Atomic Force Microscopy of Soft Materials:

Principles and Application

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Atomic force microscopy (AFM) is an invaluable versatile technique for advanced surface characterization of practically any kind of materials- polymers, biological samples, ceramics, metallic surfaces, and many others. It employs a sharp probe for profiling surfaces with unique resolution, imaging structures from a few nanometers to hundreds of micrometers. The advances in AFM of polymers relate to a better understanding of tip–sample force interactions and their use for examination of local sample properties. The different responses of the probing tip to surface locations with different mechanical and adhesive properties are used for compositional imaging of heterogeneous polymeric systems. AFM is useful for quantitative information of a thin film surface morphology and roughness with a high precision. The straight visualization of polymer structures, from single macromolecules to granular and lamellar nanostructures or other morphologic patterns, makes from AFM an important complementary tool for many of the techniques (optical and electron microscopy, X-ray diffraction analysis, light scattering, etc.) used in polymer analysis.

In particular, this workshop (both lectures and exercises) will cover the fundamentals of AFM, sample preparation and knowledge of various substrates, different operation modes, imaging of surfaces (block copolymer morphologies, single molecules (DNA, conventional polymers, etc.), bio-related motifs (DNA origami, nucleotide sequences, etc.), surface property determination, image and data interpretation, data evaluation, environmental control, and some advanced applications (Magnetic Force Microscopy and others). A broad range of examples will illustrate the general tendencies in AFM of polymeric materials.

SPM course primary program

Lecture 1: Introduction to SPM

Scanning Tunneling Microscopy (STM)
Principles of STM
STM imaging of semiconductors, metals & molecules
Atomic Force Microscopy (AFM)
Principles of AFM
AFM set-up
AFM probes
Primary operating modes
Contact mode
Imaging
Application
Artefacts

Lecture 2: AFM operating modes (continuation)

Tapping mode
Topography and Phase Imaging
Artefacts
Liquid state measurements
Temperature gradient
Application
Non-contact mode

Lecture 3: Electrostatic and Magnetic Force Microscope

Operating EFM and MFM modes
Preparation of EFM and MFM probes
How to separate topography and magnetism?
Applications

Lecture 4: Practical issues for SPM

Sample preparation (conventional and advanced methods)
SPM in Chemistry and Soft Matter
Self assembled structures, LB films, thin organic films. STM and SFM analysis of polymer surfaces, oriented polymers and copolymers, composite materials, single molecules (DNA, polyelectrolyte, etc.)
Advanced software instructions
Recent progress in SPM