Plastic Flow and Related Wear Mechanisms ofCVD Ceramic Coatings

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Abstract

Ceramic coatings have been widely used in cutting tools and various machine parts. Even though high strengths have been obtained in most ceramic coatings, it has also been shown that ceramic coatings undergo extensive plastic deformation during scratch and wear tests. Therefore, it is essential to understand the plastic flow and related friction and wear behaviour.
Reciprocating multipass wear tests have been carried out on various CVD coatings. Deformation and failure mechanisms were identified based on high resolution microstructural examination of cross-sectional fracture surfaces
Obvious plastic flow was observed on the rough surface of CVD ceramic coatings in the first sliding, due to the extremely high contact pressure developed on the contact asperities. However, shake down may be quickly reached after several subsequent traverses. In further repeated traverses, the plastic-elastic flow accumulates residual strain energy to the point where cracking, microbuckling, and microflaking may occur along the elastic-plastic interfaces behind the indenter. The new rough surface will appear after the detachment of the heavily strained plate-like wear debris. The repeated sliding allows the process- “plastic flow of asperities - flatten the surface and shake down - microbuckling and detachment of strained layer” to continue until the coating is totally worn out.
A lower sliding resistance or energy loss was obtained when the ceramic coatings contact with diamond materials, even.the asperities have been heavily deformed. The coefficient of friction or energy loss is quite high when the ceramic coatings contact with WC/Co materials, even without the occurrence of obvious

plastic flow. The strong adhesion between WC/Co and
ceramic coatings is the main reason for the large amount of energy loss, rather than the deformation of the coating materials.
The energy released by the localized chemical reaction or diffusion is probably much higher than energy dissipated by physical
deformation process.

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