INFLUENCE OF CRYSTALLIZATION RATE ON A MICROSTRUCTURE AND MECHANICAL PROPERTIES OF THE DIRECTIONALLY SOLIDIFIED Mo-17,5Si-8B ALLOY

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Used for today for producing of turbine blades nickel-based superalloys exhausted the temperature limit of application (to 1100 °C) due to quite low melting point [1]. Thus absence of new high-temperature materials is the principal reason of slow development in area of turbine industry [2].

One of the most perspective candidates for replacement of nickel superalloys are alloys on the base of molybdenum. Especially well-recomended molybdenum alloys doped with silicon and boron. There are plenty of examples in literature of producing of such alloys by casting [3] and powder metallurgy methods [4]. The floating zone method used in our research is new approach for obtaining of Mo-Si-B alloys.

A microstructure and mechanical properties of the alloy Mo-17,5Si-8B (the values are set in atomic percents) as function of solidification rate are the main aims of this work. The investigated alloys were grown by a modified floating zone method based on crucible-free zone melting of compacted powders. The solidification rate was varied in range of 40-80 mm/hour.

The SEM and XRD analyses showed that the alloys consisted of three phases: Mo_3Si, Mo_5SiB_2 and solid solution of molybdenum independently of solidification rate. The molybdenum silicide Mo_3Si occurred as a matrix phase, and two other phases were disposed as discrete fibres along direction of solidification. Also for each samples the amount of every phase was calculated. And direct dependence on speed of growing was here noticed. So with increasing of rate from 40 to 80 mm/hour the volume fraction of solid solution of molybdenum was also increased (from 15,2 % to 25,4 %), and the volumes fractions of Mo_3Si and Mo_5SiB_2 were decreased (63,7 % - 58,2 % and 21,1 % - 16,4 %, accordingly).

The grown alloys were tested on a three-point bend in the temperature range of 871 - 1093 °C. It was shown, that the increase of solidification rate and testing temperature results in the increase of strength of the composites. So an eutectic alloy grown at a speed of 80 mm/hour and tested at 1093 °C had maximal bending strength value (725 MPa).

In addition, the creep behavior of this alloy at 1093 °C was investigated. For these tests the alloys grown with solidification rate 40 and 80 mm/hour were used. At loads from 50 to 150 MPa the small increasing in creep resistance with solidification rate was observed. At loads higher then 150 MPa the creep rate did not depend on solidification rate. Comparison of creep rate of the Mo-17,5Si-8B alloy with creep rates of pure molybdenum, nickel superalloy CMSX4 and other molybdenum-based alloys shown, that the investigated alloy has promoted creep resistance and is a perspective candidate for producing of details for gas-turbine engines.

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