Doping layered materials with metal particles deposited or grown on their surfaces is attractive for applications in nanoelectronics, photovoltaics, catalysis, electrochemical sensing, hydrogen storage and more. However, the extremely low friction of these materials raises questions on the mechanical stability of the structures so formed. Controlled nanomanipulation of the metal particles based on atomic force microscopy (AFM) is a very efficient way to investigate this issue. By measuring force variations and other physical quantities during the manipulation process, AFM can be used, for instance, to estimate the interfacial shear strength between particles and substrates. On flat surfaces AFM-based manipulation can also promote the assembly of the metal particles into well-defined geometric configurations, which could enhance functional properties of the particles. However, most surfaces used in technical applications are far from being flat, which makes the process difficult to control. In this context, a systematic characterization of metal particles sliding on layered materials with characteristic surface textures would allow to shed light on the complex relation between morphology, friction and adhesion at the metal-substrate interface, which is a prerequisite to extend established manipulation protocols to a wide range of surfaces of technological interest.

The goal of this OPUS project is to understand and control the ***motion of gold particles on textured transition metal dichalcogenide (TMD) surfaces***. The particles will consist in micro- and nanospheres deposited on the surfaces, and in nanoislands grown *in situ* under ultrahigh vacuum conditions. The textures will be obtained by defocused ion beam sputtering on multilayer TMDs (MoS_2, WS_2, $MoSe_2$, and WSe_2), or by transferring exfoliated TMD layers on rippled TiO_2 surfaces or anodic porous alumina. State-of-the-art AFM will be used for both imaging and manipulating the particles. The Au microspheres will be also attached to tipless cantilevers and used as scanning force sensors on the TMD-coated surfaces. The manipulation experiments will be performed at different temperatures in ambient atmosphere, water, and dry nitrogen to study the influence of the surrounding environment on the interfacial friction forces. The results will be interpreted by extending the modeling work developed and/or supervised by the PI on AFM-based manipulation of Au nanospheres on flat and wavy surfaces and on Au islands manipulated on MoS_2. The knowledge so gathered will be finally used to develop manipulation protocols aimed to arrange the Au particles in desired geometric configurations on the textured surfaces.