DEVELOPING NB-SI BASED ULTRA-HIGH TEMPERATURE MATERIALS IN BIAM

Yongwang Kang, Science and Technology on Advanced High temperature Structural Materials Laboratory, Beijing Institute of Aeronautical Materials, China
ywkang1208@126.com
Ming Li, Science and Technology on Advanced High temperature Structural Materials Laboratory, Beijing Institute of Aeronautical Materials, China
Meiling Wu, Science and Technology on Advanced High temperature Structural Materials Laboratory, Beijing Institute of Aeronautical Materials, China
Fengwei Guo, Science and Technology on Advanced High temperature Structural Materials Laboratory, Beijing Institute of Aeronautical Materials, China

Keywords: Nb-Si based alloy; chemical composition; Microstructure; Mechanical Properties, heat treatment, manufacture processing

Nb-Si based materials have the attractive characters such as of higher melting points(＞1750℃), relatively lower densities(6.6-7.2g/cm^2) and excellent high-temperature strength in comparison with Ni based superalloys, which are greatly potential to serve in the condition with the temperature range of 1200~1400℃ as a family of ultrahigh temperature structural materials to replace Ni base superalloy. However, , there are three challenges to the application of Nb-Si based materials, including the balance of mechanical properties, the manufacturing processing and the high temperature oxidation resistance. In Beijing Institute of Aeronautical Materials, the research about optimizing chemical composition, ultrahigh temperature heat-treatment and developing special manufacturing processing have been carried out. The results showed that the V and rare metal is able to increase the room temperature toughness of Nb-Si based materials. And the addition of Cr and V are beneficial to the oxidation resistance properties, which will decreased the average oxidation rate and the spallation of oxide scale. After heat-treated at 1600℃/20h, the microstructure of Nb-Si based Materials is finer and the rupture strength at room temperature and 700℃ were raised. With the directional solidification method (DS), the materials with directional solidified microstructures are obtained and with selected laser melting method (SLM), the materials with uniform fine microstructures. The maximum value of tensile strength at 1250℃ was ~190MPa at 0.2 mm/min solidification rate. The room temperature fracture toughness and ductile are improved by SLM. Especially, the ceramic shell for the investment casting of Nb-Si based materials are manufactured successfully, which service temperature is over 300℃ higher than the conventional ceramic shell for Ni-based superalloys. Based on the ceramic shell, the simulated turbine blades with fine microstructure and without inner defects have been prepared at 2000℃.