ON THE TRIBOLOGICAL CHARACTER OF DLC COATED COMPONENTS

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ABSTRACT
The advantage of applying thin tribological coatings on metal cutting tools and forming tools is today well documented. A current trend is to use a similar approach for machine elements and other mechanical components. However, the tribological requirements on mechanical components differ significantly from those of the tools. For mechanical components

• the wear of both mating surfaces are of similar interest,
• the mating surfaces are often of the same material,
• the mating surfaces often have to be smoothened and conformed by running in,
• the contact pressures and temperatures are relatively low, and
• the tribological contact is lubricated.

Generally, coatings for mechanical components should combine low friction properties with high wear resistance, and simultaneously comply with the above characteristics.

This paper reports on the tribological performance of DLC coated ball bearing steel parts in sliding contact. The tests have been performed in a test configuration that involves two crossed, elongated cylindrical test specimens that are forced to slide reciprocally against each under a constant speed. During forward sliding, the normal load is gradually increased from a low to a high level, while the load is correspondingly decreased during the reversed sliding [1,2].

The essence of this test, which distinguishes it from all traditional tribological tests, is that each point along the contact path of both specimens will experience a unique load. Thereby each point will display a unique tribological history after test completion, which facilitates immediate friction and wear vs. load evaluation in one single test, and rapid determination of any critical load. The result is evaluated by plotting the friction history and imaging the worn surface in the SEM.

The influence of the hardness and topography of the steel substrate, the hardness of the counter surface, the state of lubrication (dry, starved, boundary, with or without additives), and running in has been investigated. The wear mechanisms, the amount of wear and the friction level have been investigated as a function of load. For the starved lubrication tests, the coating endurance has been measured as the critical number of cycles to failure.

It is seldom practical or economically possible to manufacture the contact surfaces of mechanical components with such a precision that they are optimised for the tribological performance. Instead, they must be allowed to gradually conform and become smoother by a gentle running in. The importance of surface topography on running in of tribological components is well documented. However, the application of thin wear resistant coatings on one or both contacting surfaces entirely changes the running-in situation. The running in of a coated surface is retarded and very little wear can be accepted since the coating is so thin, while the running-in of an uncoated counter-surface may be facilitated. Therefore also the topographical requirements for surface finishing change. Thus, to take full advantage of any coating, special emphasis must be given to the initial surface roughness of both surfaces.

It is demonstrated that when sliding DLC coated steel against uncoated in lubricated reciprocal contact, both substrate and counter surface should be of about the same hardness. The same tests also show that there is an optimum roughness of the coated steel of about 0.1 µm (Rₐ).

In starved lubrication, DLC coating increased the number of cycles to excessive friction by a factor of the order of 50 – 500. Running in of DLC coated steel in a fully lubricated sequence of relatively low load, significantly increased the endurance life in a subsequent test with starved lubrication.

From the friction measurements it is concluded that there is no significant difference between uncoated and DLC coated steel; they all gave a friction coefficient of 0.08 – 0.09.

REFERENCES