EVALUATION OF THE CUTTING FORCES OF A THERMAL SPRAY COATING BY SCRATCH TEST IN DIFFERENT ORIENTATIONS

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Coating; Friction; Experiments in tribology, Abrasion

ABSTRACT
In internal combustion engines, the use of a full aluminum block to reduce engine weight and fuel consumption may lead to undesired tribological properties at the ring-cylinder contact. Coatings may be deposited on the cylinder bore to improve friction and wear behaviors. Iron-based coatings deposited by thermal spray process (TSP) are usually applied, given the enhanced ductility and properties similar to regular cast iron engine blocks [1-2]. TSP results in a coating presenting high porosity with large pore size distribution and an irregular surface finishing. After coating deposition, a honing process is used to improve surface quality. This work aims to evaluate the abrasion mechanisms and cutting forces when successive linear scratch tests are conducted on a 200 µm thick iron-based coating.

The scratch tests were carried out in a TI-950 triboindenter from Bruker Inc. using a cono-spherical diamond tip with radius of 100 µm and apex angle of 60º. The cutting velocity was 100 µm/min and the cutting depth was maintained constant at 400 nm. The samples were cross-sectioned and polished. Coating indentation hardness was 5.5 ± 0.8 GPa. A first scratch was initially conducted, followed by a second scratch with different orientations (10°, 20°, 30°) with respect to the first, as presented in Fig. 1. The specimens were characterized by scanning electron microscopy (SEM), optical interferometry and instrumented indentation techniques. After the scratch process, the intersection areas were analyzed for each condition by SEM to determine the deformation modes and micro-mechanisms.

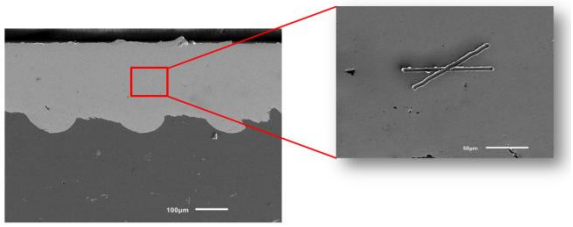

Fig. 1 SEM Image of the coating cross-section and scratches in the orientation of 30°.

Fig. 2 presents an example of the cutting forces along the scratch length. The forces decrease to a minimum value when the tip crosses the previously scratched area, which was at 60 µm in this case. Fig. 3 illustrates a comparison between three angles considering the friction coefficient (COF) minimum value. The angle between the scratches affects the friction coefficient. The case wherein the orientation was 20° shows the higher COF when the scratch crosses the scratched area. Results were also analyzed in terms of the influence of pores on the cutting forces.

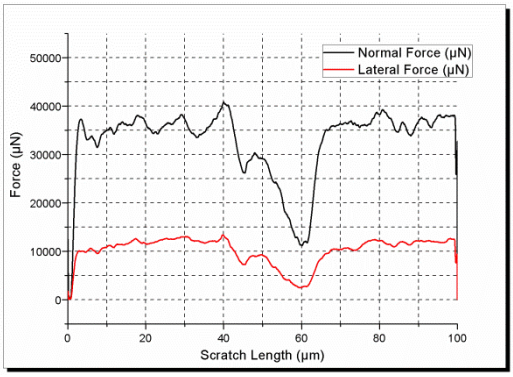

Fig. 2 Cutting forces along the scratch length

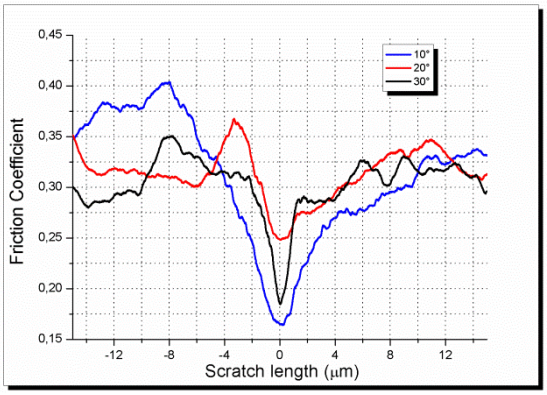

Fig. 3 Comparison of the friction coefficient in the three orientations (10°, 20° and 30°).

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