

Electronic Supplementary Material

Water-based superlubricity in vacuum

Chen XIAO¹, Jinjin LI², Lei CHEN¹, Chenhui ZHANG², Ningning ZHOU³, Tao QING³, Linmao QIAN^{1,*}, Jiyang ZHANG³, Jianbin LUO²

¹ Tribology Research Institute, State Key Laboratory of Traction Power, Southwest Jiaotong University, Chengdu 610031, China

² State Key Laboratory of Tribology, Tsinghua University, Beijing 100084, China

³ Beijing Key Laboratory of Long-life Technology of Precise Rotation and Transmission Mechanisms, Beijing Institute of Control Engineering, Beijing 100094, China

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1 The morphologies of the wear track on tribopair surfaces

The morphologies and line profiles of the wear tracks on the tribopair surfaces in vacuum and ambient environment were displayed in Fig. S1. There is little difference in the wear depth of tribopairs after the tests in air and in vacuum. It indicates that the vacuum environment has little effect on the wear behavior between the Si_3N_4 balls and glass substrates with the lubrication of H_3PO_4 solution.

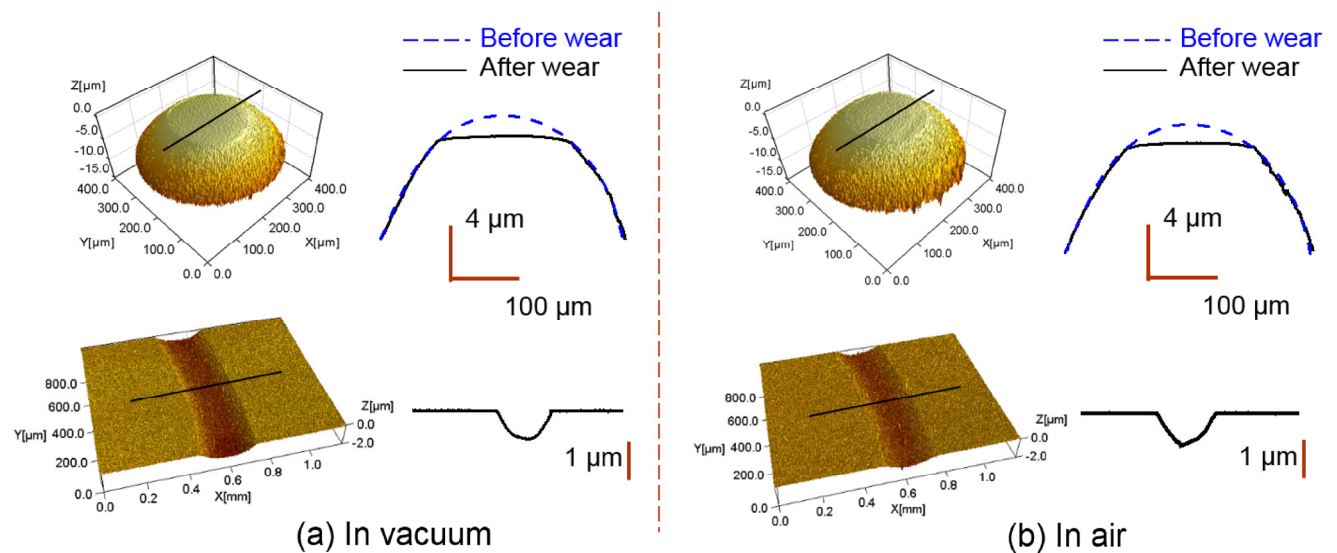


Fig. S1 Comparison of optical images and line profiles of tribopair surfaces after the tests in air and in vacuum. The sliding distance is 30 m.

* Corresponding author: Linmao QIAN, E-mail: linmao@swjtu.edu.cn

2 The friction coefficient under the lubrication of mixture of glycerol and H₂SO₄ solution in air and in vacuum

To exclude the effect of phosphoric acid concentration, we repeated that experiment with the lubrication of mixture of glycerol and H₂SO₄ solutions, whose pH value was also controlled as 1.5. As shown in Fig. S2, the change trend of friction coefficient with the lubrication of mixture of glycerol and H₂SO₄ solution is similar to that in Fig. 4. The superlubricity state was achieved after the running-in process in air, which was attributed to the hydrogen bond network formed by glycerol and water molecules with low shear strength. However, the friction coefficient immediately increased from 0.007 to 0.03 when the chamber pressure is pumped to 0.02 torr. The result indicated that the effect of phosphoric concentration on the superlubricity failure in vacuum can be ignored.

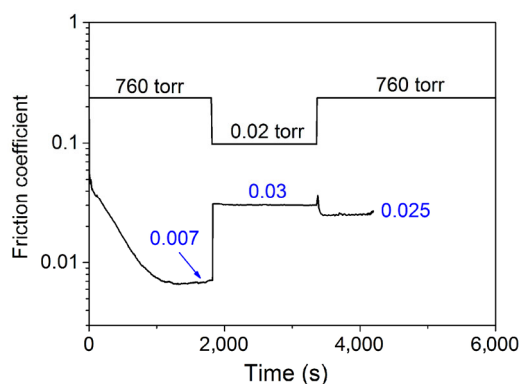


Fig. S2 Effect of the hydrogen bond strength in hydrated water layer on water-based superlubricity behavior in vacuum. The friction coefficient is measured under the lubrication of mixture of glycerol and H₂SO₄ solution, and the other experimental parameters are the same as those in Figs. 1 and 4.