The goal of this presentation is to introduce recent results on our ongoing effort of controlling basic tribological processes by atomic force microscopy. The first example is the manipulation of nanoparticles. A geometric model relating the trajectories of spherical particles on a flat substrate to the scan path followed by the AFM probe that I developed a few years ago could be recently extended to irregularly shaped islands and wavy patterns. The model predictions are considerably influenced by the friction force at the particle-substrate interface and interesting “inverse problems“ and extensions to arbitrarily rough substrates are easily conceivable.

In the second part of the talk I will extend the discussion to the formation of wear patterns on compliant surfaces also in relation to the AFM scan path. Solvent enriched polymers at room temperature are an optimum benchmark for this kind of experiments. After showing interesting (and not yet understood) boundary effects, I will discuss the dependence of those patterns on the normal force and scanning velocity as explained by an extension of the well-established Prandtl-Tomlinson model for atomic-scale friction. In particular, we predicted (and experimentally confirmed) a phase transition between wearless sliding and “rippling“ of the substrate surface, which is reminescent of the transition between frictionless and stick-slip sliding on the atomic scale. Similarly to what has been done with atomic-scale friction, we were also able to suppress the wear process by mechanical excitations of the contact resonance. Also in this case the model work is still in progress, and interesting follow-ups can be easily imagined.
Enrico Gnecco is Professor of Physics at FSU Jena since August 2015. His research group is focusing on friction phenomena on the atomic scale, controlled manipulation of nanoparticles, viscoplastic deformation of polymers and theoretical bases of nanotribology. Before moving to Germany he spent several years as postdoctoral researcher and independent group leader at the University of Basel and at IMDEA Nanoscience, Madrid. He coauthored about 80 peer-reviewed research articles, two books and various book chapters.