Imaging Of Biosystems By Dynamic Atomic Force Microscopy

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Using amplitude-mode AFM (AM-AFM), valuable information has been obtained during these recent years through the study of amplitude and phase shift dependence on tip-sample separation, leading to a comprehensive understanding of the interaction processes. Two imaging regimes, attractive and repulsive, have been identified and a relationship between phase and dissipative energy was established, providing information on observed material properties. Most of the previous studies have concerned model systems: either hard or soft materials [1-3].

In the case of biosystems, the sample is composed of biological macromolecules or thin bio/organic layers supported on mineral substrates. Then, this creates a mixed system of soft structures on a hard substrate. In this work, we propose to discuss about the dynamics of dissipation processes during scanning based on a real biosensor a DNA array, and demonstrated that information about the tip-surface interaction regime can be obtained [4]. The best experimental conditions to obtain specific information were determined: we got reliable conditions to minimize noise during topographic imaging and an understanding of the processes of energy dissipation involved in the DNA breaking for DNA arrays. By calculating the energy dissipated as a function of the amplitude of oscillation, we have demonstrated a transition from an energy dissipation process governed by localized viscoelastic interactions (due to the soft layer) to a process governed by extended irreversible deformations (due to the hard substrate). Examples of other biosystems were also presented [5, 6].

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Fast Nanomechanical Spectroscopy of Soft Matter

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A method that combines high spatial resolution, quantitative and non-destructive mapping of surfaces and interfaces is a long standing goal in nanoscale microscopy. The method would facilitate the development of hybrid devices and materials made up of nanostructures of different properties.

Bimodal atomic force microscopy is a multifrequency dynamic force method based on the simultaneous excitation of two eigenmodes of the cantilever [1,2]. We have developed a multifrequency force microscopy method that enables the simultaneous mapping of the nanomechanical spectra of soft matter surfaces with nanoscale spatial resolution [3,4]. The properties include the Young modulus and the viscous or damping coefficients. In addition, it provides the peak force and the indentation. The method has been tested on different polymers and proteins in air with near four orders of the magnitude variations in the elastic modulus, from 1 MPa to 3 GPa. The method does not limit the data acquisition speed or the spatial resolution of the force microscope. It is non-invasive and minimizes the influence of the tip radius on the measurements. The use of several information channels (first and second mode) results in the calculation of Young modulus and viscosity coefficients which do not depend on the applied force. The results coincide with the results obtained by other well-established methods (static AFM, force inversion methods).

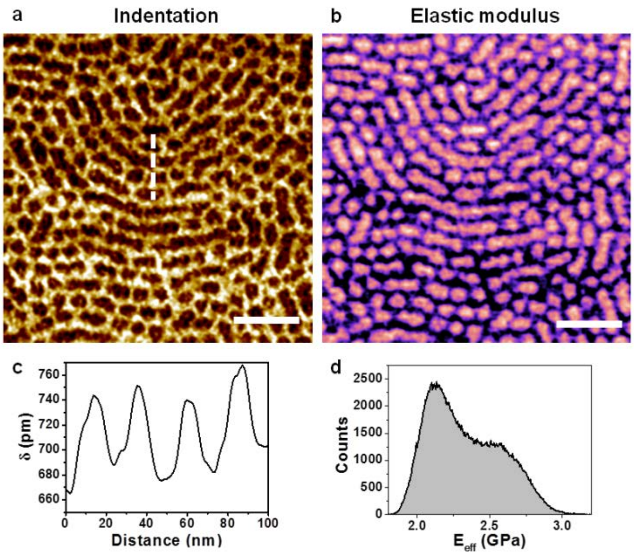

Figure: (a) Indentation map in a block copolymer (PS-b-PMMA) thin film (scale bar, 100 nm). (**b)** Map of the elastic modulus of PS-b-PMMA (scale bar, 100 nm)**. (c)** Cross-section along the dashed line shown in **a**. **(d)** Histogram of the elastic modulus obtained from **b**.

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Mechanical uncoating of a virus genome: an AFM-TIRF combined experiment

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