
A New Methodology for a Detailed Investigation of Quantized Friction in Ionic Liquids

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Abstract

Ionic liquids are pure salts that are liquid under room temperature-pressure conditions. They exhibit exceptional stability (low volatility, nonflammability, wide electrochemical windows, etc.), which makes them very promising systems for a range of applications including lubrication. During the last decade, several investigations examined the friction across a nanometric film of ionic liquid, i.e. in the *boundary lubrication regime*, where the physics is governed by subtle mechanisms at the molecular scale. When confined between two charged surfaces, an ionic liquid is squeezed-out by discrete steps, because it is arranged in ordered layers of alternating cations and anions. Surprisingly, the friction coefficient has been found to be indexed by the number of ion layers forming the liquid film, an exotic phenomenon reported as "quantized friction" [1].

In this talk, I will present the new method we designed to study this phenomenon. The technique is based on the Surface Force Balance, an ideal tool to measure the interactions between solid surfaces in point contact across a liquid film of thickness known with a precision better than the molecular scale [2]. The novelty of our methodology consists in applying simultaneous normal and lateral motions, which allows for an unprecedentedly detailed investigation of the molecular mechanisms of friction. An important result is that, unlike previous studies, we found the hygroscopic nature of ionic liquids to be an asset, with water traces inducing larger resistance to squeeze-out and lower friction coefficients.

1. R. Lhermerout, C. Diederichs and S. Perkin, *Lubricants* **6**, 9 (2018)
2. J. N. Israelachvili, *Intermolecular and Surface Forces, Third Edition* (Elsevier, 2011)

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