Title: Recent Advances in AFM Instrumentation for Biological Studies

Presenter: Mayur Savla

Affiliation: Oxford Instruments Asylum Research, Santa Barbara, CA, USA Mayur.Savla@oxinst.com

The atomic force microscope (AFM) has found broad use in the biological sciences largely due to its ability to make measurements on unfixed and unstained samples under liquid. Its ability to image at spatial scales ranging from nanometers to tens of microns has enabled observations on live samples and has given new insight into cellular and molecular processes. Recent technical innovations have further advanced the applicability and utility of the instrument. For example, Early AFMs were able to collect full-frame images at the few minutes time-scale. Advances over the past decade have increased this rate at the cost of instrument usability and flexibility. Asylum's recent launch of the Cypher VRS has demonstrated imaging scan rates of ~10 frames/sec (625 lines per sec) on a fully-featured AFM platform. Discussions of the VRS technology and examples will be presented in this talk. Further, image and force data collected using Asylum's new Fast Force Mapping mode will be presented and discussed.

In addition to imaging at multiple spatial scales, AFMs are commonly used as nanomechanical probes. This is especially pertinent for cell and tissue biology, as it has been demonstrated that the geometrical and mechanical properties of the extracellular microenvironment are important in such processes as cancer, cardiovascular disease, muscular dystrophy, and even the control of cell life and death. Because AFM can quantitatively measure the mechanical properties of various biological samples, novel insights to cell function and to cell-substrate interactions are now possible. Mechanical measurements on soft, sticky, and squishy biological samples with the Atomic Force Microscope (AFM) are straightforward to perform but complex to interpret accurately and reproducibly. Although many of the phenomena responsible for this complexity also exist at the macroscale, their influence on the measurement increases non-linearly as the spatial scale descends to the AFM's level of the cell and beyond. Further, the mechanical models we use to interpret the data are heavily borrowed from macroscale materials sciences— therefore they do not take the influence of many of these peculiarities into account. As the application of AFM to these types of problems is widened, it is important to understand the performance envelope of the technique and its associated data analyses. This talk will discuss the important issues that must be considered when macroscopic models are applied to real-world data. Examples of the effect of different model assumptions on our understanding of the measured material properties will be shown. Furthermore, specific examples of the importance of mechanical stimuli and the micromechanical environment to the structure and function of biological materials will be presented.

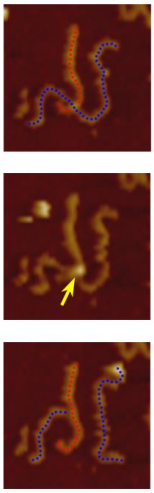

Image caption: Individual video frames taken with the Cypher VRS of DNase cleavage of lambda DNA. The DNA was imaged in buffer at 625 lines per second at 320x64 pixels for a frame rate of 8.7 fps. Movie can be viewed at www.oxford-instruments.com/Cypher-VRS