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Max-Planck-Institut für Festkörperforschung
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Fluidics and mechanics at the nanoscales: fast and curious

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Abstract

Fluid transport at the nanoscales is one of the remaining virgin territory in fluid dynamics, in spite of hydrodynamics being a very old and established domain. Over the last years, a number of striking phenomena have been unveiled, such as superfast flows in carbon nanotubes, hydrodynamicslippage, fluidic diodes, nanobubble superstability, … and many of them are still awaiting an explanation. A major challenge to adress the fundamental properties at the nanoscales lies in building distinct and well-controlled nanosystems, amenable to the systematic exploration of their properties. To this end, we have developed new methods based on the manipulation of nano-objects, displacing, cutting, and glueing these elementary building blocks. This allows us to fabricate original fluidic and mechanical systems involving single nanotubes.

I will first discuss fluidic transport inside single nanotubes. Putting osmotic transport and its fundamental origins into perspective, I will show how to harvest this powerful mechanism beyond the classical van't Hoff law. Experiments of osmotic transport across *boron-nitride*show unprecedented energy conversion from salt concentration gradients. This points to new avenues in the field of osmotic energy harvesting from salinity gradient. These results will be then compared to those obtained with *carbon* nanotubes. They point to some key differences between these two materials which exhibit the same crystallography, but very different electronic properties.

Then I will explore the friction properties between the layers of boron-nitride and carbon nanotubes in a christmas-cracker geometry, in which a multiwalled nanotube is torn apart between a nanomanipulator and a quartz-tuning-fork-based atomic force microscope. We measure a huge viscous-like interlayer friction for BNNTs, whereas for the CNTs the sliding friction vanishes within experimental uncertainty. I will discuss possible mechanisms at the origin of the contrasting behaviors of CNTs and BNNTs.