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Graphene Lubrication and Wetting Transparency Evaluated through Nanoscale Friction (I)

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Friction reducing, two-dimensional dry lubricants, such as graphene, boron nitride, and molybdenum disulphide, have been shown to have a number of interesting frictional characteristics, such as a dependence on the number of layers, an exceptional dependence on the surface adhesion properties of the underlying substrate, and environmental stability. We explored the frictional properties of these two-dimensional films under varied relative humidities and enviromental exposure times in an atomic force microscope and through molecular dynamics simulations A hysteresis in friction was observed in load-dependent friction measurements, whereby friction was observed to increase upon unloading versus loading. The friction hysteresis increased with relative humities but decreased with exposure time. This effect was linked to the wetting transparent property of two-dimensional materials, where the strength of this effect evolves with exposure to the ambient environment. Furthermore, our results suggest that the layer dependent reduction in friction observed for two dimensional films is, at least in part, a result of wetting transparency and an evolution of surface energy with time. Atomistic modeling of comparable surfaces, matched in terms of materials, surface energy, and structure, is used to explain the experimental observations of the influence of surface energy on friction and adhesion.

Authors: Ms GONG, Peng (University of Calgary); Dr YE, Zhijiang (Miami University); Mr YUAN, Lin (University of Calgary); Dr EGBERTS, Philip (University of Calgary)

Presenter: Dr EGBERTS, Philip (University of Calgary)

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