Principles of KPFM and applications

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Kelvin Probe Force Microscopy (KPFM) is a technique aiming at the detection and compensation of electrostatic forces arising between a nanoprobe (the tip of the microscope) and a surface (hereafter referred to as the electrodes) when they are biased. The origin of these forces differs upon the distance between the electrodes [1]. At large distance (>1nm), electrostatic forces can be quantitatively connected to the Contact Potential Difference (CPD) between the electrodes, i.e. the difference between their work functions. Thus the technique gives a quantitative CPD map of the surface on the local scale [2]. When measured closer to the surface (in the range of 0.5-1 nm), short-range electrostatic forces start to get involved in the imaging process. Then, a KPFM image with atomic-scale resolution can be achieved [3]. However, in this situation, the origin of the KPFM signal rather reflects atomic-scale properties of the surface, among which its local polarizability. The ability for the technique to provide access to the CPD and other properties down to the atomic-scale makes KPFM widely used in surface science nowadays. In the 1990's, the KPFM technique has been coupled with noncontact-AFM [1]. The possibility to perform experiments where structural and electronic properties become jointly accessible made the couple KPFM/nc-AFM attractive and intensively developed and used in numerous research labs (see fig.1, after [4]).

The goal of this lecture will be to discuss experimental (technical implementation, modes, time constants considerations, artefacts…) and theoretical aspects (long-/short-range electrostatic forces) of the KPFM technique when coupled with nc-AFM and to illustrate these by means of examples taken from recent literature [4, 5].

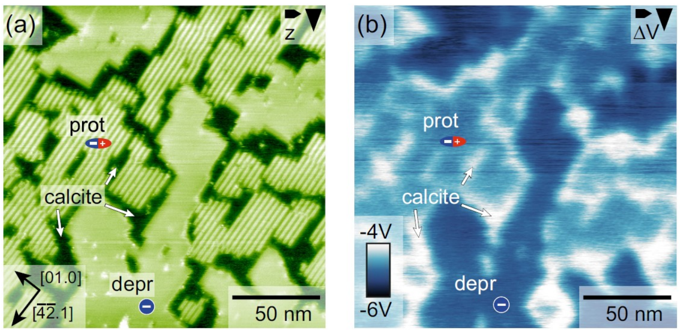

Figure 1: nc-AFM topographical (a-) and related CPD (b-) images of 2.5-dihydroxybenzoic acid molecules on a calcite substrate.

References

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