DOI: 10.1017/S1431927605508869
Microsc Microanal 11(Suppl 2), 2005

THE EFFECT OF ALLOYING ON Nb-SILICIDE PHASE STABILITY

B.P. Bewlay and K. Dovidenko

General Electric Global Research Center, Schenectady, New York 12301

Composites based on niobium solid solutions and niobium silicides, such as Nb_5Si_3 (tI32 crystal structure) and Nb_3Si (tP32 crystal structure), are presently being developed for very high-temperature structural applications [1, 2]. The use of alloying additions of elements such as Hf, Ti, Cr and Al to improve composite properties has also been explored. The present paper describes the effect of alloying on the crystallography of Nb_5Si_3 and Nb_3Si type phases. Microstructural analyses, electron backscatter diffraction pattern (EBSD), and X-ray diffraction data will be discussed.

Nb-silicide in-situ composites typically form a niobium solid solution and Nb-silicide phase on solidification [1, 2]. The present paper will show that the crystallography of the Nb_5Si_3 phase that forms from the melt upon solidification is a function of the Hf, Ti, and Al concentrations in the Nb-silicide. The composites were prepared by arc melting and heat treatment, as described previously [1]. The cast composites were also hot isostatically pressed (HIP) and homogenized.

The composite microstructure and crystallography of the phases were examined both in the as-cast, and the cast plus heat treated conditions. The microstructure of a cast Nb-24Ti-4Hf-5Cr-2Al-2W-1.5Sn-14Si alloy is shown in Figure 1(a). The composite contained large-scale (Nb) dendrites (~75μm) (light phase) that grew cooperatively with large-scale $(Nb)_5Si_3$ (dark phase). The cooperative growth of the (Nb) and $(Nb)_5Si_3$ occurred in a cellular manner, and at the intercellular boundaries a eutectic of (Nb) and hP16 $(Nb)_5Si_3$ was observed.

A similar microstructure was observed in the cast Nb-24Ti-4Hf-5Cr-2Al-2W-1.5Sn-20Si alloy as shown in Figure 1(b). However, a smaller volume fraction of (Nb) dendrites was observed, and there was a larger volume fraction of tI32 $(Nb)_5Si_3$. EDS indicated that Hf partitioned strongly to the hP16 $(Nb)_5Si_3$. Only a small volume fraction of hP16 $(Nb)_5Si_3$ was observed. The effect of additional alloying elements on the crystallography of the type $(Nb)_5Si_3$ phases will also be described.

References

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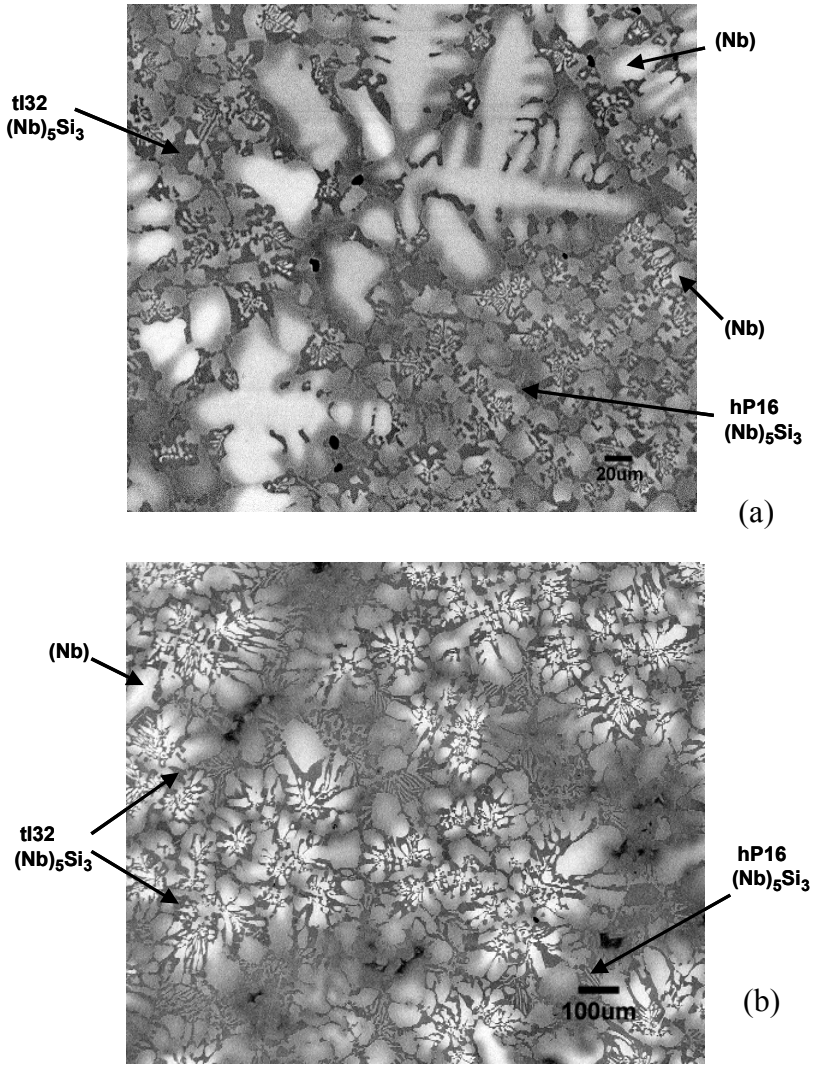

FIG. 1: Backscatter electron image (BSE) of the (a) Nb-24Ti-4Hf-5Cr-2Al-2W-1.5Sn-14Si alloy, and (b) the Nb-24Ti-4Hf-5Cr-2Al-2W-1.5Sn-20Si alloy.

https://doi.org/10.1017/S1431927605508869 Published online by Cambridge University Press