MICROSTRUCTURE, TENSILE BEHAVIOR AND OXIDATION RESISTANCE OF THE TWO-STEP HEAT TREATED NB-TI-SI BASED ALLOY

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Although the temperatures of the hottest section of advanced turbine engines are approaching the limit of nickel-based superalloys, the desire for continued performance improvements for gas turbine engines continues [1]. Nb-Ti-Si based alloys have attracted much attention for their high temperature melting points, relatively low densities and excellent high temperature mechanical properties [2]. In this alloy system, the constitute phases are niobium solid solution (Nb_{SS}), silicides (Nb_5Si_3 and / or Nb_3Si) and with / without Cr_2Nb. Among these phases, Nb_{SS} ensures room temperature fracture toughness and tensile strength, silicides offers high temperature strength, and Cr_2Nb provides the oxidation resistance [3].In this study, the Nb-Ti-Si based alloy was firstly prepared by arc-melting and then directional solidification at a rapid speed. Two-step heat treatments were carried out on the directionally solidified Nb-Ti-Si based alloy. The first-step heat treatment was performed at 1375, 1400, 1425 and 1450 °C for 10hours, respectively. According to the microstructure characteristic and their resulting tensile strength, the best condition for the first-step heat treatment is 1425 °C/10 h. Then the second step heat treatment was conducted at 1000, 1100, 1200 and 1300 °C for 50 hours, respectively. The precipitation of nano-scale Cr_2Nb particles in the Nb_{SS} matrix substantially improved the tensile strength from 850 MPa to 950 MPa, and reduced the weight gain of the alloy from 218.27 to 144.41mg/cm^2 by the second step heat treatment at 1000 °C.

References

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