

## Dynamic AFM/STM investigations of Au<sub>55</sub> monolayers

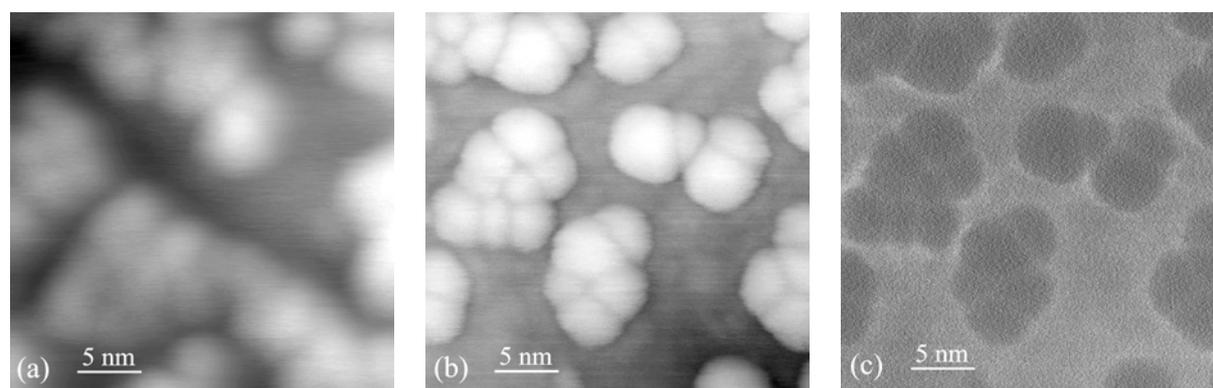
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Clusters consisting of a few up to a few hundreds of atoms are of fundamental as well as of applied interest because they exhibit interesting size-effect-dominated physical and chemical properties. The ligand-stabilized metal clusters represent a particular category. They consist of a metal core having a fixed number of metal atoms stabilized by an organic ligand shell. Large amplitude non-contact atomic force microscopy (NC-AFM) and spectroscopy were used to study thin films of ligand-stabilized Au<sub>55</sub> clusters deposited on Au(111). Dynamic STM measurements were also performed by using the mean (time-averaged) tunneling current for distance control and by simultaneously measuring the frequency shift and the damping of the cantilever oscillation [1].

The clusters were dissolved in dichloromethane (CH<sub>2</sub>Cl<sub>2</sub>) and deposited onto a freshly prepared Au(111) substrate by spin coating. The deposit consists of a layer of single cluster height covering the Au(111) substrate. Many local areas show the clusters arranged in a 2D closest packing. The NC-AFM images (frame (a), topography) as well as the dynamic STM images (frames (b) and (c), frequency shift and damping images) show single cluster resolution. The damping image shows inverted contrast. When the tip oscillates above the clusters, the increase of dissipation is smaller than that observed when the tip oscillates above the substrate. Frequency shift- and dissipation-versus-distance measurements on individual clusters as well as on the bare substrate were performed. The distance dependence of the interaction force was calculated from the experimental frequency-versus-distance curves for individual clusters as well as for the Au(111) substrate. The interaction is not purely van der Waals. In the longer range the introduction of an additional capacitive force is required to match the experimental results. Work function anisotropies [2] and cluster charging [3] are likely sources of the additional electrostatic contribution. Dissipation mechanisms for the tip-cluster and tip-substrate interaction will be discussed.



- [1] Ch. Loppacher, M. Bammerlin, et al., *Appl. Phys. A* **72**, S105 (2001)
- [2] N. Burnham, R. Colton, H. Pollock, *Nanotechnology* **4**, 64 (1993)
- [3] C. Barth, C. R. Henry, *Nanotechnology* **15**, 1264 (2004)