Tribological behaviour of ZrCN PVD and other DLC coatings for engine components

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1. Introduction

Plasma Assisted Chemical Vapour Deposition (PACVD) and Physical Vapour Deposition (PVD) coatings are used in many fields of Tribology and, in particular, as coatings for engine components in automotive applications for enhancing wear resistance and achieving friction reduction [1]. Recently, the effect of the tribo-reactive materials in combination with bio-lubricants for engine components was published by A. Igartua et al. [2].

In this work different types of commercial available Diamond Like Carbon (DLC) coatings are compared with the new proposal multilayer ZrCN coating deposited by PVD and developed by IK4-TEKNIKER, presenting the experimental/analytical approach for coating pre-selection before engine tests in actual working conditions.

2. Test setup and specimens

The test rig used for the experiments is the SRV (Schwingung-Oscillating, Reibung-Friction, and Verschleiss-Wear) Tribometer in ball-on-disc configuration, able to simulate high frequency reciprocating sliding motion to evaluate friction, wear and the maximum allowed load characteristics.

A stainless steel AISI 52100 ball is matched against a stationary coated steel test disk (substrate: M2 polished) with a roughness of 0.05µm. The system is in a bath of the reference lubricant SHELL PC 1277- SAE 15W40.

Two kinds of tests were run according to the following standards: ASTM D5707/ D6425 to evaluate the friction and wear properties (stable load is applied), and ASTM D5706/ D7421 to determinate the maximum allowed load before failure under sliding test conditions. The tests were carried out at a temperature of about 180ºC in order to reproduce actual working conditions.

3. Results and conclusions

The ZrCN (D01) coating presents the lower wear scar depth (of about 0.06 µm) while the rest of the coatings ranged between 2 - 5.5 µm.

The Figure 1and 2 show the test profile, the maximum depth on the disc scar, h (µm).

The Stribeck curve of the ZrCN coating shows a stable coefficient of friction under conditions of high load/small frequency. In fact, as seen at Figure 3, a minimum variation of 0.02 was observed with ZrCN (D01) in comparison with other coatings that ranged between 0.03 - 0.15.

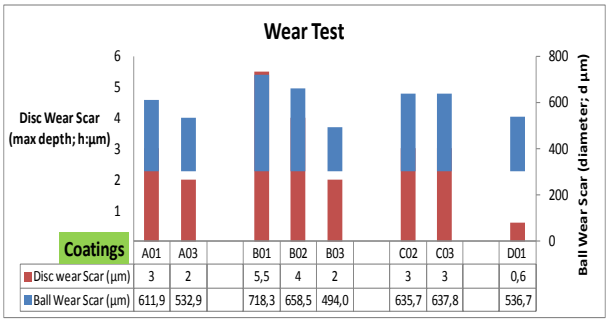

Fig 1. Friction and Wear Tests Results

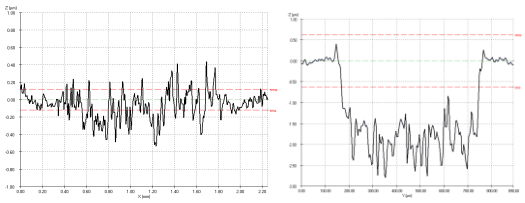

Fig 2. a) ZrCN D01 Disc wear scar (max depth: 0.6µm)
b) DLC Coating C 03Disc wear (max depth:3µm)

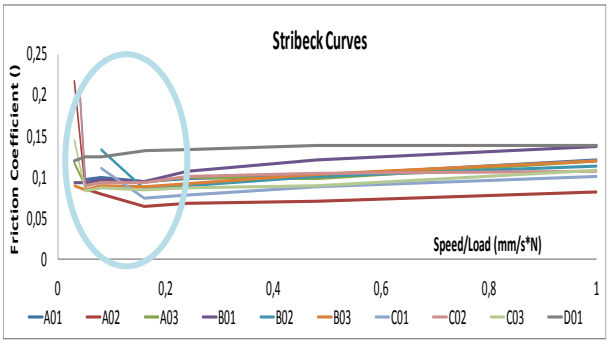

Fig 3.Stribeck curves for ZrCN and DLC´s coatings

4. References

[1] C. Donnet , Recent progress on the tribology of doped diamond-like and carbon alloy coatings: a review, Surface and CoatingsTechnology 100-101 (1998) 180-186

[2] A. Igartua, X. Fernández, et al. "Biolubricants and triboreactive materials for automotive applications", Tribology International, 42, 561 -568, 2009

6. Acknowledgements

The authors would like to acknowledge the EC funding in the frame of the European Project **Powerful (**Contract 234032).