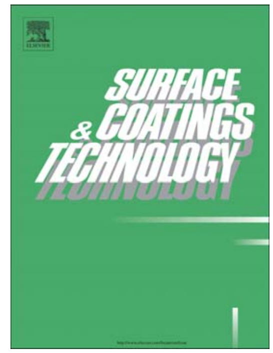

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Creep behavior evaluation and characterization of SiC film with Cr interlayer deposited by HiPIMS in Ti-6Al-4V alloy

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Key words: SiC, Ti-6Al-4V, HiPIMS, microstructural characterization, creep.

Abstract

This paper presents a study about creep behavior of SiC thin films with Cr interlayer deposited by High Power Impulse Magnetron Sputtering (HiPIMS) on Ti-6Al-4V alloys with Widmanstätten microstructure. After SiC/Cr film depositions, a microstructural characterization was performed using Scratching Test, Scanning Electron Microscopy (SEM), Scanning and Transmission Electron Microscopy (STEM), and Energy Dispersive Spectroscopy (EDS) techniques. Scratching tests showed that the film was well adhered to the substrate, which proves that the Cr interlayer is closely related to the strength of adhesion between SiC film and the substrate. The SiC film surface morphology has columnar shape according to STEM images. Creep test results were compared with earlier Ti-6Al-4V Widmanstätten microstructure studies, and they showed an increased lifetime for the Ti-6Al-4V Widmanstätten microstructure with SiC/Cr film, which indicates a higher creep resistance than the specimen without the SiC/Cr film. The SiC/Cr film deposited by HiPIMS improved the creep behavior of the Ti-6Al-4V Widmanstätten microstructure.

1. Introduction

Ti-6Al-4V alloy is the most widely used titanium alloy in the aerospace industry due to its excellent properties such as high mechanical strength, corrosion, and creep resistance. However, one of the major factors limiting the life of titanium alloys in service is their degradation particularly in environments containing oxygen at elevated temperatures during long-term use, which causes oxidation, reduces creep resistance, and consequently shortens their lifetime [1-5]. Methods to increasing alloy lifetime include heat and surface treatments, which can act as effective barriers to oxygen diffusion and avoid material surface loss [4-8]. Earlier studies have presented the influence of heat treatments in Ti-6Al-4V alloy creep tests, and the Widmanstätten microstructure was found to be the most efficient in creep tests, to increase creep life and decreased secondary stage creep rate [6-8]. At the same time, superficial treatments like nitriding laser, TBC (Thermal Barrier Coating), and PIII (Plasma Immersion Ion Implantation) have been studied, which revealed improved creep life in this alloy [4,5,8,9]. Reis et al. investigated the influence of the plasma-sprayed coatings and the atmosphere on creep of the Ti–6Al–4V alloy, and their results indicated that the creep rates of nitrogen and the coated alloy were lower than those of the uncoated in air [5]. Zepka et al. evaluated Ti-6Al-4V alloy wear resistance after plasma immersion ion implantation (PIII) in different immersion times. They concluded that the sample with more implantation time (180 minutes) showed lower wear coefficient [9]. Reis et al. carried out a detailed surface characterization of the laser surface nitrided Ti–6Al–4V alloy to evaluate creep resistance. The authors reported the creep rates of the laser nitrided alloy were lower than those of the untreated material, and the microhardness of the surface was improved to 1100 VHN compared with the 340 VHN of the substrate [4]. The ceramic coatings or thermomechanical treatment applications had good results in fatigue, wear, and creep tests [10]. Oliveira et al.