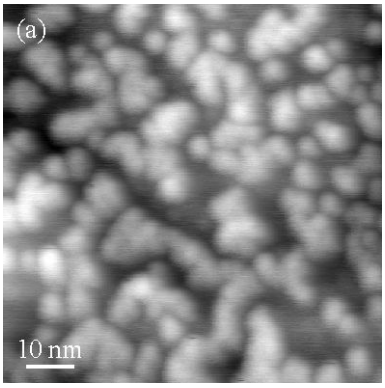
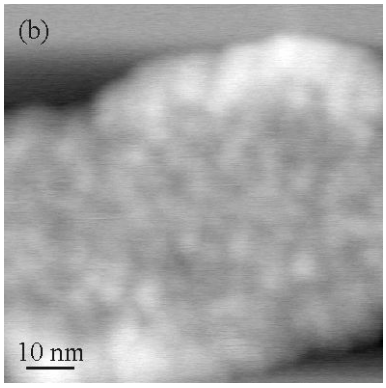
Non-Contact Atomic Force Microscopy Investigations of Au_55 Thin Films Deposited on Gold and Graphite Substrates

G. Radu, D. Mautes and U. Hartmann
Institute of Experimental Physics, Saarland University, D-66041 Saarbrücken, Germany

Clusters consisting of a few up to a few hundreds of atoms are of fundamental as well as of applied interest because they exhibit interesting size-effect-dominated physical and chemical properties. The ligand-stabilized metal clusters represent a particular category. They consist of a metal core having a fixed number of metal atoms stabilized by an organic ligand shell. Non-contact atomic force microscopy (NC-AFM) and spectroscopy were used to study thin films of ligand-stabilized Au_55 clusters [1] deposited on Au(111) and highly oriented pyrolytic graphite (HOPG) substrates.
The cluster powder which was produced by a wet chemical process [1] was dissolved in dichloromethane (CH_2Cl_2). The clusters were deposited onto freshly prepared Au(111) [2] and HOPG substrates by spin coating. For low enough cluster concentration in the solution, the deposit consists of islands of single cluster height. The NC-AFM images show islands consisting of a few up to 20 clusters on Au(111) (frame (a)) which are locally ordered (as observed in high-resolution images which are not shown here). For larger cluster concentration in the solution, a monolayer covering the Au substrate is obtained [2]. In contrast, on HOPG, the clusters are forming disordered monolayer islands of larger size (frame (b)). For larger cluster concentration, the cluster islands are connecting to each other giving rise to disordered monolayes with pores of varying size [3]. Frequency shift- and damping-versus-distance measurements on individual clusters as well as on the bare substrate were performed. The interaction force and dissipated energy were deduced from the experimental curves. The derived force curves are compared to force laws of long-range, short-range and contact forces. Significant energy dissipation takes place in the interaction between the AFM probe and Au_55 clusters deposited on the HOPG substrate. Less energy dissipation was observed when the clusters are deposited on the Au substrate. The influence of the substrate on the conservative and dissipative interaction between the AFM probe and individual clusters will be discussed.





[1] G. Schmid et al., Chem. Ber. **114**, 3634 (1981)
[2] H. Zhang et al., New. J. Phys. **5**, 30 (2003)
[3] G. Radu et al., J. Phys. Chem. **106**, 10301 (2002)