Macroscale superlubricity enabled by graphene coated surfaces

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Abstract:

Friction and wear remain the primary modes for energy dissipation in moving mechanical components. Superlubricity is highly desirable for energy saving and environmental benefits. Macroscale superlubricity was previously performed under special environments or on curved nanoscale surfaces. Nevertheless, macroscale superlubricity has not yet been demonstrated under ambient conditions on macroscale surfaces, except in humid air produced by purging water vapor into a tribometer chamber. In this study, a new tribological system was fabricated using a graphene coated plate (GCP), graphene coated microsphere (GCS) and graphene coated ball (GCB). The friction coefficient of 0.006 was achieved in air under 35 mN at a sliding speed of 0.2 mm/s for 1200 s in the developed GCB/GCS/GCP system. We, to the best of our knowledge, firstly report the macroscale superlubricity on macroscale surfaces under ambient conditions. The mechanism of macroscale superlubricity is due to the combination among of exfoliated graphene flakes and the swinging and sliding of the GCS, which is demonstrated by the experimental measurements, ab initio and molecular dynamics simulations. Our findings help to bridge macroscale superlubricity to real world applications, potentially dramatically contributing to energy savings and reduce the emission of carbon dioxide to the environment.

Biography:

Prof. Dr. Zhenyu Zhang is a professor of School of Mechanical Engineering at Dalian University of Technology, China. His research work focuses on ultraprecision grinding, chemical mechanical polishing, nanoscale precision manufacturing and nanotribology. Dr. Zhang was awarded the Excellent Young Scientists Fund of National Natural Science Foundation of China in 2014, Changjiang Scholar Program of Ministry of Education of China in 2016, Thousand Talents of Zhejiang Province, China in 2015, Distinguished Young Scholars for Science and Technology of Dalian City, Liaoning Province, China in

2016, Hundred Talents of Hundreds, Thousands and Ten Thousands Talents Program of Liaoning Province, China in 2016, Program for New Century Excellent Talents in University of China in 2013. Now he is an Associate Editor of Applied Nanoscience (SCI IF: 3.198). Dr. Zhang has published 64 peer-reviewed journal papers as the first or corresponding authors, consisting of Advanced Science, ACS Nano, Nano Letters, Nanoscale, Carbon, ACS Applied Materials & Interfaces, Materials & Design, Scripta Materialia, Applied Surface Science, Tribology Letters, CIRP Annals-Manufacturing Technology, International Journal of Machine Tools and Manufacture, etc.

Publication of speakers:

1. Lei, Ruide & Zhang, Zhenyu & Berto, Filippo & Ranjith, P.G. & Liu, Li. (2020). Cracking process and acoustic emission characteristics of sandstone with two parallel filled-flaws under biaxial compression. Engineering Fracture Mechanics. 107253. 10.1016/j.engfracmech.2020.107253.
2. Lei, Ruide & Zhang, Zhenyu & Ge, Zhaolong & Berto, Filippo & Wang, Gang & Zhou, Lei. (2020). Deformation localization and cracking processes of sandstone containing two flaws of different geometric arrangements. Fatigue & Fracture of Engineering Materials & Structures. 10.1111/ffe.13259.
3. Liu, Zhenjian & Zhang, Zhenyu & Liu, Xiaoqian & Wu, Tengfei & Du, Xidong. (2019). Supercritical CO2 Exposure-Induced Surface Property, Pore Structure, and Adsorption Capacity Alterations in Various Rank Coals. Energies. 12. 3294. 10.3390/en12173294.