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Design and construction of an STM oriented to the study of passivated metallic nanoparticles

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Abstract – The high surface to bulk ratio induce new physical and chemical properties in nanomaterials. For example, geometry and function are closely related features in metallic nanoparticle catalyst. To this end, a way to study how surface free energy influences the equilibrium geometry is highly desirable. This is the motivation for the construction of a home-made STM fitted to study small passivated nanoparticles. In this work, we present the details of the developed STM and, preliminary results. All instrumentation has been already designed to be UHV compatible.

The equilibrium geometry of metal nanoparticles can be reasonably described by the Wulff construction considering clean surfaces [1]. This is not true for passivated particles where capping molecules presence, concentration and organization can drastically change surface free energy. The wet chemical synthesis maybe considered out of equilibrium problem where aggregation history can generate several metastable minima on configuration space. Since electronic and mechanical properties are intimately related to geometry on the few nm scale, control over surface free energy (and consequently on shape) using passivation is highly desirable [2]. Despite its importance, this is not a well-known process which requires a more detailed experimental analysis for a precise understanding.

To address this problem, a high spatial (atomic) resolution imaging of surfaces is required. This is the motivation for the atomic-resolution STM [3] construction project. In this work we describe in details the design and final assembly process of our home-made equipment. We have chosen a hybrid system using a 30 nm picomotor pushing a parallel-guiding spring table [4] as coarse approach. The scanning is based on the simple tripod system due to its linearity and stability. All electronics was home-built in our group. The pre-amplifier can detect currents on pA range. The high voltage driver was entirely developed using discrete components with good noise and stability results. Control and acquisition uses a 16 bits DSP embedded digital microcontroller. The control and interface software were fully developed in order to satisfy the design requirements. Vibration control uses an optical table configuration which provides support for the ultra-high vacuum system. We present some preliminary results with thiol-passivated nanoparticles.

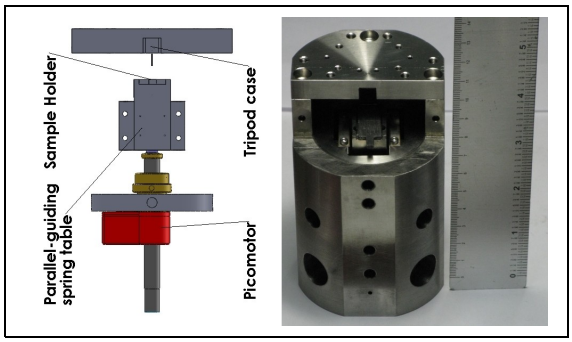

Figure 1: STM head

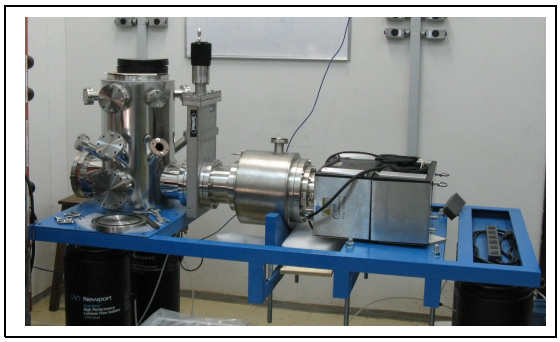

Figure 2: UHV system.

References

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