Microsc. Microanal. 8 (Suppl. 2), 2002
DOI 10.1017.S1431927602107707

Nb-SILICIDE PHASE STABILIZATION IN CAST AND HIP IN-SITU COMPOSITES

B.P. Bewlay, M. Larsen, P.R. Subramanian and M.R. Jackson

G.E. Global Research, Schenectady, New York 12301.

In-situ composites based on (Nb) and (Nb) silicides, such as Nb_5Si_3 (tI32 crystal structure) and Nb_3Si (tP32 crystal structure), are being investigated 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 is also being explored. The present paper describes microstructure and electron backscatter diffraction pattern (EBSD) analyses of Nb-silicide based composites with new phase architectures.

Nb-silicide in-situ composites typically form (Nb) and Nb_3Si type phases on solidification [1, 2]. The Nb_3Si is metastable and upon heat treatment it transforms to (Nb) and Nb_5Si_3. Thus, Nb_5Si_3 is formed by combined processes of solidification and high-temperature (1500^{o}C) heat treatment. This places a major limitation on the volume fraction of Nb_5Si_3 that can be generated in the composite. The present paper will show that with appropriate alloying elements, Nb_5Si_3 and (Nb) phases can be formed directly from the melt upon solidification (without subsequent heat treatment), and these phases remain stable after heat treatment at 1500^{o}C.

The composites were directionally solidified and investment cast using advanced ceramic molds. In selected cases, cast composites were also hot isostatically pressed (HIP). Microstructure and phase characterization were performed using scanning electron microscopy, EDS, and EBSD. The microstructure of a directionally solidified 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 tI32 $(Nb)_5Si_3$ occurred in a cellular manner, and at the intercellular boundaries a eutectic of (Nb) and hP16 $(Nb)_5Si_3$ was observed. EBSD was used to identify the phases; it was not possible to differentiate the silicides using only BSE imaging and EDS.

A similar microstructure was observed in the investment 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 $(Nb)_5Si_3$. Only a small volume fraction of hP16 $(Nb)_5Si_3$ was observed. EDS indicated that Hf partitioned strongly to the hP16 $(Nb)_5Si_3$. The microstructure of the same composition is shown after HIP in Figure 1(c). The HIP treatment has provided homogenization and coarsening of the microstructure. However, the same phases were observed in the HIP composite as in the investment cast composite.

References

1. B.P. Bewlay, M.R. Jackson, and P.R. Subramanian, JOM, (1999) Vol 51(4) (1999), pp. 32-36.
2. M.G. Mendiratta and D.M. Dimiduk, Metall. Trans. A 24A (1993), pp. 501-504.

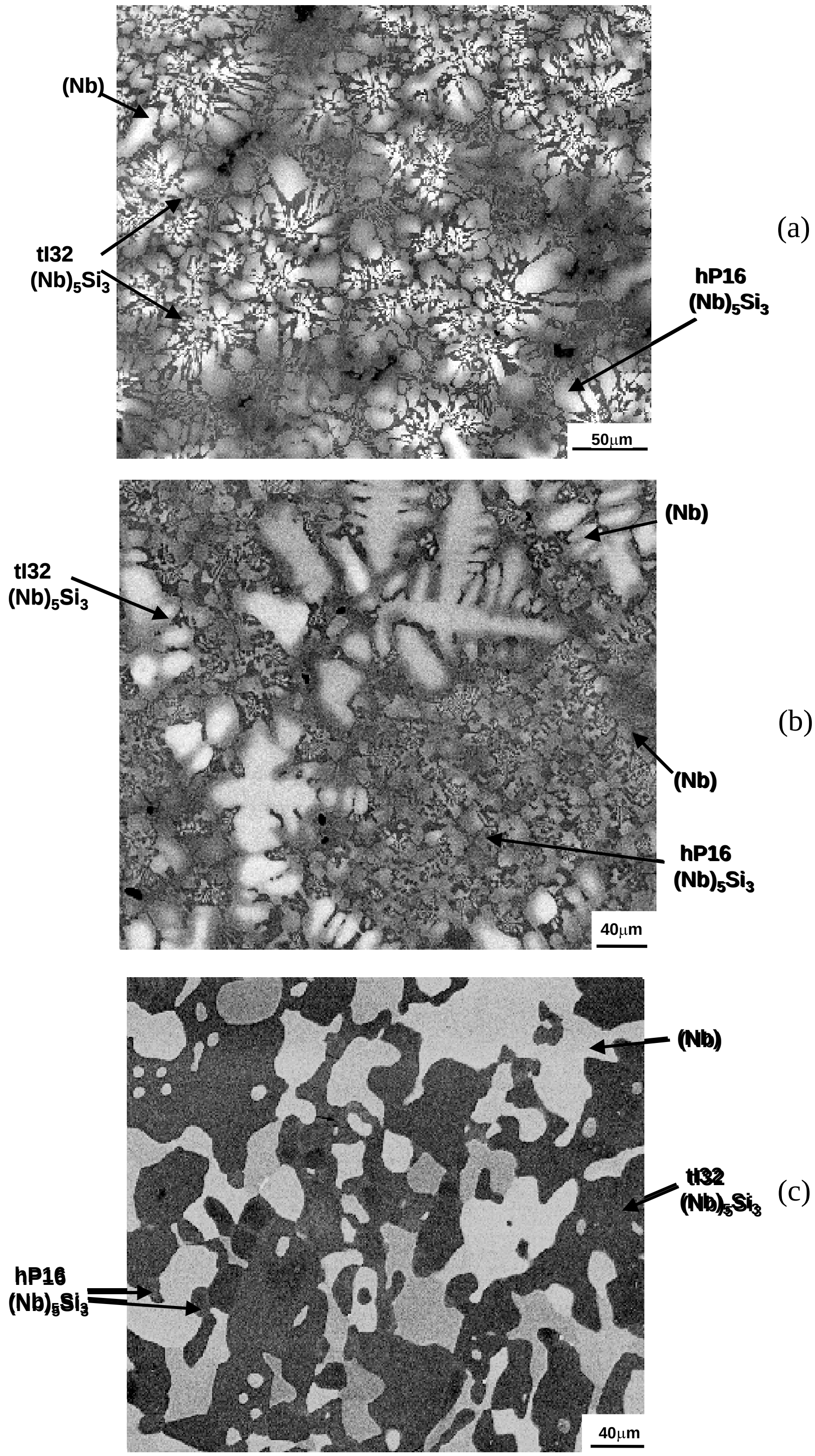

FIG. 1: Backscatter electron images (BSE) of the (a) directionally solidified, (b) investment cast, and (c) investment cast plus HIP Nb-silicide in-situ composites.

https://doi.org/10.1017/S1431927602107707 Published online by Cambridge University Press