The Role of Fracture Toughness in the Mechanics of Wear of Polymer Materials

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The wear behaviour of epoxy and polyetheretherketone (PEEK) was investigated and compared under dry sliding conditions. The effect of the surface roughness of steel counterparts was studied at different temperatures. Figure 1 compares microscopy images of steel counterparts before and after polishing.

Figure 1 Microscopic images of the counterpart surfaces of (a) original steel disk and (b) the one prepared by polishing.

It was found that the wear rate of polymeric specimens always decreases with the surface roughness of steel counterparts. However, with the changes in the counterface roughness, the polymer specimens may show distinct worn surfaces, suggesting different failure mechanics in wear processing. As shown in Figure 2, a transition of abrasive to adhesive/fatigue wear was observed for epoxy specimens, as the surface roughness of the steel counterpart was reduced. However, for PEEK, the worn surfaces were less significantly affected, as shown in Figure 3.

Figure 2 SEM images of the worn surfaces of epoxy against (a) the original steel disk and (b) the polished steel disk.
It is worthwhile mentioning the resemblance between abrasive wear and orthogonal cutting (cf. Figure 4). The latter can be modeled as the fracture process [1, 2]. It was proposed that with the increase of tool bluntness, the transition from stable micro-cutting process to unstable chipping may occur, depending on the mechanical properties of polymer workpiece, $G_c/\sigma_Y$ ($G_c$, fracture toughness; $\sigma_Y$, tensile yielding strength). This explains our wear results, i.e. PEEK was less sensitive to the changes in counterface roughness, thanks to its relatively high $G_c/\sigma_Y$ value. The results also highlight the important role the fracture toughness in determining wear performance of polymeric specimens. It is concluded that the fracture behavior of polymers will greatly affect the formation of their worn surface, as well as wear debris. The latter will contribute to the formation of the transfer film layer on the counterface and thus determines the wear performance in the steady stage.

**REFERENCES**


