Enhanced Wear Resistance of Nano-Carbon and Graphene Based PTFE Composites

by

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Abstract

The wear resistance of polytetrafluoroethylene (PTFE) can be greatly improved by adding a small amount of nano-sized filler material. This study investigated the behavior of PTFE and four forms of carbon based filler composite samples. The four carbon materials used were nano-carbon (carbon black), graphene, carbon nano-tubes, and micro-graphite. The nano-carbon and graphene showed wear rate improvements as weight content increased beyond 0.12%, reducing wear rates below the ~10^{-3} mm^3/Nm attained by unfilled PTFE. The wear rates of nano-carbon filled PTFE reduced as filler content increased with a power law relationship to the -2.0 power. A wear rate of $4*10^{-8}$ mm^3/Nm was achieved with the 5% nano-carbon filler. The graphene displayed a power law relationship between wear rate and filler content percent to a similar -1.9 power, but only at weight percents above 0.12% At lower filler contents wear rate was unaffected relative to that of unfilled PTFE. The 10% graphene sample yielded a wear rate as low as 10^{-7} mm^3/Nm. The carbon nano-tubes and micro-graphite both also showed a decrease in wear rate as filler content increased. A wear rate of $1.5*10^{-8}$ mm^3/Nm by the 10% carbon nano-tubes was achieved, which is considerably below wear rates achieved in others' previous wear tests. The micro-graphite had a wear rate of $3*10^{-6}$ mm^3/Nm at 10% filler content. Optical microscope images of the composite wear tracks, counter-surface wear tracks, and wear debris indicated a loose correlation between their structures and the samples' wear rate.