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# Effects of V and B, Y additions on the microstructure and creep behaviour of high-Nb TiAl alloys

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## Abstract

The influence of the addition of V and B, Y on the microstructure, microsegregation and creep behaviour of the Ti–44Al–6Nb–1Cr (at.%) alloy is investigated. The creep tests performed at 800 °C and 150 MPa show that the Ti–44Al–6Nb–1Cr alloy with a small blocky microsegregation region and smooth colony boundary exhibits the poorest creep resistance. The addition of 2.0 V at.% promotes the formation of a γ phase in the microsegregation region and leads to a large blocky microsegregation area in the matrix. The large blocky microsegregation region with a low specific surface area provides colony boundary strengthening and improves creep resistance. The addition of B and Y affords an obvious refinement in the lamellar colony, provides an increasing opportunity for cavity nucleation at the colony boundary, and thus reduces the creep resistance. The creep failure mechanisms of the three alloys are compared and analysed.

***Keywords***: TiAl; Microsegregation; Creep; Microstructure; Failure mechanism

## 1. Introduction

Advanced intermetallic TiAl alloys are considered promising high-temperature structural materials for use in aerospace engineering and automotive applications; particularly, high Nb-containing TiAl alloys have attracted a great deal of attention due to their excellent properties and oxidation resistance at elevated temperatures [1-3]. However, in a high-Nb TiAl alloy, the high Nb-containing alloy combined with a low aluminium-containing alloy usually induces the formation of a β(B2) phase in the matrix due to elemental segregation, which is harmful to the room-temperature ductility and high-temperature creep resistance [4, 5]. Recent results have shown that the ductility and strength of high-Nb TiAl alloys could be significantly improved by refining grains and the addition of alloying elements [4, 6, 7]. Furthermore, the high-temperature properties of TiAl alloys depend strongly on the microstructure, and the microstructure is very sensitive to the addition of alloying elements [2, 8].

It has been reported that when solid solution strengthening elements such as Nb, V and Cr were used in TiAl alloys for improving their room-temperature ductility and elevated-temperature strength, they showed great potential in controlling and stabilizing the microstructure [8-10]. The addition of the β-stabilizer Nb or V to the TiAl alloys can improve the creep resistance [11, 12]; however, the addition of V in high-Nb TiAl alloys may alter the microstructure and microsegregation. Therefore, it is necessary to investigate the effect of the addition of V on the microstructure and creep behaviour in high Nb-containing TiAl alloys. It is recognized that the as-cast high-Nb TiAl alloy, which possesses a good balance of mechanical properties, needs to be refined by the addition of refining elements such as B and Y [4, 6, 13]. B additions are known to act as an effective grain refining agent in low aluminium-containing TiAl alloys at levels as low as 0.1-0.2 at.% (all chemical compositions are in at.%) and can be very effective reducing grain sizes to approximately 30 μm [10, 14, 15]. Both the lamellar colony and lamellar spacing were refined