THERMAL DIFFUSIVITY AND CONDUCTIVITY AT LAYER $ZrO_2/20\%Y_2O_3$ SPRAYED WITH ATMOSPHERIC PLASMA SPRAY

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Abstract: *The method of deposition atmospheric plasma spray (APS) is famous among the methods usually used for coating layer thicknesses on surfaces with different degrees of complexity. One of the most delicate issues in the case of thermal barrier applied to the turbine blades is to determine the causes of exfoliation of the ceramic layer due to the large number of thermal cycles. The present paper presents a new concept of thermal barrier layer. The novelty is delaminating prevention and consists of a sprayed layer adherent Ni Mo Al (05-05-90) filed by electric arc and a layer of $ZrO_2/20\%Y_2O_3$, deposited by plasma spraying specimens of Ni base super alloys, which aircraft turbine blades are manufactured of. Samples were subjected to heat treatment at 1150°C in order to study the behavior of these metal layers during heating. These layers we have chosen to spray induce a low thermal diffusivity and conductivity. The reason for this test is just that, to prove the thermal insulation of the ceramic layer. Scanning electron microscope was used to observe the morphology and microstructure of phases. X-ray diffraction analysis was performed in order to notice the change of diffraction curves, and to observe the new phases obtained after the heat treatment.*

Keywords: *SEM, XRD, thermal diffusivity, thermal conductivity*

1. INTRODUCTION

The desire to improve the performance of aircraft motors led to the rising temperatures of the hot sources.

By rising the operating temperature can significantly improve performance and other important functional parameters of a heat engine. Turbine blades are the most stressed components of a jet engine both thermo-mechanically and chemically.

Because the steel the turbine blades is made of has maximum operating temperatures near to 1000°C value the idea of using ceramic materials was foreseen.

2. EXPERIMENTAL PROCEDURE SPRAYING EQUIPMENT AND MATERIAL POWDER

Thermal barrier coatings were obtained by atmospheric plasma spraying deposition (APS). Samples were sprayed with ceramic powder $ZrO_2/20\%Y_2O_3$ using SPRAYWIZARD 9MCE by Sulzer Metco.

The bond coating was sprayed with Ni Mo Al powder on rectangular specimens with electric arc using Sulzer Metco Smart Arc 350, on super alloy specimens of Ni base, cleaned in an ultrasonic bath with acetone and sand blasted with electro corundum. The size of the specimens is 8x30x2 mm.

To highlight the results, analysis were performed using electron microscopy with electron microscope QUANTA 200 3D DUAL BEAM. X-Ray diffraction was performed using an X' Pert PRO MRD equipment. Thermo physical properties of materials were analyzed with the device 457 LFA Micro Flash.

Samples were subjected to a heat treatment in furnace Chamber Furnaces with Gas Heating at the temperature of 1150°C.

3. EXPERIMENTAL RESULTS

3.1 Atmospheric plasmaspray (APS). Thermal spraying is a group of processes designed to achieve thin layers, in which fine powders, metallic or nonmetallic, shall be deposited, melted or semi-melted, to form a coating.

3.2 Particle size distribution. Particle size is an important variable that influences coverage characteristics. To ensure the powder's melting in the plasma spraying, for a given set of parameters, the spraying powder's size should be checked.

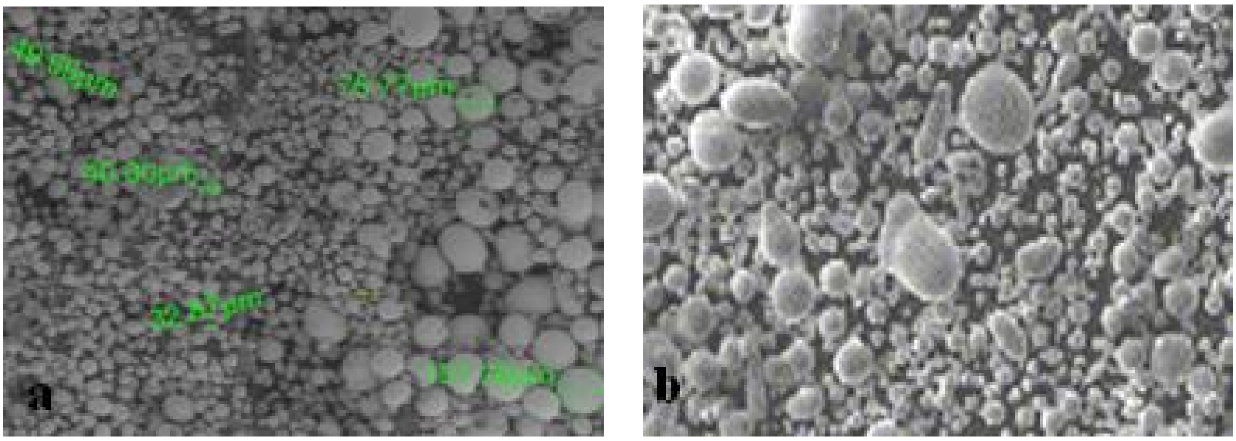


Fig. 1. Powder morphology used in thermal spraying: a) ZrO_2/20% Y_2O_3 and b) Ni5Mo5Al

3.3 Micro structural characteristics. In SEM images of the surface layer small cracks, with diameter of 200 μm, can be observed (Figure 2.a.).

Heat treatment at a temperature of 1150°C for 100 hours, has led to a compaction of layer deposited (Figure 2.b.), only a few separate particles can be seen, resulting in a good compact layer.

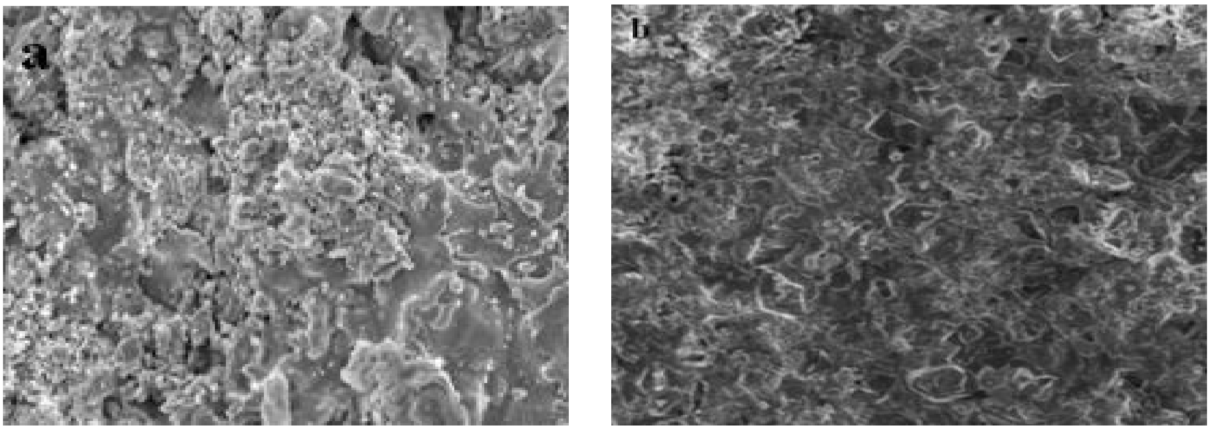


Fig. 2. SEM images of the layer obtained by plasma spray deposition of powder ZrO_2/20% Y_2O_3: a) before heat treatment at 1000X, b) after heat treatment at 1000X

4. X-RAY DIFFRACTION

With XRD analysis observations will be made on constituents and phases of the layer deposited by thermal spraying. With the help of x-ray diffraction we could see the modification of the diffraction curves before and after thermal treatment, thus highlighting the phases obtained after sintering.

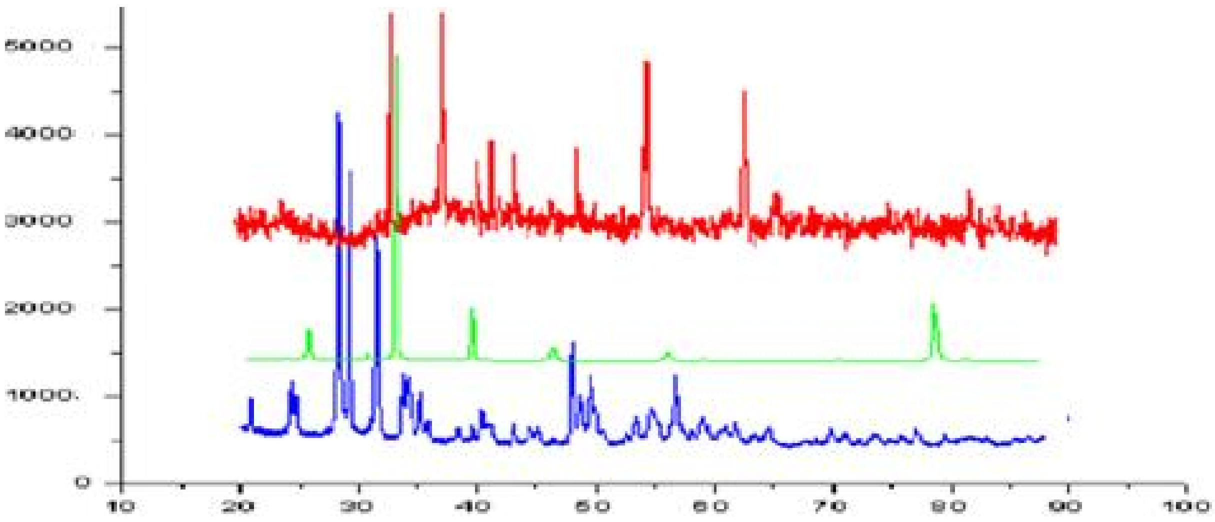
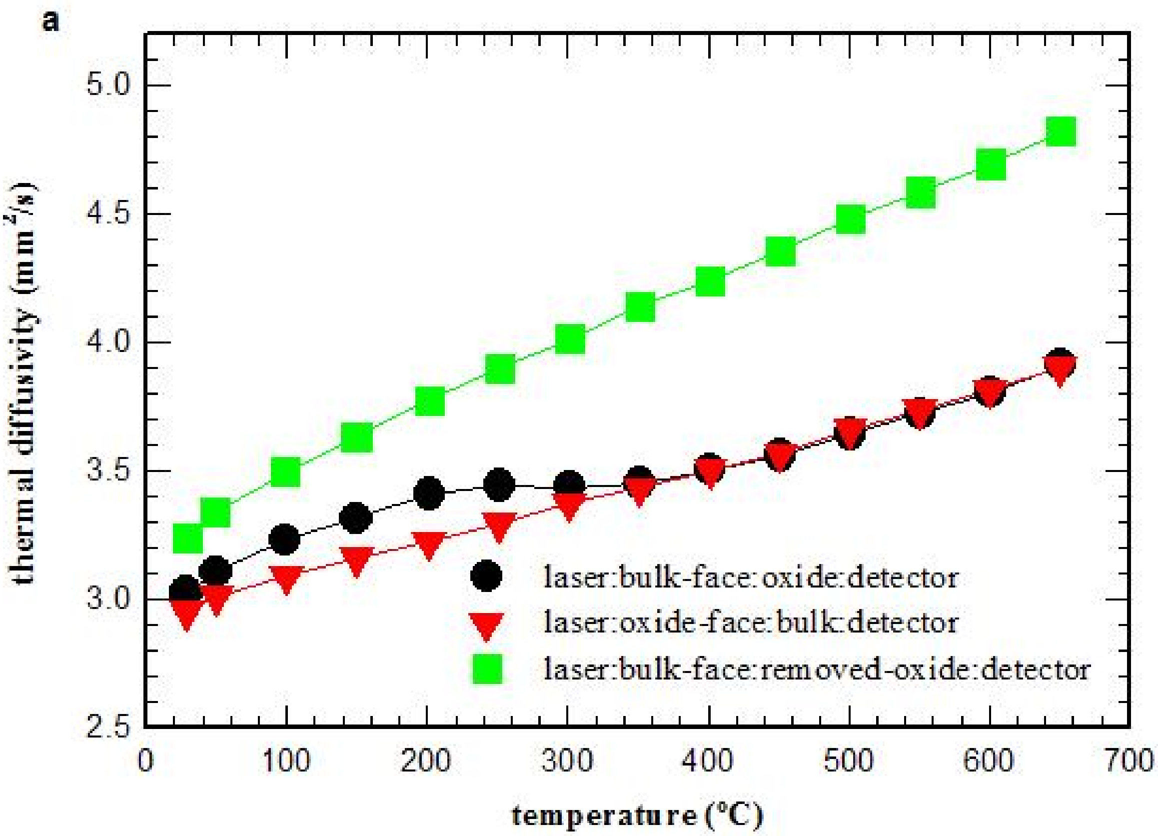


Fig. 3. X-Ray diffraction

5. THERMO PHYSICAL PROPERTIES OF MATERIALS ANALYSIS

This study describes the experimental results of thermal diffusivity, specific heat at constant pressure, and thermal conductivity of porous 20 mol% yttria-stabilized zirconia (YSZ).



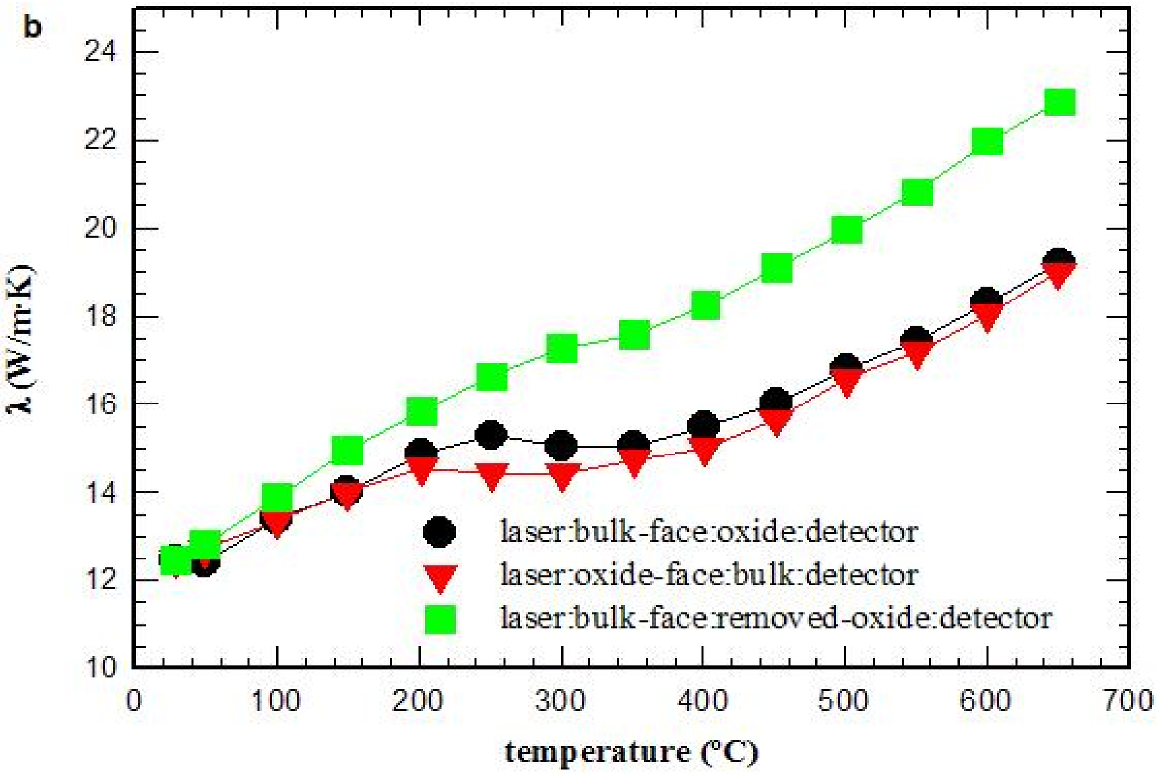


Fig. 4. The thermal diffusivity

5. CONCLUSIONS & ACKNOWLEDGMENT

With this APS technique, almost any material can be deposited, provided it can be melted or become plastic during the spraying process.

Particle size is an important stage in the metallization process that influences coating characteristics. For this reason, in certain sets of parameters the size of the spray powder should be taken into account.

After heat treatment at a temperature of 1150°C for 100 hours deposited layer compaction can be seen. You can see very few separate particles, resulting in a great compact layer.

After X diffraction analysis and heat treatment at 1150 ° C we found areas devoid of peaks characteristic of the solid solution obtained after heat treatment, which shows a very specific complete and ordered structure close to amorphous layers.

Improving the thermal conductivity and diffusivity is possible to increase the entrance temperature of gas turbines and improve performance.

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