

On surface roughness in tribology

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This paper brings up some critical aspects on the importance of surface roughness in tribology. Examples are given from sliding and rolling contact. They include bulk materials as well as thin coatings, and dry as well as lubricated tests. Rolling contact evaluated in a dedicated equipment where a cylindrical test rod rotates against to hardened steel disks. Sliding contact was assessed both by conventional scratch testing and uni-directional as well as reciprocal sliding in a ball-on-disk equipment and a dedicated load scanner, respectively.

It is demonstrated that friction, wear, galling, and coating decohesion and delamination all reduce with surface smoothness.

Dry friction and tendency for galling between hardened steel and austenitic stainless steel is dramatically reduced if the surface roughness (R_a) is reduced from 0.25 μm to 0.15 μm or lower. The friction coefficient typically drops from 0.6 to below 0.2. TiN and a DLC coatings behave similarly, the latter giving the lowest dry friction coefficient of about 0.10 – 0.15.

For thin coatings in sliding and rolling contact, surface asperities such as ridges formed during machining may act as initiators for decohesion and coating detachment. Numerous of SEM-micrographs will demonstrate the appearance of such damage. One reason why most PVD coatings are sensitive to surface roughness is their intrinsic compressive stresses. Combined with surface roughness, these stresses will add to the stresses caused by the external loading, and the most critical situation occurs at ridges and other asperities.

Finally, if a rough and hard surface, such as that of a PVD coated coarsely ground component, slides against a softer counter-material, the wear of the soft surface will increase with the coating roughness. This is an important note for coating machine components where both surfaces often are of equal value.