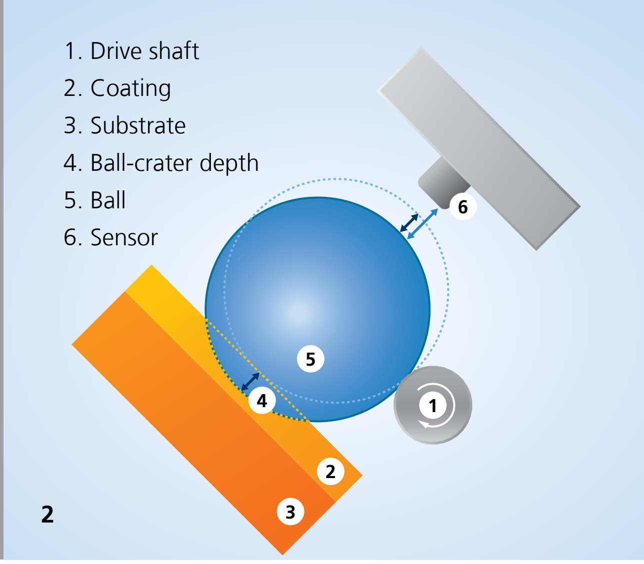
1



2

CONTINUOUS BALL-CRATER ABRASION MEASUREMENT IN REAL TIME

For many years the abrasive wear of coatings has been measured by the well-established ball-crater abrasion test. With a modified ball-crater abrasion tester the abrasion behavior of coatings can now also be viewed as a function of time. Here the crater depth is measured continuously, thereby eliminating the additional manual evaluations hitherto necessary. The method developed at the Fraunhofer IST thus saves time as well as delivering certainty of results.

The ball-crater abrasion method

The traditional ball-crater abrasion test works on a very simple principle. A ball crater is ground into the coating under investigation with the aid of a rotating steel sphere to which an abrasive suspension is applied. After a specified test period the volume of the crater is measured and the wear coefficient obtained from this. In itself the method is very easy to handle but does have some disadvantages. For example, the abraded volume is usually determined as part of a visual evaluation and is thus dependent on the experience of the person carrying out the test. Furthermore, the wear coefficients of coating systems are determined at different surface pressures since with a specified test duration ball craters of different sizes form depending on the wear resistance of the coatings being tested. A further disadvantage of the traditional method is that it cannot describe dynamic, in other words, time-dependent wear behavior.

Continuous measurement of wear

In order to investigate dynamic wear behavior and at a future stage to determine wear coefficients under comparable surface pressures, a measurement system has been developed at the Fraunhofer IST which measures and displays in real time the ball-crater depth during grinding. To do so a ball-crater grinding device was modified to enable a displacement sensor to continuously record the change in the position of the rotating ball – in other words, the crater depth ground into the material under test by the ball. The sensor, based on eddy-current technology, can be positioned in such a way that abrasion measurements can be carried out even with different bearing forces. The sensor can be moved laterally for handling and specimen changing.

Comparison of wear coefficients and surface pressures

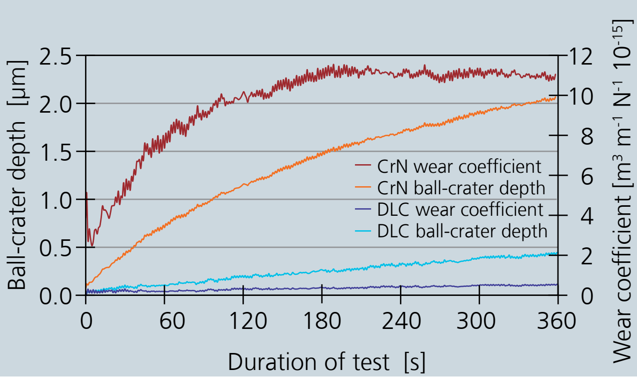
To give an example, the different dynamic wear behaviors of a DLC and a CrN coating were recorded in a test set-up. Results are shown in the graph opposite. The time-dependent wear behavior of the CrN coating here shows a marked difference from that of the DLC coating: while the wear coefficient of the DLC coating increases continuously, the wear on the CrN coating approaches a constant value.

The table shows different evaluations of the measurement curves shown in the graph opposite. With the same test duration, the traditional method yields a wear coefficient for CrN which is higher than that of the DLC coating by a factor of 20. The ball-crater depths are also different. With normalization to the same surface pressure the ball-crater depth on the other hand is identical and the ratio of the wear coefficients markedly lower (wear coefficient CrN/DLC = 10). With the aid of dynamic measurement the wear coefficients of coatings and materials can be evaluated under uniform surface pressure and thus better compared.

Outlook

So far only the basics of the method have been tested. In further test series the as yet unsatisfactory reproducibility is to be examined more closely.

Dynamic wear behaviors of a DLC and a CrN coating



Determination of the wear coefficients	Reference value (DLC)	Traditional method Identical test duration (CrN)	New method Identical surface pressure (CrN)
Duration of test [s]	**360**	**360**	30
Ball-crater depth [µm]	**0.43**	2.0	**0.43**
Surface pressure [N/mm^2]	**13.3**	2.8	**13.3**
Wear coefficient [m^3 m^{-1} N^{-1} 10^{-15}]	0.5	~ 11	~ 5.0

1 *New ball-crater abrasion tester with sensor.*

2 *Principle of the new measurement set-up.*

CONTACT

Dipl.-Ing. Reinhold Bethke
Phone +49 531 2155-572
reinhold.bethke@ist.fraunhofer.de

Fraunhofer Institute for Surface Engineering and Thin Films IST | Bienroder Weg 54 E | 38108 Braunschweig | Germany