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# Distinct Tribological Mechanisms of Various Oxide Nanoparticles Added in PEEK Composite Reinforced with Carbon Fibers

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## Abstract

The tribological behaviors of various oxide nanoparticles, i.e.  $\text{Bi}_2\text{O}_3$ ,  $\text{CuO}$ ,  $\text{SiO}_2$  and  $\text{ZrO}_2$ , added into a carbon fibers reinforced polyether-ether-ketone were comprehensively investigated. It was demonstrated that nanoparticle types played an important role in the tribological performance. When sliding took place at a low FV (load  $\times$  speed) condition, the addition of  $\text{CuO}$  and  $\text{ZrO}_2$  nanoparticles led to the formation of patch-like tribofilms increasing friction and wear. However, at FV factors ranging from 30 to 300 N·m/s, the hard nanoparticles, i.e.  $\text{SiO}_2$  and  $\text{ZrO}_2$ , resulted in dramatic improvement of the tribological properties. Moreover, nano- $\text{ZrO}_2$  was significantly more effective than nano- $\text{SiO}_2$  for enhancing the tribological performance. Hard nanoparticles released onto the sliding interface removed the tribo-oxidation layer on steel counterface. Hereafter, they were “tribo-sintered” into an oxide-based tribofilm having a high load-carrying capability. However, the soft nanoparticles, i.e.  $\text{Bi}_2\text{O}_3$  and  $\text{CuO}$ , did not help to form a robust and lubricating tribofilm.

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