

EFFECT OF SURFACTANT ON WEAR OF POLYMER NANOCOMPOSITES

Aravind Dasari, Zhong-Zhen Yu, Yiu-Wing Mai
[Zhong-Zhen Yu]: zhongzhen.yu@aeromech.usyd.edu.au
Centre for Advanced Materials Technology (CAMT)
School of Aerospace, Mechanical and Mechatronic Engineering (J07)
The University of Sydney, Sydney, NSW 2006, Australia

Keywords: wear, calcium carbonate, nanocomposites, tribology, polypropylene

Abstract

In the last decade, many studies were reported on the wear damage in polymers filled with different nanoparticles based on titanium-, aluminium-, zinc-, iron-, silicon-compounds, carbon nanotubes, clay, etc. Based on these studies, it has been suggested that the presence of nanoparticles possesses many advantages over micron-sized particles if all the nanoparticles are dispersed uniformly in the matrix and with good bonding (either physical or chemical) to the matrix. But, in our previous study on the wear behaviour of polymer nanocomposites [1], we have observed that whilst the above-mentioned conditions are needed, they may not fully control the removal of material. Thus, it is not totally valid to assume that nano-fillers will irrevocably improve the friction and wear properties and that other conditions may also have significant effects on material removal like tribochemical reactions that may occur during the wearing process between the nanocomposite and the counterface leading to the formation of a thin, stable transfer film on the counterface resulting in an effective 'polymer on polymer' contact instead of a 'hard metal/ceramic on polymer' contact. Moreover, in most previous studies, the role of the surfactant (unbound or excessive) which is used to improve the dispersion of nanoparticles in the polymer matrix is unclear.

Therefore, in this study, we will endeavour to separate the effects of nanoparticles and the modifier/surfactant on the wear resistance of polymer nanocomposites. Polypropylene/calcium carbonate nanocomposites were prepared at varying percentages of calcium carbonate (up to 15 wt.%) with and without stearic acid (1.5 phr), which is a saturated fatty acid added as a modifier to improve the dispersion of CaCO₃ nanoparticles. The mechanisms of sliding wear damage and the individual effects of calcium

carbonate and stearic acid were studied in detail at different loading conditions.

Significant improvements in the specific wear resistance of the nanocomposites with stearic acid were observed along with a decreased friction coefficient compared to those without stearic acid at all testing conditions. Optical micrographs of the silicon nitride counterface after wear testing of those materials with stearic acid showed the presence of a thin, stable and uniform film (For example, see Fig. 1); while in other materials without stearic acid, no such films are formed.



Fig. 1. Optical micrograph of the silicon nitride counterface after wear testing on polypropylene/calcium carbonate (85/15) nanocomposite having 1.5 phr stearic acid showing the presence of a thin, stable and uniform film.

References

- [1] Dasari A., Yu Z.-Z., Mai Y.-W., Hu G.-H., and Varlet J. "Clay exfoliation and organic modification on wear of nylon 6 nanocomposites processed by different routes". *Composites Science and Technology*, Vol. 65, No. 15-16, pp 2314-2328, 2005.