Simultaneous Topography and Electrochemical Imaging (SECM)

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Laterally resolved (electro)chemical information on a sample can be obtained with scanning electrochemical microscopy (SECM), where a biased ultra-microelectrode is scanned at a defined distance across the sample surface. However, conventional SECM suffers the lack of sufficient spatial resolution and the convolution of topography and electrochemical response due to the current-dependent positioning of the microelectrode.

Within the last decade several approaches have been reported, for directly integrating a micro- or nanoelectrode into an AFM probe. In order to maintain the functionality of both techniques, the integrated electrode is recessed from the end of the AFM tip. Consequently, the electrode is located at a defined distance to the sample surface, which is now defined by the length of the actual AFM tip. Thus, by applying a potential to this AFM-SECM probe and recording the Faradaic current related to electroactive surface processes, laterally resolved (electro)chemical information can be directly correlated to the topographical information obtained by the AFM measurement. So far, combining AFM with SECM required customized solutions, as no commercial SECM module for AFM systems was available and therefore the technology could only be used by a limited number of researchers.

Recently we have succeeded in bringing an SECM module onto a commercial AFM platform, providing a dedicated mount with integrated preamplifier for AFM-SECM probes and a bi-potentiostat, which allows to control the potential of the sample and the AFM tip-integrated electrode. This mechanism not only greatly minimizes the effort required for experimental setup, but also enables the capability of multifunctional imaging and surface modification with combined AFM-SECM modes. The advantage of the combined technique is that measurements are not limited to amperometry but can be extended to a multitude of electroanalytical techniques during AFM imaging. Several applications of this new SECM approach will be shown, starting from test structures up to redox-mediated membrane transport in cell membranes.

References

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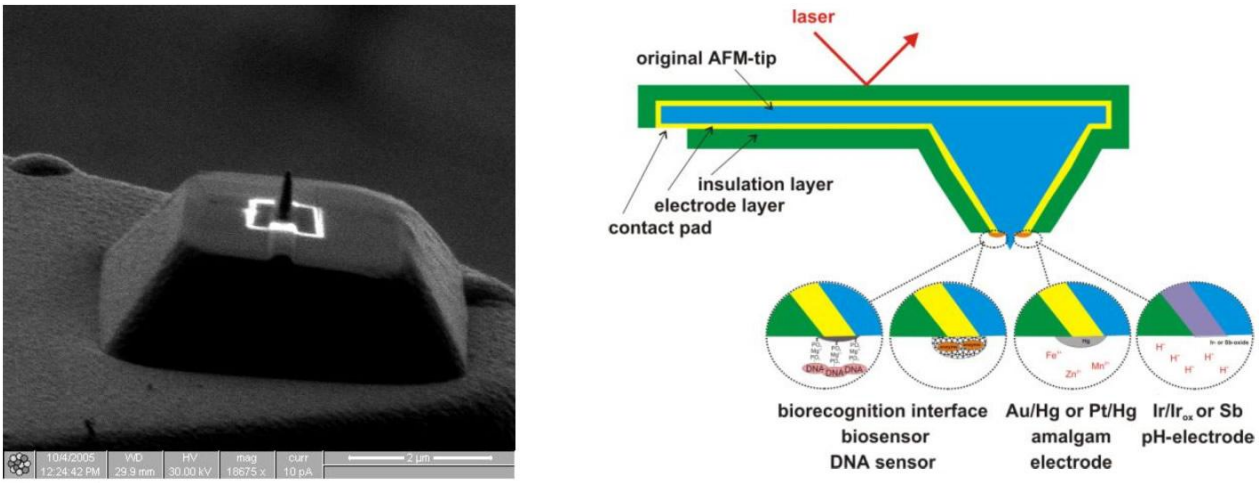

Figure 1. (Left) Electron microscopy image of an AFM tip with integrated nano-electrode for SECM. (Right) Applications of SECM using derivatized electrodes.