Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

Linking Friction with Mechanical Properties of Graphene Modulated by Supporting Substrates

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ABSTRACT

Two-dimensional (2D) materials, such as graphene, h-BN, and MoS_2, have shown very desirable friction-reducing properties resulting from their excellent mechanical strength, lubricating abilities, and other desirable physical properties. While these properties are excellent, they also show variation with the number of layers covering a substrate. Given the potential application of 2D materials as lubricants in microelectromechanical (MEMS) devices, or as friction reducing additives in conventional oil-based lubricants, understanding the exact physical parameters that control these layer-dependent properties is essential. Several studies have proposed that out-of-plane stiffness of 2D materials is linked with their lubricating properties without a true physical description of how the two are related. We have used atomic force microscopy to investigate these properties in both ambient and vacuum environments to separate environmental and ageing effects from intrinsic materials properties, providing the beginnings of a physical model to understand the interplay between adhesion, out-of-plane stiffness, and friction.

Word count: 149