Imaging nanoclusters with the Noncontact AFM and Kelvin microscope: Cluster structure and chemistry at the nm scale

Clemens Barth

CINAM-CNRS, Campus de Luminy, Case 913, 13288 Marseille Cedex 09, France
barth@cinam.univ-mrs.fr
www.cinam.univ-mrs.fr/barth/default.htm

In the last 10 years, Noncontact Atomic Force Microscopy (NC-AFM) has successfully proven that true atomic resolution can be gained on any clean and almost atomically flat surface of even bulk insulators [1]. However, emerging fields in surface science and nanotechnology like nanocatalysis [2] ask now for an application of this type of force microscope, which leads to new challenges in NC-AFM.

One challenge is the imaging of nanometer-sized metal cluster with highest possible resolution, which permits a precise characterization of the lateral cluster shape. Another challenge is to extend the microscope in such a way that it gets “chemically” sensitive or, at least, sensitive on more specific force channels of e.g. electrostatic nature. Measuring the local work function of a cluster-surface system at the nanometer scale would be of a high interest in many fields of surface science.

In this contribution it will be discussed to which degree NC-AFM can master these two challenges. In the first part of the contribution, the constant height mode in NC-AFM is presented, which is a suitable technique to image the lateral shape of metal nanocluster with high precision [3]. A comparison between experiment and theory explains that only the last nanometer of the tip images the correct shape of the cluster reducing to a large part the tip-surface convolution effect. In the second part it will be shown that the Kelvin modulation technique can be implemented in NC-AFM in such a way that, alongside the topography, also the work function of supported metal nanoclusters can be imaged at nanometer scale [4]. Possible electronic modifications of single clusters by the substrate but also changes of the cluster work function in the presence of adsorbed gaseous species will be discussed.

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