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Role of hBN on tribological response of HVOF sprayed hybrid ceramic composite coating for advanced steel

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The present work focuses on the improvement of characteristics of high-velocity oxygen-fuel (HVOF) sprayed alumina-ceria based hybrid composite coating. Authors have selected SAE 4150 steel as the substrate material. The study also explores the effect of hBN addition to the base matrix of alumina and ceria on sliding friction and wear behaviour of the coatings. The fabricated samples are mechanically, tribologically and metallurgically characterized. The tribological test results indicate a significant improvement in friction and wear response of hBN doped hybrid composite coating. The enhancement in the performance is attributed to the improved microstructural properties and lubricating effect of hBN.

Keywords: HVOF, hBN, hybrid composite coating, friction, wear

1. Introduction

At high translational speeds, an extremely inert solid lubricant like hexagonal boron nitride (hBN) has been found useful in terms of improved abradability by reducing the frictional heating on contact [1]. The present study aims at enhancing the friction and wear response of SAE 4150 steel by HVOF sprayed surface coatings. The investigation further explores the role of hBN in improving the coating characteristics when used as a solid lubricant reinforcement in alumina-ceria matrix.

2. Methods

The coatings are fabricated through the high-velocity oxygen-fuel process. The coating deposition parameters are mentioned in table 1. hBN is added in various weight fractions of 3% and 6% in Al_2O_3-0.8CeO_2 matrix.

Table 1: Coating deposition parameters

HVOF	Oxygen	Pressure	2.5 bar
		Flow	45 slpm
	Acetylene	Pressure	1.0 bar
		Flow	55 scfh
	Air	Pressure	2.5-3 bar
		Flow	460-500 slpm
	Spray distance	4”	
	Nitrogen Carrier gas	Flow	20 scfh
	Powder feed rate	25 g/min.	

2.1. Characterization

Metallurgical characterization was carried out by scanning electron microscopy (SEM), X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS) and transmission electron microscopy (TEM). Moreover, scratch testing and ball on flat sliding tests were performed for tribological characterization of the substrate and coatings. Nano-indention was used to measure the hardness and elastic modulus of all the samples.

2.2. Results

Al_2O_3-0.8CeO_2-3hBN coating showed the best tribological response. Increasing the content of hBN content to 6wt.% lowered the friction coefficient value but increased the wear.

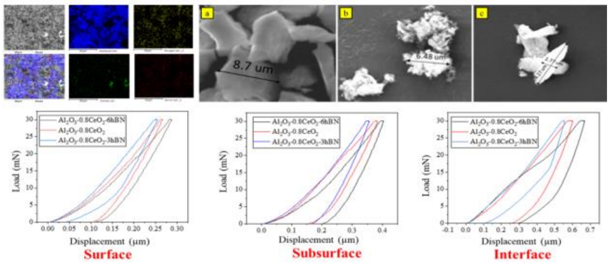

Figure 1: Representative figures of mechanically and metallurgically characterized samples.

3. Discussion

Tribological wear response of the coated and uncoated specimens is related to the microstructural aspects and mechanical properties (hardness and elastic modulus values). Doping with hBN reduced the friction coefficient of the coatings because of its lubricity. However, increasing the hBN weight percentage to 6 caused softening of the coating, which resulted in more wear. $\frac{H}{E}$, $\frac{H}{E^2}$ and $\frac{H^3}{E^2}$ values were also calculated and used to hypothesize the wear behaviour of the materials

4. References

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