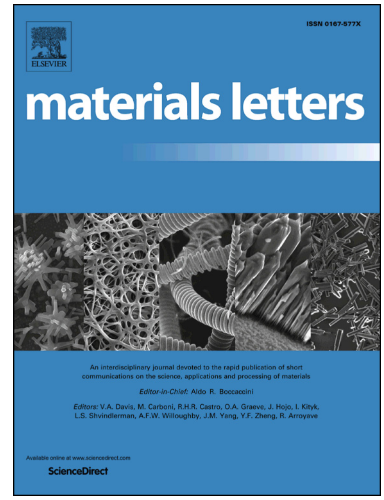

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Substrate-Regulated Nanoscale Friction of Graphene

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Abstract

In the present study, nanotribological measurements were performed via atomic force microscopy on Si/SiO_2-supported graphene monolayers with varying oxide layer thicknesses. The observations uncovered significant discrepancies in resulting friction forces between each graphene sample. Nanoscale interfacial friction forces were observed to increase from ~0.49 nN to ~1.00 nN when the oxide layer thickness was increased from 90 nm to 300 nm. The findings were determined to be the result of increased phonon scattering which is responsible for the removal of the vibrational reduction of nanoscale friction. Such discrepancies in friction forces points toward the potential tunability of nanoscale friction in supported graphene.

Keywords: Graphene, friction, atomic force microscopy, substrate-regulation

1. Introduction

With the continuous miniaturization of contemporary nano and micromechanical systems, the study and development of stable, solid-state lubricants for enhancing efficiency, durability, and extending the lifetime of these devices is of great importance. As a model material, and primarily due to its superb lubricity, graphene is well suited to diminish the parasitic effects of friction and wear of sliding, rotating, and oscillating nano and micro components [1]. Additionally, from a scientific standpoint, studies like this are especially interesting since they lay the groundwork for investigating a variety of physical, chemical, and engineering concepts.

Previous reports have discovered substrate-regulated effects on a number of graphene's intrinsic properties such as its extreme electrical and thermal conductivity [2,3]. Additionally, alterations in graphene's frictional characteristics have also been realized as a result of variations in the supporting medium [4]. Nanoscale tribological measurements have illustrated that the morphology and adhesion force of the underlying substrate influences interfacial friction on multi and monolayer graphene films [4,5]. To date, there have been very few experimental