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Wear in Polymer Composite with Solid Lubricants for Cage of Cryogenic Ball Bearing

Seo, Woo-Seok[1]; Choe, Bokseong[2]; Lee, Yongbok[2], Lee, Jeon-Kook[1*]
[1]Center for Opto-Electronic Materials and Devices, Korea Institute of Science and Technology, Seoul, Korea (the Republic of). [2]Center for Urban Energy Research, Korea Institute of Science and Technology, Seoul, Korea (the Republic of).
*corresponding email: jkleemc@kist.re.kr.

It was experimentally elucidate the mechanism of friction wear surface for the sliding and rolling contact movement in the cryogenic atmosphere, such as low temperature for the equipment and space for the machine element. To evaluate the properties of the solid lubricating cage, we should minimize the frictional wear of the contact surface at a low temperature condition.[1] Investigations of wear resistance of polymers with additives, using the cryogenic pin-on-disk apparatus has been carried out. Normal load, rotating speed and liquid nitrogen flow rate were considered variables in the cryogenic wear tests. The friction and the wear mechanisms are briefly reviewed. Various polymeric materials containing solid lubricants were investigated.

The self-lubricating effect of polymer composite cage fabricated by pure PTFE (Teflon), composites PTFE + MoS_2 + glass fibers, PTFE + bronze particles were verified by friction coefficient and wear rate. Disc of PTFE composite with MoS_2 and bronze were tested against metal round pin. In all tests, debris and flakes of worn materials were verified to define the wear mechanism.[2] Wear resistance of polymers and composites is its strong dependence on the environmental relative humidity and normal load.[3] In this experiment, the ball bearing cage composition change in the cryogenic atmosphere were also investigated to analyze the effect of bearing friction and wear.

Solid lubricant MoS_2 and bronze particles mixed with polymer precursor powder are shown in Fig.1. Fabricated cage and assembled ball bearing (Fig.2) is tested in cryogenic atmosphere. As shown in Fig.3, polymer composite cage with MoS_2 solid lubricant shows stable torque variation due to the rigid cage pocket shape. Fig.4 shows that the wear loss and mass transport from cage to race way are changed by the adhesion of the lubricant. MoS_2 and PTFE materials easily adhere to the raceway surface.

Cage center-of-mass orbits for cryogenic ball bearing with different solid lubricant are demonstrated as shown in Fig. 5. In the case of MoS_2 containing composite cage, circular orbit is observed.

Among the tested materials, the composites PTFE with additive MoS_2 have shown good friction coefficient.

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KEYWORDS
Polymer Composite, Solid Lubricant, Cryogenic Ball Bearing, Cage Pocket, MoS_2, Bronze Particle

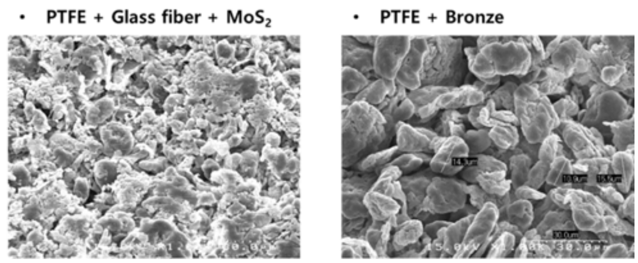


Fig. 1. Microstructures of composite powders.

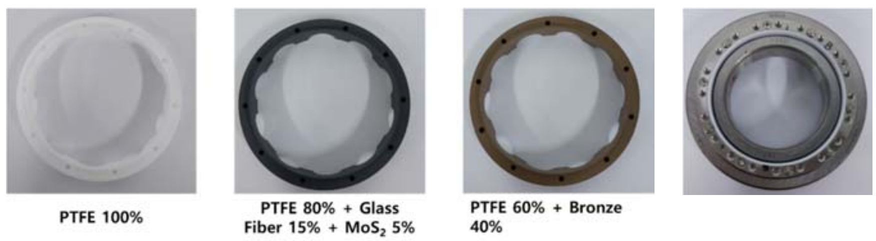
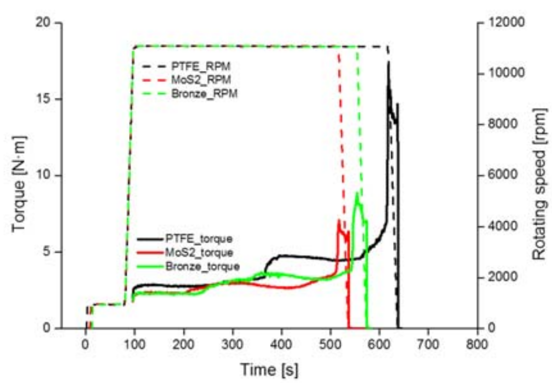


Fig. 2. Composite cages and assembled ball bearing.



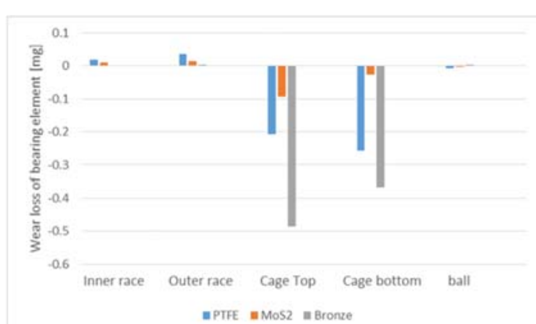


Fig. 3.   Fig. 4.

Fig.3. Torque changes with various composite solid lubricant.

Fig. 4. Wear loss of various composite.

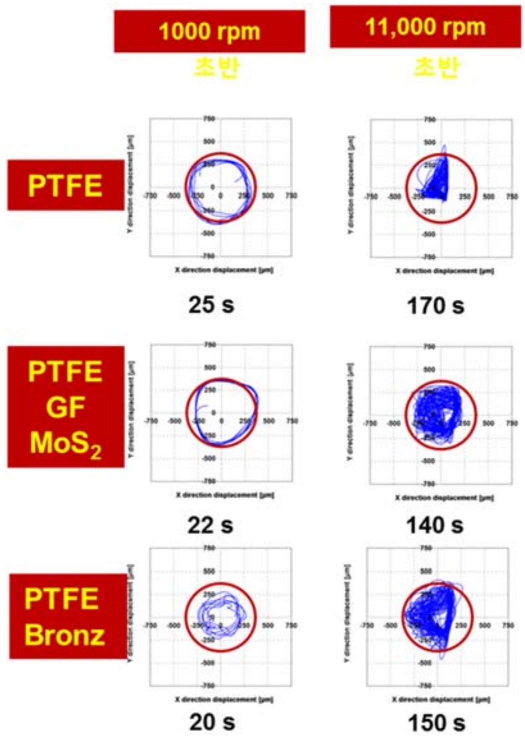


Fig. 5. Cage center-of-mass orbits for cryogenic ball bearing with different solid lubricant.