# High-temperature Superlubricity in van der Waals Heterostructures

**Yuyang Long**
Xiao Wang, Baowen Li, Jun Yin*
*Nanjing University of Aeronautics and Astronautics, No. 29, Yudao Street, Qinhuai District, Nanjing, China*
yuyanglong@nuaa.edu.cn, yinjun@nuaa.edu.cn

Abstract

Achieving high-temperature superlubricity is essential for modern extreme tribosystems. Solid lubrication is the sole viable alternative due to the degradation of liquid ones but currently suffers from notable wear, instability, and high friction coefficient. Here, we report robust superlubricity in $MoS_2$/ graphene van der Waals heterostructures at high temperatures up to ~850 K, achieved through localized heating to enable reliable friction testing. The ultralow friction of the $MoS_2$/graphene heterostructure is found to be notably further reduced at elevated temperature and dominantly contributed by the $MoS_2$ edge. The observation can be well described by a multi-contact model, wherein the thermally activated rupture of edge-contacts facilitates the sliding. Our results should be applicable to other van der Waals heterostructures and shed light on their applications for superlubricity at elevated temperature.

References

[1] Yuyang Long, et al. Nano Letters, 24 (2025) 7572-7577

Figures

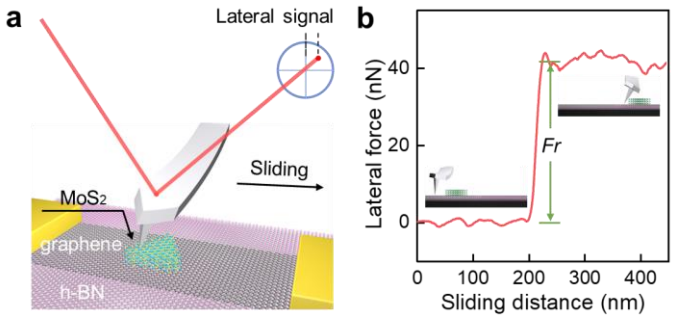


**Figure 1:** Friction characterizations of $MoS_2$/graphene interface. (a) Schematic illustration of the friction force measurement. (b) Typical friction curve measured through pushing the $MoS_2$ flake from its edge.

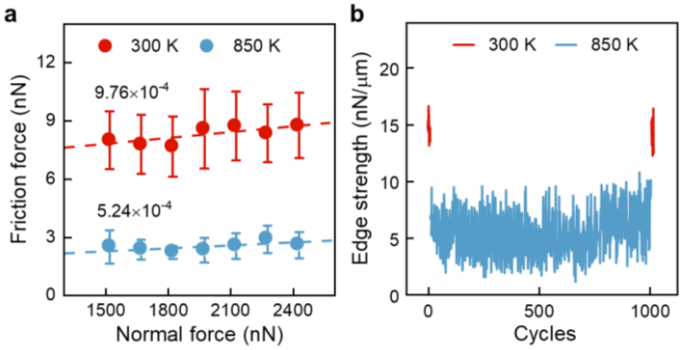


**Figure 2:** Robust superlubricity at elevated temperature. (a) Load dependence of the friction force at 300 K and 850 K. (b) Edge strength as a function of cycle times.