Materials and Design 32 (2011) 5010–5014

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Short Communication

Producing Ti–6Al–4V/TiC composite with good ductility by vacuum induction melting furnace and hot rolling process

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ARTICLE INFO

Article history:
Received 23 March 2011
Accepted 6 June 2011
Available online 13 June 2011

ABSTRACT

In this paper, Ti–6Al–4V/TiC composite was fabricated by VIM furnace and graphite crucible. X-ray diffraction analysis and EDS techniques were used to identify the phases in the material. Microstructure characteristics of the Ti–6Al–4V/TiC composite were evaluated by means of optical microscopy. The tensile test was performed at room temperature after hot-rolling of the samples in the beta phase field. The results revealed that at different melting times, three kinds of precipitates are formed in the microstructure including grain boundary, eutectic and transgranular precipitates. The size of transgranular precipitates was significantly larger than that of the other two types of carbides and had the worst effect on ductility. Furthermore, an increase in the amount of carbon by increasing the melting time led to an increase in hardness and strength and decrease in ductility. Finally, TiC/Ti–6Al–4V with high strength (~1200 MPa) and good ductility (10% elongation and 15% reduction in area) was produced in VIM furnace using 0.5 min melting time.

1. Introduction

Metal matrix composites (MMCs) offer considerable potential for improvement in various mechanical properties over unreinforced alloys, particularly in stiffness and strength titanium alloys are an important class of engineering materials widely used in aerospace, chemical, biomedical and marine applications because of their low density and excellent mechanical strength at ambient temperature [1]. Ti–6Al–4V is one of the most widely used Ti alloys, because of its high specific strength and corrosion resistance [2].

Ti–6Al–4V alloy reinforced by useful reinforcements has high specific strength and specific modulus in comparison to Ti–6Al–4V alloy. Among the reinforcements generally used for titanium alloys including SiC, TiC, Al_2O_3, TiB and TiB_2 [3], TiB and TiC have been widely considered as two of the best reinforcements because of their high modulus, relative chemical stability, high thermal stability and having a density similar to titanium [4,5]. But, TiC particulate reinforced Ti–6Al–4V alloy has emerged much attentions in the recent years due to its excellent combined properties including superior specific strength as well as high temperature properties [6–9].

The reaction between a Ti–6Al–4V matrix and TiC reinforcements have been studied in previous works [10,11]. The reaction between TiC and Ti–6Al–4V results in a layer of Ti_2C growing around each TiC particles [10], with the two phases separated by a wall of dislocations. The reaction zone is thought to form through the diffusion of Ti into the particle and/or diffusion of carbon out of the particle.

In recent years, in situ reinforced titanium matrix composites produced by casting, compared to those produced by other techniques such as self-propagation high-temperature synthesis [11], powder metallurgy [12], mechanical alloying [13], rapid solidification process [14], offer a low cost and possibilities to improve remarkably their mechanical properties and temperature capabilities by thermomechanical treatments.

In this work, vacuum induction melting (VIM) furnace was used to produce TiC containing Ti–6Al–4V alloy. The focus was on the preparation and the microstructure characteristics of the ingot, especially the changes in the morphology of TiC in terms of the alloy composition. At present, there are few reports in the literature on the mechanical characteristics of TiC/Ti–6Al–4V prepared by casting techniques.

2. Experimental procedure

For preparing Ti–6Al–4V/TiC, pure titanium (>99 wt.%), pure aluminum (>99.9 wt.%) and V–42 wt.%Al masteralloy were charged into a high density graphite crucible (80 mm in outside diameter and 130 mm in height) and melted in VIM furnace. The compositions of raw material are listed in Table 1. The density of graphite crucible was 1.8 g/cm^3 and the measured melting temperature by pyrometer was about 1900 °C. The carbon was added to chemical

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0261-3069/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.matdes.2011.06.009