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Phase Stability and Microstructural Formations in the Niobium Carbides

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Abstract

The phase stability and microstructural formations for a series of hot isostatically pressed (HIP) NbC_x compositions was investigated. Based on the composition, single-phase B1 ($Fm\bar{3}m$) NbC or ($P\bar{3}1m$) β–Nb_2C equiaxed grains were observed as well as β–Nb_2C lath precipitation within NbC. Particular discussion is given to the complexities of X-ray and electron diffraction for proper identification for the various poly-types of Nb_2C that have been computationally predicted. The phase transformation pathways for these microstructures was revealed by a NbC-Nb diffusion couple from the HIP powders. The migration of vacancies towards the NbC side resulted in a refinement of the NbC grains whereas carbon's migration into the Nb formed an uniform and distinct reaction front with a mixture of β-Nb_2C and Nb grains. This latter microstructure suggests carbon's reaction through the matrix grain is as significant in the conversion process as is the precipitation of β-Nb_2C at the grain boundaries.

Keywords: Transmission electron microscopy (TEM), Transition metal carbides, Niobium carbide, Precipitation, Hardness