A study of the normal impact fatigue and impact wear behavior of thick hard carbide coatings

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1. Introduction

Thermal sprayed hard carbide coatings perform well under sliding loads, in part due to relatively high hardness [1, 2]. However, under impact wear conditions, their behavior is not well understood. Such coatings are commonly used in corrosive and erosive environments, for example in mineral and slurry transportation pipelines. Consequently, there is scope to optimize material and processing parameters to offer increased impact wear resistance.

2. Materials and methods

The coatings were sprayed on AISI316L to a pre-ground thickness of 300µm. Before testing, the samples were ground and polished to R_a = 0.1µm or less. The basic coating composition is shown in Table 1. Two different fuels were investigated; kerosene (CJS) and Hydrogen (DJ-H). With the DJ-H technique, we expect that the higher flame temperature has an effect upon the coating ductility and impact wear resistance. Tests were assessed and compared against a standard reference 316L.

Table 1 Coating material and general spray method

Sample ID	**Coating composition**	**Spray method**	**Substrate**
DJ-H	WC-10Co-4Cr	HVOF	AISI 316L
CJS	WC-10Co-4Cr	HVOF	AISI 316L
AISI 316L substrate	-	-	AISI 316L

Impact fatigue testing was performed at the University of Sheffield. The impact was normal, i.e. at 90° relative to the impact surface. The counterface was a Tungsten Carbide ball with a 6mm diameter. The peak impact force was set to 100N. The cycling regime varied between 1000 and 50,000 impacts. A limited number of tests were performed at higher peak impacts loads of 800N, 1000N and 2000N.

3. Results

The coatings develop circular and radial cracks developing outside of the impact crater. The radial cracks coalesce and lead to local coating removal at the crack intersections, shown in Fig. 1

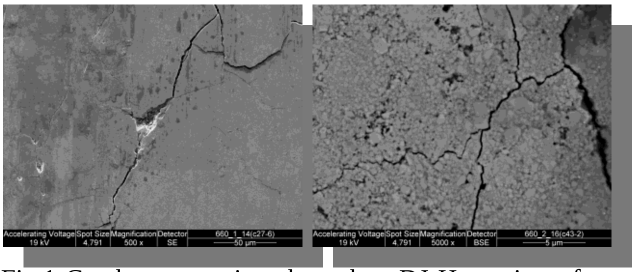

Fig.1-Crack propagation through a DJ-H coating after 20,000 normal impacts at 100N

Impact crater area and volume are assessed by optical profilometry. Both parameters increase with non-linearly with number of impact cycles. Examples of the impact craters are shown in Fig. 2. Note that radial cracks are not visible at the current magnification.

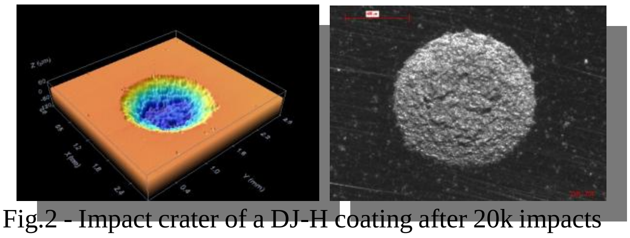

Fig.2 - Impact crater of a DJ-H coating after 20k impacts with a peak impact force of 2kN

4. Conclusions

The impacting regime does not promote widespread delamination at the edges of the crater. Radial cracks are observed. Certain features are promoted depending upon the impact test.SEM imaging has shown that converging radial cracks propagate around carbide grains through the ductile Cobalt matrix volume. These radial cracks meet and result in local coating loss. This debris may act as harmful hard debris in sliding conditions, accelerating abrasive wear.

5. References

[1] Nohava, J.*et al*, "Interesting aspects of indentation and scratch methods for characterization of thermally-sprayed coatings,''Surface and Coatings Technology, 205 (2010) 1127-1131

[2] Sudaprasert, T, *et al*., "Sliding wear behaviour of HVOF sprayed WC–Co coatings deposited with both gas-fuelled and liquid-fuelled systems," Wear, Volume 255, Issues 7–12, Aug–Sep 2003, 943–949,