the kinetics of crystalline cellulose hydrolysis by cellulases has been investi-
gated intensively so far, the mechanism of crystalline cellulose degradation still contains many mysteries. The main reason for the difficulty to understand the mechanism is the lack of analytical methods to monitor the enzymatic re-
action at a solid/liquid interface. We here use high-speed atomic force micro-
copy (HS-AFM) to reveal how the enzyme molecules behave on the substrate. When glucose hydrolyase family 7 cellulobiohydrolase from Trichoderma reesei (TrCel7A) was incubated with crystalline cellulose, many enzyme mole-
cules moved unidirectionally on the cellulose surface with the velocity of 7.2 ± 3.9 nm/sec but at some point the movement of individual molecules was halted, leading to appearance of traffic jams of enzyme molecules. The present results suggest that solving the traffic jams of productively bound cel-
lulose is a key to enhance the hydrolytic activity of cellulases on crystalline cellulose.

2979-Pos Board B749
Towards Tracking Moving Single Molecules in Atomic Force Microscopy
Peng Huang, Sean B. Andersson.
Boston University, Boston, MA, USA.
The atomic force microscope (AFM) is an invaluable tool for observing bio-
logical systems, due in part to its incomparable resolution as well as its ability to observe systems in their physiological environments and to measure me-
chanical properties directly. Its slow imaging rate, however, greatly reduces its applicability in recording fast-changing mechanisms. Such studies are of critical importance. For example, investigating the dynamics of protein motors and other macromolecules is essential for understanding and treating a variety of genetic diseases. Motivated by this, we are developing an approach to AFM centered on tracking rather than imaging. The scheme is primarily designed to follow the motion of a single macromolecule moving along a biopolymer.

In approaching this problem, we consider that the presence of the moving macromolecule on its track results in a change in the apparent width of the track. Based on this, we have developed a high-speed width detector that rap-
idly determines the width by detecting the two edges of the sample during a fast scan. As a result, the motion of these single macromolecules is derived directly from tracking rather than a sequence of images. Such an approach promises a much higher temporal resolution than is achievable in time-lapse imaging.

2980-Pos Board B750
Encased Cantilevers and Alternative Scan Algorithms for Ultra-Gentle High Speed Atomic Force Microscopy
Paul Ashby1, Dominik Ziegler1, Andreas Frank2, Sindye Frank2, Alex Chen2, Travis Meyer2, Rodrigo Farnham3, Nen Huynh3, Ivo Rangelow2, Jen-Mei Chang2, Andrea Bertozzi3.
1Lawrence Berkeley National Lab, Berkeley, CA, USA, 2Technical University Ilmenau, Ilmenau, Germany, 3UCLA, Los Angeles, CA, USA.
Encased cantilevers are capable of measuring ionic currents in fluid were designed and fabricated using Parylene C. These cantilevers are also capable of performing high speed imaging up to 10 times faster than conventional AFM techniques. In addition, we report on a new optical trap design and associated scan synthesis algorithm that can operate at high speeds while maintaining stability and accuracy.

2981-Pos Board B751
Ultrasonic Force Spectroscopy with Tuning Fork Based Frequency Modulation
Aaron Lewis1, Andrey Ignatov2, Alina Strinikovska2, Ori Avayu2, Patricia Hamra2.
1Hebrew University of Jerusalem, Jerusalem, Israel, 2Nanonics Imaging Ltd., Jerusalem, Israel.
The standard method that is used with atomic force microscopy to monitor me-
chanical properties of materials such as elasticity and adhesion is based on beam bending technology. With such an approach there are two major prob-
lems: one is jump to contact and the other is adhesion ringing. Numerous methods have evolved for trying to resolve these problems from methods call pulsed force mode to peak force. However, what is desired is a smooth approach and retract from a surface or molecule where force measurements need to be implemented.

Over the last few years, it has been realized that the best method of force feedback in atomic force microscopy is based on tuning fork modulation but there have been few studies implementing these advances into the realm of force spectroscopy. In this paper, force spec-
troscopic analysis is implemented based on tuning forks and it is demonstrated that there is close to single pN force sensitivity. These efforts use the pioneerr-
ing theory of Sader and Jarvis that has shown theoretically that it is possible to derive accurate formulas for the force versus frequency in such Frequency Modulations methods [J.E. Sader and S. P. Jarvis, “Accurate formulas for the interaction force and energy in frequency modulation force spectroscopy” Appl. Phys. Lett.84, 1801 (2004)]. It will be further shown that such normal force tuning fork based force spectroscopy can readily be integrated with other chemical and structural tools such as Raman microSpectroscopy and Scanning Electron Microscopy.

2982-Pos Board B752
Measuring a Stabilization Constant Between Two Bio-Molecules using Atomic Force Microscopy
Byung I. Kim, Jennifer Rice, Hyonjee Joo, Joseph Holmes, Jonathan Walsh.
Boise State University, Boise, ID, USA.
Stabilization force constants are known to play an important role in biomolec-
ular functions that carry out delicate structural conformation changes along a re-
action coordinate during bio-molecular activation. Atomic force microscopy (AFM) has been used as a tool for probing protein-ligand interactions at the single molecular level. We developed a method that converts AFM force-
distance curves into intermolecular force-distance curves. This method was applied to a model enzyme-inhibitor system of 5’-methylthioadenosine/S-
adenosylhomocysteine nucleo-sidase (MTN) and its transition state analogue homoeysteinyl Immucillin A (HIA). Both the MTN and HIA molecules were attached to the sample and probe surfaces, respectively, through the flexible polymer polyethylene glycol. The stabilization force constant is found to be 0.235 N/m between MTN and HIA from the intermolecular force-distance curve, which is consistent with those measured by other techniques.

2983-Pos Board B753
Conducting Atomic Force Microscopy for Simultaneous Imaging of Structure and Ionic Current Through Nanopores
Brian Meckes, Fernando T. Arce, Alan Gillman, Alexander Mo, Ratnesh Lal.
University of California, San Diego, La Jolla, CA, USA.
Ionic currents through nanopores in both biological and synthetic materials play an important role in the function of the material. For biological systems, these pores are critical for normal physiological function and abnormalities lead to various disease states. The ability to measure the current through nano-
pores, while simultaneously relating their molecular and atomic structure, is currently limited in resolution. In order to perform structure-function measure-
ments using an atomic force microscope (AFM), conducting cantilevered tips capable of measuring ionic currents in fluid were designed and fabricated using various techniques. Insulated tungsten wires with conducting tips were fixed to steel supports to create cantilevers for AFM imaging. Gold films in fluid were imaged with simultaneous electrical current measurements by the conducting cantilevers to reveal the topography of the film. These simultaneous recordings of the current and the 3D structure demonstrate the conducting capabilities of the cantilever. Ionic currents through membrane filters were successfully mea-
sured through 20 nm pores in the membrane. The results from this technology show promise for future structure-function imaging of macromolecules, such as ion-channels in health and disease as well as for the synthetic nanopores for en-
ergy and environmental applications.