

The new methods for scuffing and pitting investigation of coated materials for heavy loaded, lubricated elements

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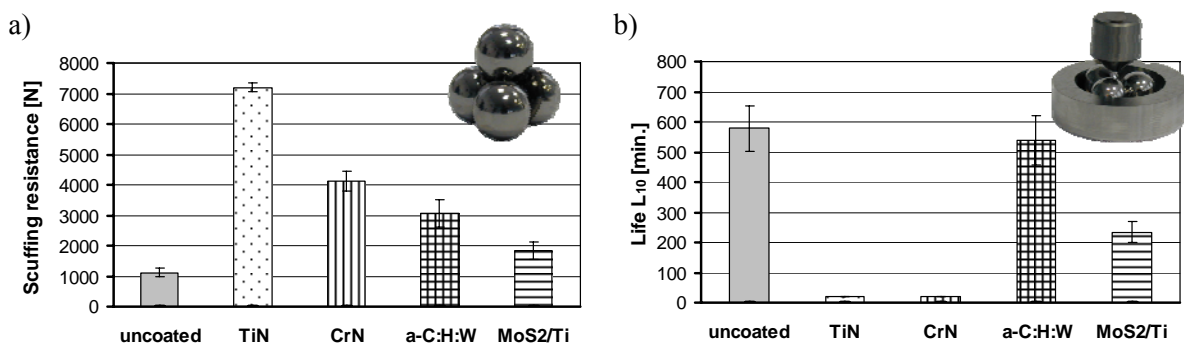
There are many successful applications of thin hard PVD/CVD coatings in various technical devices like engines, pumps, compressors. However the problem of application of such coatings for heavy-loaded friction parts (e.g. gears, bearings) is still open - the share of mechanical components that are coated is extremely small (less than 2%). Why? The service life of heavy-loaded machine parts is essentially determined by two types of tribological failures: scuffing which is a severe form of mechanical wear, and pitting which is a surface fatigue phenomenon. Up to now, there was a lack of verified laboratory test methods intended for correlated determination of coating material and lubricating media on scuffing and pitting resistance of heavy-loaded system. So, the selection of coating material and technology was realised mainly basing on very expensive and long-term practical component research and the results are frequently contradictory.

The authors worked out two new methods using very well known and worldwide popular four-ball apparatus.

The **scuffing** four-ball method is carried out using T-02 tester. The three stationary, bottom balls fixed in the ball pot are pressed against the top ball at the continuously increasing load. The top ball is fixed in the ball chuck and rotates at the constant speed. The balls are immersed in the tested lubricant. During the run the friction torque is observed until seizure occurs. The scuffing resistance is characterised by the so-called scuffing load (P_1) and limiting pressure of seizure (p_{oz}).

The **pitting** cone-three ball method is carried out using T-03 tester. The tribosystem consists of three lower balls freely rotating in a special race, and driven by the top cone with the investigated coating. The specimens are completely immersed in the tested lubricant. Pitting is detected by a special system with a vibration sensor. At least 24 top cone failures were necessary to assess the lubricant performance. The fatigue life (pitting) is characterised by the 10% fatigue life L_{10} . The L_{10} life is obtained by a linear regression analysis of the trend line for each specimen (Weibull analysis).

The above mentioned methods were successfully applied to investigate different types of surface coatings, among others: single, multilayer and low-friction.



The scuffing resistance (a) and fatigue life (b) of tribosystems with coated elements.

The new methods exhibit very good resolution and precision comparable to standardised test methods and are time and cost effective. Furthermore the cone-three ball method gives the possibility of testing fatigue wear of any coating and substrate material. The elaborated methods allow the optimal selection and development of PVD/CVD technologies for extension of the life of the heavy-loaded friction joints as well as the elimination of toxic lubricating additives.