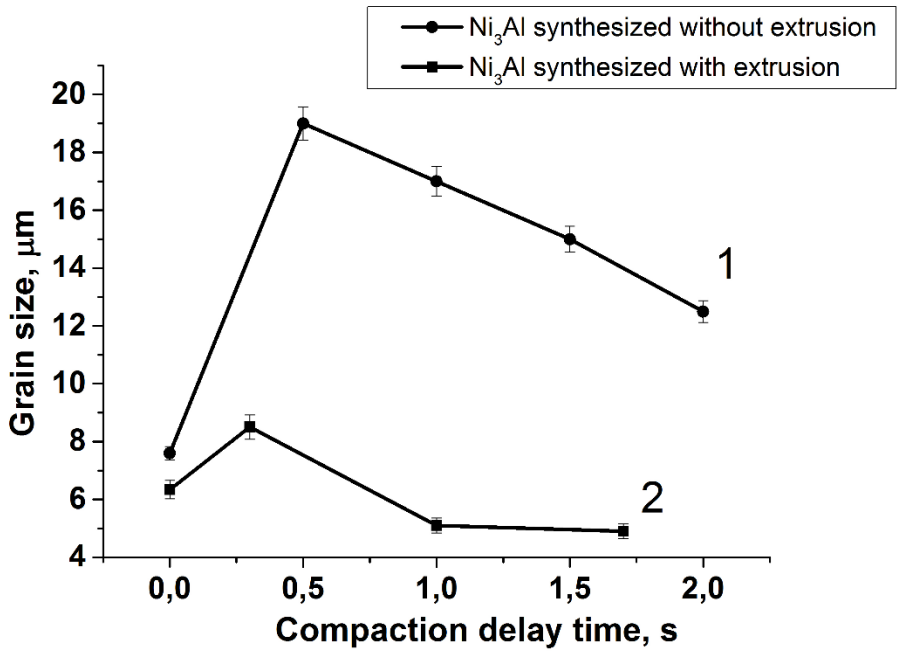

Fig.1. Dependence of grain size in the Ni_3Al intermetallic compound synthesized under pressure in closed (1) and open (2) die-molds on the delay time for the application of pressure to the high-temperature synthesis product.

It is established that an increase in the deformation ratio of the high-temperature synthesis product during its deformation in an open die-mold (with partial extrusion of the product of synthesis) leads to a fold decrease in the grain size in the intermetallic compound synthesized under pressure.

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