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Tribological behaviour of TiO_2 Atmospheric Plasma Spray (APS) coating under mixed and boundary lubrication conditions in presence of oil containing MoDTC

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Abstract:

Tribological behaviour of steel APS coating and TiO_2 APS coating was investigated and compared with reference steel material under boundary lubrication in presence of MoDTC. Significant friction and wear reduction was observed in case of TiO_2 APS coating compared to conventional steel and steel APS coating. This was due to the formation of pure MoS_2 in the form of long crystalline flakes directly attached to TiO_2 substrate. Friction was slightly higher in case of steel since Mo-oxysulphide formation was observed along with some MoS_2 flakes embedded in an amorphous matrix. Effect of roughness and addition of ZDDP on MoDTC decomposition mechanism was discussed. Tribocatalytic effect was proposed to explain the complete decomposition of MoDTC in steel / TiO_2 APS contact.

1. Introduction

Recent engine design trends demand low fuel consumption [1], emission reduction for low environmental impacts [2], increased lifetime as well as higher engine efficiencies. This has led to use of lightweight materials like aluminum, magnesium and its alloys instead of steel and cast iron for various engine components. As the corrosion, wear and friction behaviour of aluminium alloys is not up to the mark in case of tribological systems like piston ring – cylinder liner, protection of the surface is indispensable [3].

More effective lubrication is required in piston-ring - cylinder liner contact as half of the friction losses occur in this contact [4]. To meet the severe conditions of this engine contact, protect the surface and reduce friction and wear, various lubricant additives are used [5][6]. Different lubrication regimes exist in this type of contact from elastohydrodynamic lubrication to boundary lubrication regime. Various types of additives are used in boundary lubrication conditions which form a tribofilm on the counterpart materials and prevent the friction and wear of the components [7]. On the contrary, low additivated engine oils [8] are desired to reduce the content of various elements like Zn, Mo, P and S (low SAPS) in the engine which are responsible for increase in engine emissions. Therefore, these problems should be addressed by the different materials used for piston rings and cylinder liners. It is necessary to use certain materials which are able to exhibit low friction and are wear

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