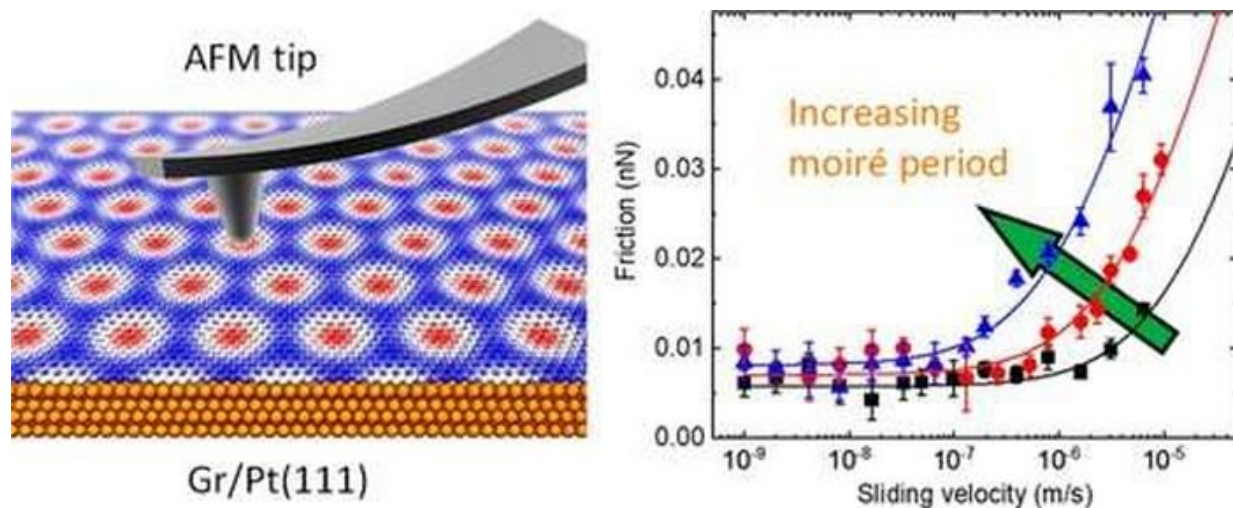


Unexpected speed-dependent friction in graphene

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Graphical abstract. Credit: *Nano Letters* (2022). DOI: 10.1021/acs.nanolett.2c03667

Due to their low-friction properties, materials consisting of single atomic layers are of great interest for applications where the aim is to reduce friction—such as hard disks or moving components for satellites or space telescopes.

One such example is graphene, which consists of a single layer of carbon atoms in a honeycomb arrangement and is being examined with a view to potential use as a lubricating layer. Indeed, previous studies have

shown that a graphene ribbon can be moved across a [gold surface](#) with almost no friction.

Surprising results with a rough surface

If graphene is applied to a platinum surface, it has a significant impact on the measurable friction forces. Now, physicists from the University of Basel and Tel Aviv University have reported in the journal *Nano Letters* that, in this instance, the friction depends on the [speed](#) at which the tip of an atomic [force](#) microscope is moved across the surface.

This finding is surprising because friction does not depend on speed according to Coulomb's law, which applies in the macro world.

In conjunction with the platinum substrate, [graphene](#) no longer forms only the hexagonal honeycomb pattern of carbon atoms and instead forms superstructures known as Moiré superlattices. The surface is then no longer completely flat and exhibits a certain degree of roughness.

"If we move the AFM tip across this slightly corrugated surface at low speed, we measure a weak and almost constant frictional force," explains Professor Ernst Meyer from the Swiss Nanoscience Institute and the Department of Physics at Basel University.

"Above a certain threshold, however, the friction then increases with the speed of the AFM tip," adds first author Dr. Yiming Song. "The larger the Moiré superstructure, the lower the threshold at which the [friction](#) becomes speed-dependent."

The researchers found that there is greater resistance at the ridges of the Moiré superstructures during the movement of the tip. These ridges undergo elastic deformation due to the pushing tip before relaxing again when the pressure is sufficiently high. This effect results in greater

frictional forces that increase with the speed of the tip. Simulations and an analytical model confirm the experimental findings obtained by this international team of researchers.

More information: Yiming Song et al, Velocity Dependence of Moiré Friction, *Nano Letters* (2022). [DOI: 10.1021/acs.nanolett.2c03667](https://doi.org/10.1021/acs.nanolett.2c03667)

Provided by Swiss Nanoscience Institute, University of Basel

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