

## CREEP BEHAVIOR OF THE TITANIUM ALLOY WITH ZIRCONIA PLASMA SPRAYED COATING

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**Abstract.** The proposal of this research has been the study of the plasma sprayed coating on creep of the Ti-6Al-4V, focusing on the determination of the experimental parameters related to the first and second creep stages. Yttria (8 wt %) stabilized zirconia (YSZ) (Metco 204B-NS) with CoNiCrAlY (AMDRY 995C) has been plasma sprayed coated on Ti-6Al-4V substrate. Creep tests with constant load had been done on Ti-6Al-4V coated samples, the stress level was from 250 to 319 MPa at 600 °C. Highest values of  $t_p$  and the decrease of the second stage rate had shown a better creep resistance on coated sample. Results indicate that the coated sample was greater than uncoated sample, thus the plasma sprayed coating prevent the sample oxidation efficiently.

### Introduction

Usually the Ti-6Al-4V alloy is used in the aeronautic and aerospace industry, mainly applied where is needed high oxidation resistance, like aero gas turbine component. The titanium affinity for oxygen is one of the principal factors that limit the titanium alloys applications as structural material at high temperatures. Advances in the development of titanium alloys has been possible a better resistance in proprieties at high temperatures and creep resistance. However, the superficial oxidation is increased with temperatures up to 600 °C [1] that limit the titanium alloys applications. The oxygen interaction with the titanium alloys causes loss of weight due to oxide formation and embrittlement of the alloy by dissolved oxygen in the grain boundary [2].

To prevent the superficial oxidation and in the grain boundary the sample is plasma sprayed coated Yttria (8 wt%) stabilized zirconia (YSZ) with CoNiCrAlY (AMDRY 995C), an technique studied recently named thermal barrier coating (TBC). The YSZ ceramic coating, which is the outer layer, is used to insulation and the CoNiCrAlY metallic coating, which is the inner layer, prevent corrosion/oxidation at high temperatures and stick the YSZ

ceramic coating to the titanium alloy [3]. These characteristics provide an improvement in the creep resistance [4-8].

In this paper is shown a study about the influence of the plasma sprayed coating on creep test in Ti-6Al-4V at 600 °C in air and the determination of the first and second creep stage experimental parameters at these conditions.

### Experimental procedure

The commercial Ti-6Al-4V alloy samples have been hot-rolled with the dimension and shape shown in Fig. 1.

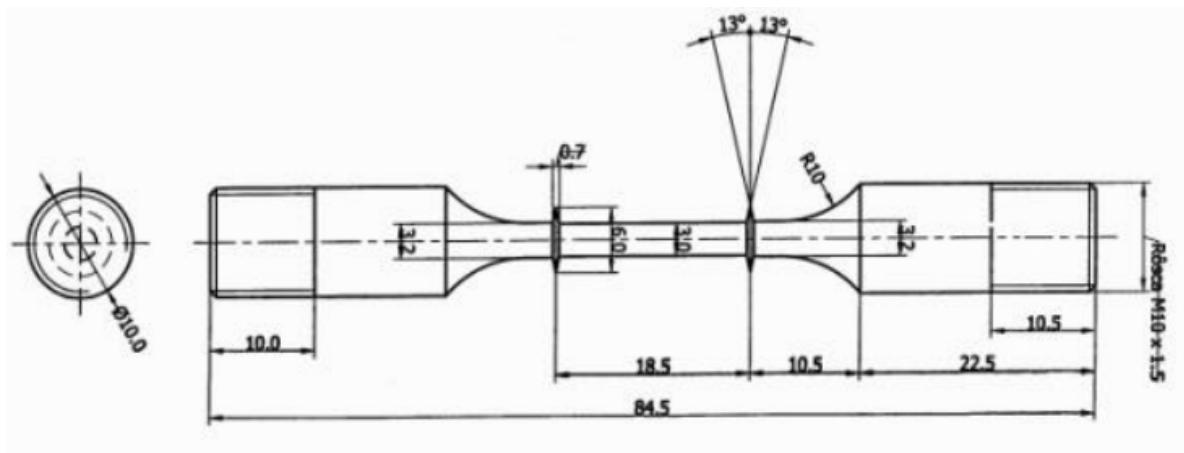


Figure 1: Ti-6Al-4V sample dimensions and shape .

Yttria (8 wt.%) stabilized zirconia (YSZ) (Metco 204B-NS) with a CoNiCrAlY bond coat (AMDRY 995C) was atmospherically plasma sprayed on Ti-6Al-4V substrates by Sulzer Metco Type 9 MB.

Using a MAYES creep machine adapted with electrical systems and controllers developed by BSW Tecnologia, Indústria e Comércio Ltda following specifications by ASTM E139/83 and Antares software, developed by BSW too, to collect the test temperature and strain. Constant creep test has been done with stress from 250 to 319 MPa at 600 °C in sample coat and uncoated.

### Results and Discussion

The creep curves at 600 °C with stress from 250 to 319 MPa is shown in Figure 2. As could have been observed when bigger the stress, smaller is the creep resistance. Furthermore the coated sample has shown a higher creep resistance in all of the stress at constant temperature.

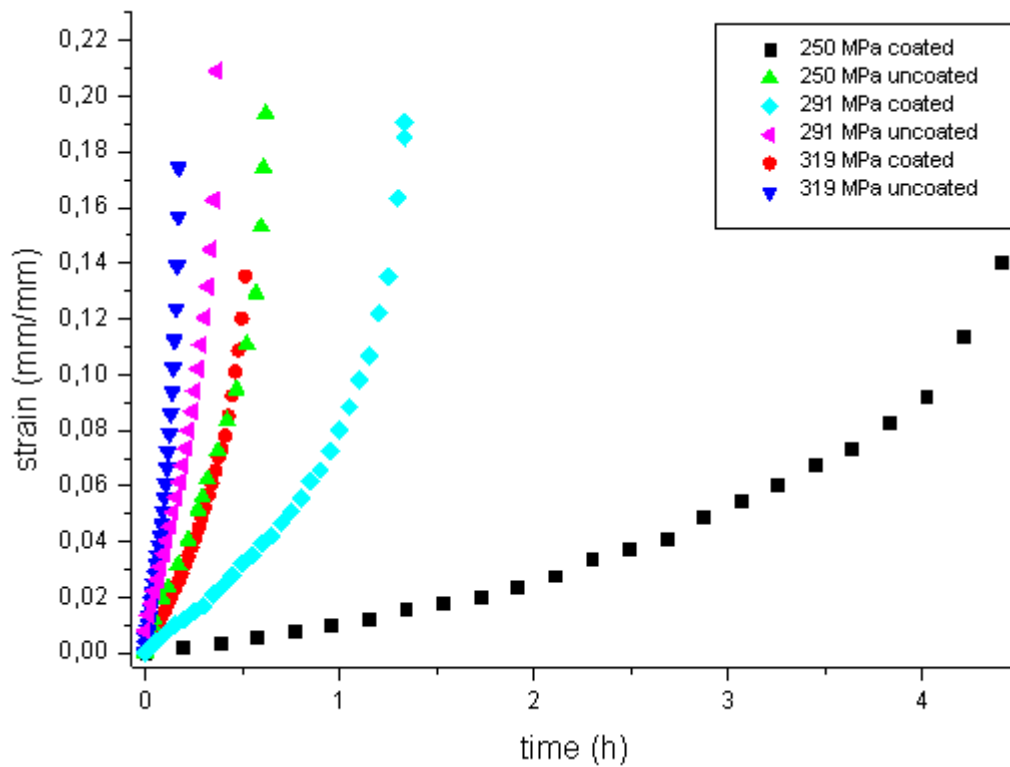


Figure 2: Creep curves at 600 °C, from 250 to 319 MPa coated and uncoated.

Results from the creep tests at 600 °C are summarized in Table 1, which shows the experimental creep parameters. The reduction of the steady-state creep rate demonstrates that the higher creep resistance of Ti-6Al-4V is observed in coated samples.

Table 1: Comparative table for the experimental parameters.

Treatment	$\sigma$ [MPa]	$t_p$ [h]	$\dot{\epsilon}_s$ [1/h]	$t_r$ [h]	$\epsilon_r$ [mm/mm]	RA [%]
<b>Coated</b>	250	0.38	0.0104	4.59	0.1490	71.91
	291	0.25	0.0797	1.33	0.1908	43.26
	319	0.03	0.1401	0.51	0.1353	69.75
<b>Uncoated</b>	250	0.03	0.1597	0.62	0.1940	75.83
	291	0.05	0.2808	0.37	0.2090	-
	319	0.01	0.4990	0.17	0.1740	62.99

## Conclusions

Creep tests with constant load had been done on Ti-6Al-4V coated samples, the stress level was from 250 to 319 MPa at 600 °C. Highest values of  $t_p$  and the decrease of the second stage rate had shown a better creep resistance on coated sample. Results indicate that the coated sample was greater than uncoated sample, thus the plasma sprayed coating prevent the sample oxidation efficiently.

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