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Application of DLCs to engine valve train systems: Effects of coating both the cam and follower

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1. Abstract

In this study, the tribological properties of two commercial diamond like carbon (DLC) coatings of taC-H and A-carbon were investigated on a single cam rig. The uncoated tribopair was used as a reference while the cam/follower was tested with both surface treatment conditions. A-carbon and taC-H had hardness of 20±4GPa and 35±7GPa respectively. All materials had a centerline average surface roughness (R_a) of 0.02-0.03 µm. XPS and SEM/EDX was used to evaluation the tribochemical films which was formed on the surfaces. It was observed that the interaction of the coating with the oil has been significantly reduced as zinc does not absorb to the surface of the DLC.

2. Introduction

DLC coatings are widely used in automotive valve train subcomponents such as valves, collets, spring retainers, inserts, buckets and even on camlobes. This is due to their excellent tribological properties of lower coefficient of friction, high wear resistance and unique running-in properties[1]. For high performance engines such as formula 1, they are becoming a necessary requirement due to the high pressure variation and temperature experienced in the cam-follower system.
This paper characterizes the potential advantages of coating the cam, leaving it uncoated, as well as evaluating the cam and follower in an uncoated stated.

3. Material and Methods

The substrate material (follower) for all test was a 16MnCr5 (Steel) which was coated with 2µm A-Carbon and 1.5µm taC-H respectively. Both coatings had similar roughness with the cam. For the cam, this was achieved by micro-mechanical polishing to R_a of 0.02 µm. Lubricant used for this setup is a 5W30 fully formulated oil here after referred to as FFB.

4. Results

During 50hrs testing, where the camlobes were uncoated, the taC-H coating showed significant friction improvements in the boundary/mixed regime for the speed range tested. No significant friction benefits were achieved in the EHL lubrication regime, as expected, since both surfaces were separated by a lubricant film and friction in controlled by the viscosity of the lubricant. The wear results showed that harder coatings on the camlobes do not provide the required wear resistance because ta-C:H had significant delamination due to edge loading. This was not observed for a softer a-C-H coatings. The results also show that the hard coating has an adverse effect on the uncoated camlobe and wear is higher on the rising edge of the cam and to the best of the knowledge of the authors, this has not been reported in previous cam follower research works.

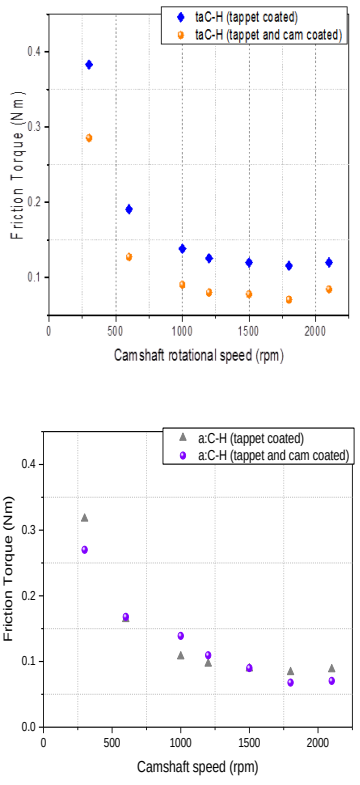

Figure 1Effects of DLC Coating of inserts in a single cam rig

References

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