Surface Potential Mapping in Any Environment by Dual-Harmonic Scanning Force Microscopy

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Surface potentials play a key role for both structure formation and functionality in a wide range of molecular systems, e.g. in biological[1] or organic and molecular electronic systems[2]. The process of molecular self-assembly, for example, is often determined by the electrical interaction of different moieties and side groups. For Kelvin probe force microscopy (KPFM) the mapping of surface potentials has been demonstrated at nanometer resolution in air and even at atomic resolution in ultra-high vacuum (UHV)[3]. The operation of conventional KPFM requires the application of a DC voltage between tip and sample. In voltage sensitive materials such as certain biomolecules or ferroelectrics, this DC voltage can cause irreversible changes in conformation or the electronic state of the sample. Furthermore, in aqueous environments, the DC voltage can lead to spurious forces and electrochemical reactions that hamper the operation of KPFM.

Thus, a KPFM system that can be operated in any environment from UHV to ambient to liquid environments would be highly desirable. Recently, a multi-frequency approach for quantitative surface potential mapping without the necessity to apply a DC voltage was reported[4]. The technique analyses the response of the cantilever to an AC voltage of frequency f. By recording the response at both the fundamental frequency f and the second harmonic frequency of 2f, quantitative surface potential values can be obtained. We will present a detailed comparison of conventional KPFM techniques with this so-called dual harmonic KPFM (DH-KPFM) in both ambient and liquid environment. Furthermore, we will demonstrate the future potential of DH-KPFM by first comparative measurements on self-assembled layers of biologically relevant molecular systems.

References

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