Detailed insight into friction: How objects start to slide

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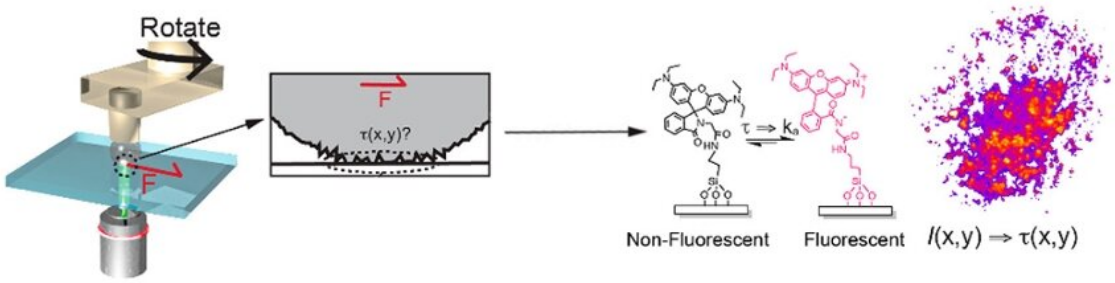

The researchers dragged a sphere over a glass surface decorated with special fluorescent molecules. Credit: HIMS / UvA

Chemists and physicists at the University of Amsterdam shed light on a crucial aspect of friction: how things begin to slide. Using fluorescence microscopy and dedicated fluorescent molecules, they are able to pinpoint how and when the friction at the contact between two objects is overcome and sliding starts to occur. They report on the details of this important transition from static to dynamic friction in *The Journal of Physical Chemistry Letters*.

Friction is responsible for an estimated 25% of world energy consumption. One of the key questions for the stability of many systems is how and when objects start to slide with respect to each other—think

of earthquakes or your foot on the ground. When two objects touch, the contact area is formed by the many microscopic protrusions of the two interfaces that touch and interlock. Application of a shear force makes the objects slide along each other, breaking these initial contacts.

Dragging a sphere over a glass surface

At the University of Amsterdam, the groups of Prof. Daniel Bonn (Institute of Physics) and Prof. Fred Brouwer (Van 't Hoff Institute of Molecular Sciences) have an ongoing cooperation to investigate the process of friction down to the microscopic level of roughness. In the paper just published in *The Journal of Physical Chemistry Letters* they report on experiments where a sphere is dragged over a glass surface.

The glass surface has been decorated with a special type of molecules (fluorogenic mechanophores) that start to emit light (fluorescence) when under the stress of the shearing force. The moment this force disappears, the molecules return to their stable, non-fluorescent form.

This allows scientists to directly visualize and quantify the microscopic shear force down to the microscopic roughness level, and establish how it evolves during the transition from the static to the moving state. The researchers find, among other things, that just before sliding occurs, a slip wave propagates from the edge toward the center of the macroscopic contact area. This allows for a quantitative and microscopic local understanding of how surfaces start to slide.

More information: Chao-Chun Hsu et al, Local Shearing Force Measurement during Frictional Sliding Using Fluorogenic Mechanophores, *The Journal of Physical Chemistry Letters* (2022). DOI: 10.1021/acs.jpclett.2c02010

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