Controlled nanomanipulation and nanolithography on mono- and multilayer MoS2 surfaces

Enrico Gnecco1,\*

# 1Instytut Fizyki im. M. Smoluchowskiego, Uniwersytet Jagielloński, ul. Łojasiewicza 11, 30‑348 Kraków

\*autor korespondencyjny: enrico.gnecco@uj.edu.pl

Due to their superlubric properties and their wear resistance, MoS2 surfaces are very attractive for applications and fundamental investigations in the field of so-called nanotribology, i.e., the study of friction, wear, and adhesion at the nanoscale.

In the first part of the talk, I will discuss the collective manipulation of metal clusters on mono- and multilayer MoS2 surfaces performed by AFM under ambient conditions. Starting with a general equation that relates the direction of motion of spherical particles to the scanning pattern, the influence of friction on the manipulated particle trajectory fluctuations, and the influence of particle shape on the manipulation process will be introduced. Atomic-scale effects become important when the cluster and substrate form commensurable contacts, as for triangular Au clusters on MoS2. In this case we observed a preferential motion along the zigzag direction of the substrate regardless of the moment imparted by the AFM tip. The formation of long Au stripes parallel to the fast scan direction is also an important effect observed when the cluster density is sufficiently high, albeit hampered by the corrugation of the underlying SiO2 substrate.

In the second part, I will discuss the formation of wear nanostructures from AFM lithography on mono- and multilayer MoS2. The typical result on a multilayer is the detachment of flakes from the surface with crack propagation from the main direction of the scratch. On a monolayer, nanoexfoliation accompanied by surface rippling of the silica substrate is rather observed. This will lead to a final digression on the formation of wavy patterns on (non-layered) compliant surfaces, which we have recently attempted to model based on the frictional stick-slip accompanying the wear process.