Easy-to-Use High-Spatial and High-Temporal Atomic Force Microscopy Simultaneous to Advanced Optical Microscopy

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Last few decades have established the atomic force microscope (AFM) as an indispensable tool for high-resolution studies under native conditions. Recent tip-scanning AFM developments now offer an insight into the dynamics of macromolecular systems, while simultaneously offering a seamless integration with advanced optical microscopy.

Here, we introduce the latest JPK NanoWizard® 4 with the latest "Quantitative Imaging" (QI™) mode for the simultaneous acquisition of topographic, nano-mechanical, and adhesive sample properties. Next to this classical information, even more complex data, such as, contact point images, Young´s moduli images, or even recognition events can be achieved. In QI most parameters are set automatically which makes it easy to use and allows non-expert users to acquire data of highest standards. This will be demonstrated by showing images of the membrane protein bacteriorhodopsin (BR) in buffered solution. Further research towards automated AFM has been put into the feature "Experiment Control" which gives the opportunity to control all main parameters of the AFM remotely conveniently on any device, such as, a tablet, PC or mobile phone without interfering with the setup.

Additionally, we show the capability of combining AFM with super-resolution techniques. Firstly, we demonstrate the relation of cytoskeleton distribution and mechanical properties of HeLa cells. Alexa647 labeled microtubules are imaged with dSTORM, while the cell surface and mechanical information are measured in parallel by AFM. Secondly, we show AFM QI elastic moduli data of individual living fibroblast cells and actin super-resolution STED images of the same cell acquired in one experiment. For this research, the JPK NanoWizard® 4 AFM has been integrated into the Abberior easy3D STED microscope.

In another study, we monitor and modify the kinetics of collagen type I fibrillogenesis. It can be shown that fast AFM imaging can be successfully applied to understand the real-time kinetics of collagen type I formation. By further modifying the used buffer compositions, pH value and potassium ion content, we demonstrate that we can alter the kinetics of the fibrillar nanomatrix formation and successfully study it with high spatial and temporal resolution. In addition, the dynamics of a calcite crystal surface at the atomic scale will be demonstrated.