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Effect of an temperatures of post-spray heat treatment on wear behavior of 8%Y_2O_3-ZrO_2 coating

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Most recent, Plasma ceramic spray is used on parts of tribosystem, has been investigated on the tribological performance. The application of ceramic coatings by plasma spray has become essential in tribosystems to produce better wear resistance and longer life in various conditions. The purpose of this work was to investigate the wear behavior of 8%Y_2O_3-ZrO_2 coating due to temperatures of post-spay heat treatment. The plasma-sprayed 8%Y_2O_3-Zirconia coating was idiscussed to know the relationship between phase transformations and temperatures of post-spray heat treatment. Wear tests was carried out with ball on disk type on normal load of 50N, 70N and 90N under room temperature. The transformation of phase and the value of residual stress were measured by X-ray diffraction method(XRD). Tribological characteristics and wear mechanisms of coatings was observed by SEM. The tribological wear performance was discussed a point of view for residual stress. Consequently, post-spray heat treatment plays an important role in decreasing residual stress. Residual stress in coating system has a significant influence on the wear mechanism of coating.

Keywords : Plasma Spray, Ceramic, ZrO2, Residual Stress, XRD, Wear, Wear Mechanism

1. INTRODUCTION

The application of ceramic coatings by plasma spray has become essential in tribosystems to produce wear resistance and long life in severe conditions[1]. Ceramic coating such as Al_2O_3, Cr_2O_3, Al_2O_3-TiO_2, Y_2O_3-ZrO_2, and ZrO_2 etc. are an attractive material because they can be used under severe operating conditions, whereas conventional tribomaterials exhibit performance difficulties at larger loads, higher speeds and higher temperatures[2]. It was reported that PSZ(Partially Stabilize Zirconia) coating have better wear resistance than its sliding against a metallic substrate[7-9]. Wear mechanism of plasma sprayed 8%Y_2O_3-ZrO_2 coatings, carried out in a reciprocating sliding tester at a temperature of 200°C, was affected by plastic deformation and material transfer[7]. The wear mechanism of plasma-sprayed coating was dominated by a value of residual tress owing to the mismatch of the TEC of coating system[4]. The defaults include cohesive failure, spallation in the coating, weak adhesive strength of the interface and high residual stress of coating, all of which influence the wear resistance characteristics of a coating[3-6]. In order to reduce residual stress of coating the tribological coatings have been carefully applied the post-spray process. It is important to improve tribological characteristics of coating with post-spray treatment. For a better understanding of the post-spray heat treatment, which can evaluate wear behavior of plasma-sprayed coating and the relationship residual stress between and temperature of post-spray heat treatment from a new perspective. Therefore, the purpose of this study is to evaluate the wear behavior of a plasma-sprayed 8%Y_2O_3-ZrO_2 coating on a casting iron and understand the correlation between wear performance and temperature of post-spray heat treatment. And we identify their phase transformations due to post-spray heat treatment. Also, The effect of residual stress as post-spay heat treatment temperature will be discussed.

2. Experimental procedure

The casting iron(GC200) was provided by a commercial supplier. The casting iron was machined to make disk specimens with a 20mm diameter and 5mm thickness. The materials used in the coating process were commercial powders, 8%Y_2O_3-ZrO_2 (Metco 204B-NS) and NiCrAlY. In order to obtain specimens of post-spray heat treatment, keeping at 200°C, 400°C, 600°C and 800°C, during 1hour in furnace, and then furnace cooling. A wear test was carried out between a disc-type coated and ball-type SiC specimens. The details of the wear test method and specimen configurations. The loads used in this experiment were 50N, 70N, and 90N. Also, the sliding velocity of wear test was kept a constant of 0.1m/sec.

3. The results

3.1 The Phase Transformation by post-spray heat treatment

The phase of tetragonal structure is transferred from monoclinic with an increase temperature of post-spray heat treatment, At 200C and 400C, the phase transfer from t-phase to m-phase is shown a relatively increasing with as-spray coating. On the other hand, on post-spray heat treatment at 600C, 800C, we can observe the increasing t-phase in comparison to the as-spray coating.

3.2 X-ray diffraction analysis by post-spray heat treatment

At this point, this peak indicated the change of d-spacing on the *hkl* plane at 2θ. From this we can identify the existence of the residual stress, which is the tensile residual stress in coating. As the heat treatment temperature of post-spray is increasing, the tensile residual stress of coating is decreasing.

3.3 Specific wear rate of coating for post-spray heat treatment

It is found that the specific wear rate for post-spray heat

treatment at 200 °C is higher and there of post-spray heat treatment at 400 °C is independent of the normal load. Especially, the specific wear rate for post-spray temperature at 600 °C is indicated higher wear resistance among wear test. Therefore, it was identified that the wear behavior was dependent on the temperature of post-spray heat treatment. We will discuss this reason in chapter 4.

3.4 Observation of worn surface

It is observed that abrasive wear is generated by the concentration stress on the defect of coating, such as the hole's pattern during the process of wear. The worn surface have severe pull-out of wear debris and tribo-film due to material transfer during the wear process.

The SEM photograph of worn surface for heat treatment temperature at 400 °C under normal load 70N. It is shown the brittle of coating, which are the typical wear properties of zirconia coating. Also, it is observed severe plastic deformation of coating and surface crack owing to the normal load. It is found wear mechanism for heat treatment temperature at 600 °C of is plastic deformation in worn surface.

4. Discussion

The results showed the wear behavior of 8%Y_2O_3-ZrO_2 coating with post-spray heat treatment during sliding. It is seen that temperatures of post-spray heat treatment have influence on the wear characteristics of coating. It is convinced that the phase transformation of coating is due to temperature of post-spray heat treatment. Also, We can shown the result of X-ray diffraction pattern for temperatures of post-spray heat treatment .

Improved plasma-sprayed coatings require certain tribological characteristics including the wear resistance of the coatings. However, generally speaking, the trouble of plasma spray can be solved by the residual stress in coating system. Therefore, it will discuss the tribological wear performance as a magnitude of residual stress in detail.

The wear performace of coating is thus correlated to the residual stress [6]. The value of tensile residual stress in coating is decreased as elevated temperature of post-spay heat treatment, as shown in Fig . 1. The result of XRD indicated decreasing residual stress of coating according to elevated temperature of post-spray heat treatment. Fig. 1 is showed the linear fit curve of residual stress as a function of temperature of post-spray heat treatment. It was found that the wear mechanism of coating, which of a high level of residual stress, is abrasive wear and micro-fractures. The wear performance relate to the value of residual stress in coating. Therefore, it is important to control the residual stress of coating within an optimal range.

5. Conclusion

To gain a better understanding wear behavior of a plasma-sprayed 8%Y_2O_3-ZrO_2 coating of the post-spray heat treatment, experimental tests were performed and analysis of XRD and worn surface were conducted. As a result, the following conclusions can be drawn.

1. The specific wear rate of coating strongly influenced temperatures of post-spray heat treatment.
2. Phase transformation from the tetragonal to monoclinic structure was observed to influence the wear behavior of 8%Y_2O_3-ZrO_2 coating.
3. Post-spray heat treatment plays an important role in decreasing residual stress. Residual stress in coating system has a significant influence on the wear mechanism of coating.

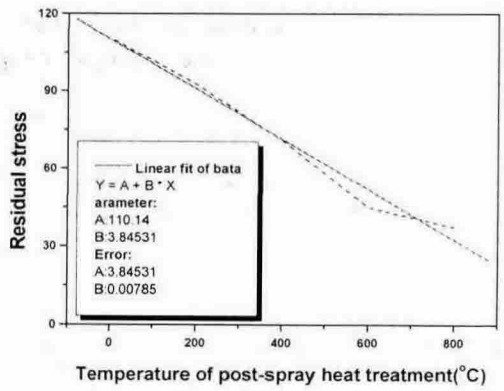

Fig. 1 Relationship between the residual stress of coating and the temperature of post-spray heat treatment

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