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ARTICLE

Nb-Ti Based Alloy Powder Prepared by Hydride-Dehydride Method

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Abstract: Micro-fine lightweight Nb-Ti based alloy powder was fabricated by a hydride-dehydride method, and the hydrogen absorption/desorption behavior was investigated. Results show that obvious hydrogen absorption occurs at 300 °C, and the absorbed hydrogen quantity reaches a saturation value of 1.12 wt% at 400 °C. Binary and ternary hydrides ($Nb_{0.803}V_{0.197}H$, $Nb_{0.696}V_{0.304}H$ and TiH_x) are formed after hydrogenation. Hydrogen-induced embrittlement facilitates the pulverization of the thin alloy plate. During dehydrogenation process, hydrogen content is effectively reduced to 0.001 wt% at 300 °C. Phase transformation from niobium or titanium hydrides to single phase solid solution alloy (β phase) was achieved. Oxygen content of the powder increases with increasing hydrogenation or dehydrogenation temperature due to the high reactivity of constituent elements with oxygen, and both hydrogenation and dehydrogenation temperature of 400 °C is selected in order to prevent severe oxygen intake. Micro-fine Nb-based alloy powder with average particle size of 16 μm and oxygen content of 2980 μg/g is obtained. Superfacial contamination of the obtained powder is detected, and oxygen impurity exists in the form of Nb_2O_5 and TiO_2.

Key words: powder metallurgy; Nb-Ti based alloy; powder preparation; hydrogenation; dehydrogenation

With low density, high melting point, high strength, and favorable oxidation resistance, Nb-Ti based alloy has attracted increasing attention as a promising high-performance lightweight refractory metal for high-temperature structural application in aerospace and military weapon industries[1-3]. A muplticomponented, body centered cubic solid solution strengthened Nb-Ti based alloy is developed, aiming at service temperatures above 1200 °C. This temperature is beyond the scope of Ni-based superalloys[4,5]. The alloying elements not only ensure high temperature strength and oxidation resistance of the alloys but also lower density (6.85 $g\cdot cm^{-3}$). Conventionally, Nb-Ti based alloys were fabricated by vacuum arc melting, casting and rolling[6-8]. The complexities in their thermo-mechanical processing and the subsequent machining, coarse microstructure and composition macrosegregation greatly restrict their widespread usage. The complex shaped Nb-Ti based alloy components are difficult to be fabricated due to its high resistance to deformation and hard machinability. In order to overcome these shortcomings, a powder metallurgy based processing approach has attracted increasing attention in recent years as it offers the prospect of producing complex shaped parts with homogeneous microstructure and fine grains.

Raw powder material with fine particle size and low oxygen content is prerequisite for niobium powder metallurgy. The preparation of Nb-Ti based powder has several difficulties due to its high melting temperature and high activity. The traditional powder preparation process of Nb-Ti alloy mainly involves mechanical alloying and atomization technologies[9,10]. Due to the high melting temperature of Nb-Ti alloy, argon atomization (AA) is no longer applicable. Mechanical alloying has the disadvantage of low efficiency and high risk of contamination[11,12]. Although the spherical powder prepared by plasma rotating electrode process (PREP) is suitable for pow-

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