ID 124: SiC/Cr THIN FILMS DEPOSITED BY HiPIMS ON Ti-6Al-4V USED AS PROTECTIVE COATING IN CREEP TESTS

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1. Introduction

Ti-6Al-4V alloy is the most widely titanium alloy used 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 causing oxidation and reducing creep resistance and consequently the lifetime [1,2]. In order to associate these two techniques (heating and surface treatments) and evaluate the Ti-6Al-4V creep behavior, SiC film was chosen like surface coating. SiC properties like good mechanical resistance, high hardness, high thermal conductivity and very high thermal stability make it attractive coating [3]. These SiC coatings can be used from protective layer against the corrosion of steel to microelectronic devices, and from X-ray mask materials to the protection of thermonuclear reactor walls, among others [4]. Costa et al. carried out an investigation of SiC films deposited by RF magnetron sputtering, with the aim of developing a material for applications as metallurgical and protective coatings. The results showed that films with hardness values larger than that of crystalline SiC can be produced, provided that Si and C sputtered atoms can reach the surface of the growing film with sufficient high energy and low deposition rates, ensuring a high surface mobility [5]. Thus, in this paper we carried out an investigation of SiC/Cr films deposited by HiPIMS on Ti-6Al-4V alloy with Widmanstätten microstructure in creep tests, aiming developing a material as protective coating. SiC/Cr film mechanical properties were evaluated through scratching test, SEM, STEM, EDS and creep test.

2. Experimental

SiC thin film and Cr interlayer were deposited by HiPIMS on Ti-6Al-4V surfaces samples. Initially, the depositions were made in blank samples for subsequent microstructural and tribological Si/Cr film characterization. After this first stage, SiC/Cr coatings were deposited on the creep tests samples surface. The coatings were deposited using a home-made stainless steel cylindrical reactor. An argon plasma was used to sputter high purity 4.00" targets of (99.95%) SiC and (99.95%) Cr.

3. Results and Discussions

Figure 1 show SEM images of SiC film deposited on Ti-6Al-4V alloy with Cr interlayer. From the images 1B and 1C, it can be observed that the thin films grow in a columnar shape and the surface is very compact and homogeneous. Spherical shaped small nodules were observed on the surface Fig.1A. A similar morphology with larger nodules also was observed on coatings grown at low Si target power, regardless of temperature for the SiCxNy coatings by Pettersson et al [6].

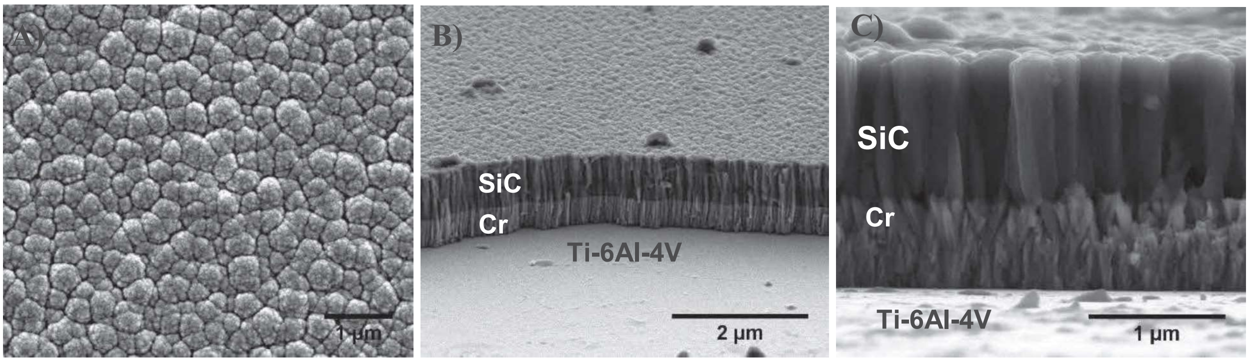

Fig. 1. *SiC film deposited on Ti-6Al-4V alloy with Cr interlayer, image obtained by SEM. (A) Overview, (B) Magnified overview and (C) Detailed layers view.*

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Figure 2 presents creep curves at 600 °C and 250 MPa for Widmanstätten microstructure Ti-6Al-4V sample [7] and the Ti-6Al-4V sample with Widmanstätten microstructure and SiC film. It can be seen for the specimen with SiC film lifetime was higher, indicating a longer life in creep relative to the specimen without the SiC film. It is also observed that the creep rate in stationary stage is lower for SiC film specimen and the curve slope is lower than in specimen without SiC film curve, showing once more increasing creep resistance for the alloy with SiC film application. The improvement in steady state creep rate and time to fracture is attributed to the SiC coating presence, which is oxidation resistant. It can be concluded preliminarily by comparing the curves and creep parameters between the alloy with and without SiC film, that the SiC film was effective in protecting against oxidation of Ti-6Al-4V.

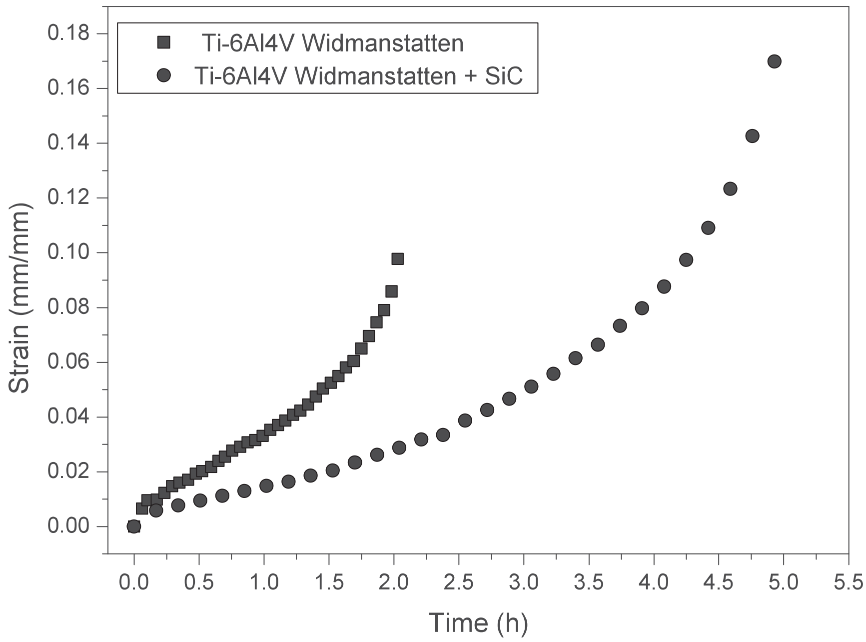

Fig. 2. *Creep curves at 600 ° C and 250 MPa of Widmanstätten microstructure Ti-6Al-4V sample [7] and Widmanstätten microstructure with SiC/Cr film Ti-6Al4V sample.*

4. References

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