ABRASIVE WEAR BY TiO_2 ON HARD AND LOW FRICTION COATINGS

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ABSTRACT

Several components in paint and plastic industry, like mixers, extrusion screws and dies, injection moulds, suffer heavily from abrasive wear. This wear is mainly induced by the presence of TiO_2 in the paint or in the plastic blend. Coating technology offers a solution to increase the wear resistance and consequently the lifetime of those components. The aim of this study is the evaluation of the micro-abrasive wear resistance of a range of commercially available hard and/or low friction coatings against rutile particles. Therefore, ball cratering tests [1, 2] have been set up with a suspension of TiO_2 abrasive in water to simulate the real micro-abrasion as accurate as possible. The tests result in a clear ranking of the 10 investigated coatings. The accuracy of the test results is discussed and a comparison with other abrasive types (SiC and diamond) has been performed.

EXPERIMENTAL SET-UP

The tests were performed on a TE66 micro-scale abrasion tester manufactured by Plint. As abrasive suspensions, a typical rutile powder with small particle size (Ø 0.1-0.4 µm) and spherical grains in distilled water was used. Ball bearing steel was used as counter-body.

The selected coatings ranged from hard ceramic coatings to softer low friction coatings.

Four PVD coatings were used (TiN, CrN, TiCN and low temperature CrN), one CVD (TiN) and three PACVD (DLC and diamond-like nanocomposites Dylyn® a-C:H/a-Si:O) [3]. Additionally, hard chromium and elec-troless Ni with embedded PTFE particles have also been tested. All coatings were deposited on a X42Cr13 steel with hardness 50 HRc.

TEST RESULTS AND EVALUATION

The micro abrasion test resulted in a clear ranking of the selected coatings in function of the wear coefficient. In general, the hard ceramic coatings have the lowest wear coefficient. DLC and CrN performed very well. The softer coating types which are designed for reduction of the surface energy, such as NiP+PTFE, show an increase in wear of three orders of magnitude.

However, there is no evidence for a close correlation between the wear rate and the coating hardness measured by depth sensing indentation. Only when the three very similar PACVD coatings are considered separately, the wear coefficient is significantly increasing with decreasing coating hardness.

The results are obtained by using the extended Archard equation:

$$SN = \frac{1}{K_c} V_c + \frac{1}{K_s} V_s \qquad (1)$$

with K_c and K_s are the wear coefficients of the coating and substrate respectively, V_c and V_s the measured wear volumes and SN the sliding distance multiplied by the applied load.

Different ways of implementing equation (1), e.g. the equations of Rutherford and Hutchings [1], are dis-cussed and their accuracy is evaluated.

COMPARISON WITH OTHER ABRASIVES

The results of the abrasive wear by TiO_2 are compared to the wear by other types of abrasive, like SiC and diamond. A comparison of TiO_2 and SiC for 4 different types of coatings is given in figure 1. The differences in absolute values and differences in ranking are explained in terms of changes in the wear mechanism.

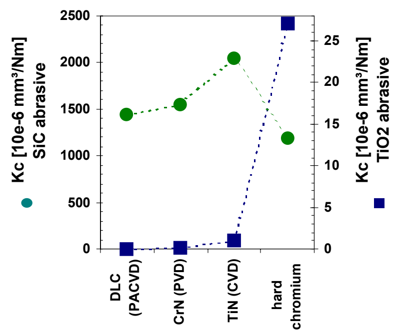

Figure 1: Comparison of the wear coefficients obtained with a SiC abrasive to the wear coefficients obtained with the TiO_2 abrasive for different types of coatings.

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