**NiAl-BASED ALLOY BY SHS METALURGY**

**AND SUBSEQUENT REMELTING AND CASTING IN STEEL PIPE**

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High-alloyed Ni, Co, or Fe presently are base alloys when developing many materials operated in extreme conditions (high temperatures and loads) used in such industries as aircraft and marine engine building, rocket and space vehicle technology, special techniques, technologies for creating nuclear power plants, etc. A significant number of works in this area is aimed at solving problems concerned with the development of new alloys with an increased level of physicochemical characteristics and technologies for their production. Particular attention is paid to alloys based on equiatomic nickel aluminide, which have unique combinations of chemical, physical, and operational properties: high melting point (1640⁰C), chemical stability, low density, high heat and corrosion resistance. Despite the above advantages, these alloys have not yet been implemented on a large-scale, which is due to their lack of manufacturability, low ductility and strength at room temperature.

Common production technologies for such materials often do not allow achieving the required set of properties and, in addition, are complex, multi-step, energy-intensive. The combination of such factors does not allow for the commercial launch of these materials. One of the efficient directions in solving the problem of guaranteed increase product quality of these materials while reducing the energy and material manufacture-related costs is the development of a comprehensive technology for the production of NiAl-based cast materials.

The present paper suggests a complex technology for the production of blend billets based on nickel aluminide, which includes: (1) synthesis of cast charge materials (SCCM) with a regulated chemical composition by centrifugal self-propagating high-temperature casting method [1], (2) one-stage metallurgical processing (induction remelting under vacuum or inert medium) of synthesized SHS materials (SCCM) with subsequent pouring into ingots to form blend billets of s set geometry. Initially, a set of experiments was performed to optimize the synthesis conditions for a multicomponent intermetallic alloy. The analysis of the samples in the investigated range of (g) values showed that the mass of the ingots of the alloy synthesized at 50–150 g (± 5 g) was close to the calculated (~ 98 mass %), and its loss (spread) in the combustion process did not exceed 1.5% by weight. All samples obtained at the given overload had a cast shape, and a clear separation into 2 layers was observed: the target alloy and the oxide layer (Al2O3). It is evident that residual porosity was not detected on the transverse cleavage of the ingot under the condition of synthesis of more than 50 g (Fig. 1).

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| --- | --- | --- | --- |
| 1 g | 15 g | 50 g | 150 g |
| IMG_2726 | IMG_2726 | IMG_2727 | IMG_2727 |

Fig. 1. Overall view of samples obtained with various overloads (g) after transverse cleavage.

During the next stage of the research, a remelting of the previously synthesized SCCM in a high-temperature viscometer VIC-VRM was performed to find the exact melting point of the investigated alloy, which equaled to 1570°C. Melting was carried out in an Ar atmosphere with an excess pressure of 0.3 atm. The next stage was vacuum induction remelting (VIR) of the obtained SHS-alloy blanks and pipe-casting followed by crystallization and preservation of this alloy in this cylindrical form. Based on the data obtained in earlier studies of these alloys [2], the main task was to study the required diameter of the cylindrical crystallizer, as well as its composition. A series of melting and casting in various diameters and compositions of steels was carried out. The optimum variant was a cylindrical crystallizer made of steel grade 10 with a wall thickness of 6 mm. Figure 2a shows the resulting long-length sample. There is no chemical interaction of NiAl-based alloy with in the inner part of the pipe wall. The alloy is retained in the pipe only due to the coefficient of thermal expansion (CTE) and mechanical interaction by means of incisions (previously shown on the inner part of the pipe) (Fig. 2b).

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| (a) | (b) | (c) |

Fig. 2. (a) The resulting NiAl-alloy in the tube, (b, с) cut of NiAl-alloy.

After casting and crystallization, the pipe walls do not melt. Figure 2c shows samples taken from the base, middle and upper parts of the long-length sample. Thus, it is the possibility of subsequent turning on the entire surface.

Thus, a one-piece long-dimensional (L = 600 mm) cylindrical sample (d = 70 mm) was obtained from the NiAl-based alloy for subsequent plasma centrifugal sputtering and obtaining spherical pellets based on Fe + NiAl alloy with improved performance.

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