Accepted Manuscript

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Leyu Lin, Alois K. Schlarb

PII: S0301-679X(17)30539-X

DOI: 10.1016/j.triboint.2017.11.024

Reference: JTRI 4964

To appear in: *Tribology International*

Received Date: 23 August 2017

Revised Date: 10 October 2017

Accepted Date: 14 November 2017

Please cite this article as: Lin L, Schlarb AK, The roles of rigid particles on the friction and wear behavior of short carbon fiber reinforced PBT hybrid materials in the absence of solid lubricants, *Tribology International* (2017), doi: 10.1016/j.triboint.2017.11.024.

The roles of rigid particles on the friction and wear behavior of short carbon fiber reinforced PBT hybrid materials in the absence of solid lubricants

Leyu Lin[a] *and Alois K. Schlarb*[a,b,c]

[a] *Chair of Composite Engineering, University of Kaiserslautern, 67663 Kaiserslautern*

[b] *Research Center OPTIMAS, University of Kaiserslautern, 67663 Kaiserslautern*

[c] *INM - Leibniz Institute for New Materials, 66123 Saarbruecken*

Abstract

Polymeric materials filled with micro-sized short carbon fiber (SCF) and various internal lubricants, i.e. graphite and PTFE etc., have been proved as a beneficial tribomaterial formulation in contact with a steel counterbody. The SCFs carry the most load applied on the tribosystem, while the internal lubricants improve the friction behavior of the polymer matrix. In the present study, the roles of rigid particles on the friction and wear performance of SCF filled Polybutylenterephthalate (PBT) with and without graphite were investigated by using a pin-on-disc (PoD) tribometer under dry sliding condition. The experimental results show that the tribocomposite filled with nanoparticles without graphite particles presents outstanding friction and wear performance especially under moderate and severe load conditions in combination with superior mechanical properties compared with graphite-filled tribocomposite. The friction coefficient and wear rate under a pv-condition of 3 MPa and 2 m/s are 0.18 and $0.8*10^{-6}$ mm^3/Nm, respectively. Based-on the optical analysis of the worn surfaces of the polymer samples and the transfer layers formed on the steel disc, the possible friction and wear mechanisms were discussed.

Keywords: PBT; solid lubricants; rigid particles; friction and wear properties.

1. Introduction

Due to the high requirements of different tribological applications in the motion systems, polymer-based tribomaterials are attracted increasing attentions. It is commonly accepted that polymeric material filled with short carbon fiber (SCF), PTFE or/and graphite is a successful formulation of tribomaterials [1]. The fibers carry the load applied on the polymer and reduce the wear; the solid lubricants improve the friction behavior [2]. In the last decade, it has been proved that the incorporation of rigid inorganic particles in submicro- and nanoscale into such traditional tribological composites consist of polymeric materials, short carbo fibers and internal solid lubricants, i.e. PTFE, graphite, MoS_2 etc., can effectively enhanced the friction and wear performance especially under dry sliding conditions [3-8]. The reinforcing mechanisms can be attributed to the formation of homogenous transfer layer on the steel counterpart [9], positive rolling effect of the tiny particles between body and counterbody [3, 10] and the protection effect of the inorganic particles in front of the SCFs [7]. In these studies, internal solid lubricants, such as PTFE, Graphite and MoS_2, are commonly indispensable component for designing the polymer-based tribological materials due to their high potential for reducing friction between two sliding parts. Such materials can reduce the friction owing to their layered structure resulted easy-to-shear characteristics [11-14]. Moreover, the solid lubricants generally promote a