7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Tribological behaviour of UHMWPE reinforced by metal sulphides under dry sliding conditions

Bruno Pizone Vaz, Karthik Namachivayam, Maksim Nikonovich, Nazanin Emami*

Polymer-tribology group, Division of Machine Element, Luleå University of Technology, Sweden
*Corresponding author: nazanin.emami@ltu.se

Ultra-high molecular weight polyethylene (UHMWPE) exhibits greater tribological properties among polyethylene family, which makes it suitable for multiple areas of applications as tribo-component. However, the neat polymer disadvantages are such as tendency to creep under higher loads and low strength. To improve tribological and mechanical properties and understand the mechanism behind the incorporation of fillers, UHMWPE was reinforced by 2D solid lubricants, particularly, metal sulphides (MoS_2 and SnS_2).

Keywords: UHMWPE, molybdenum sulphide, tin sulphide, tribology, polymer composites

Introduction

UHMWPE is one of the promising matrix materials for applications where self-lubricity, low friction, low wear, and hydrophobicity are required such as devices, bearing components and gears. Tribological behaviour of neat polymers might be significantly improved through reinforcement, particularly, metal sulphides, which easy shearing of the layers against one another promotes good self-lubrication, while wear resistance is improved by the strong interatomic bonding [1]. The aim of the present work is to compare the effects of different solid-lubricants on tribological properties of experimentally made UHMWPE composites, and investigate the effect of counter-surface roughness, sliding speed and contact pressure on the tribological performance.

Methods

UHMWPE was reinforced with three solid metal sulphides provided by Tribotecc GmbH, Austria: MOS XF (molybdenum disulphide grade), SNS 2 Grade A (synthetic tin sulphide and tin disulphide grade) and SLS 22F (synthetic lubricant containing phosphates and tin sulphides). Essential properties are presented in Table 1.

Table 1: Main properties of the fillers.

Fillers	Density, g/cm^3	Particle size, µm D50	Particle size, µm D90	Fillers, wt. %
MOS XF	4.8	10	23	
SNS2 A	4.5	3	9	0, 5, 10
SLS 22F	3.1	3	9	

Tribological tests were performed using the reciprocation pin-on-plate configuration, which main parameters are summarised in Table 2.

Table 2: Pin-on-plate test conditions.

Contact pressure, MPa	Sliding speed, m/s	Counter surface (c/f)	c/f Ra, µm	Time, hr
10	0.02 0.15 0.2	Stainless steel 316L	0.1 ± 0.01 0.4 ± 0.04	10

Results

The fillers were found to have minor influence on the friction coefficient, which was suggested due to matrix dominant behaviour, whilst the wear rate of the composites notably reduced compared to pure UHMWPE. The effect of counter-surface roughness was found to be not notable, but the increase of sliding speed, significantly reduced the wear rate (up to 60%).

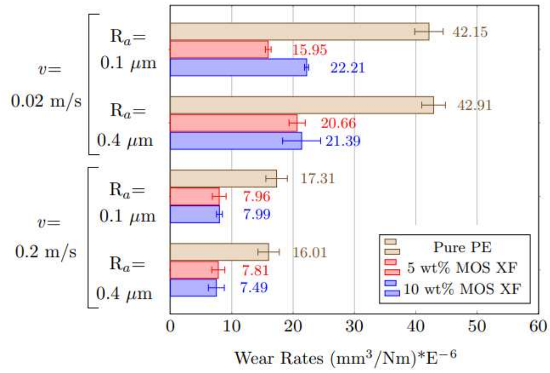

Figure 1: Wear rate of MOS XF reinforced UHMWPE.

Discussion

Based on the results, the optimal filler content was suggested to be 5 wt.%, which promoted improved tribological response due to considerable dispersion of the fillers in the matrix, hindering the formation of agglomeration, which affect tribological properties of the polymer composite. Among the studied metal sulphides, MOS XF exhibited better tribological behaviour: the larger particle size reduced the risk of the formation of larger polymer flakes, and reduced tribofilm formation on counter surface. However, the opposite was observed for tin disulphides (SLS 22F), where significant transfer film was formed on counter surface. Generally, correlating the results of this work to previous research regarding UHMWPE-metal sulphide composites, the same range of wear resistance improvements is observed, although it is important to note that current tribo-study was carried out under significant higher contact pressure (10 MPa) compare to previous studies on similar composites with contact pressure up to 1.5 MPa.

References

[1] Panin, S. et al., "Increasing the wear resistance of ultra-high molecular weight polyethylene by adding solid lubricating fillers," AIP Conference Proc., 1623, 1, 2014, 471–474.