Program of training course on SPM FemtoScan operation

1.Introduction

- **a.**Principal scheme of SPM
  - **I.**Positioning system
  - **II.**Probe and the system for determination of its state
  - **III.**Feedback system
- **b.**Surface scanning
  - **I.**With feedback
  - **II.**Without feedback
- **c.**General measurement technique
  - **I.**Preparation of the sample and the microscope
  - **II.**Surface measurements and parameters adjusting
  - **III.**Processing and interpretation of the data

2.Terminology

- **a.**Cantilever
- **b.**Probe
- **c.**Holder
- **d.**Head
- **e.**Stage

3.Scanning Probe Microscope FemtoScan

- **a.**The general form

- b.Mechanical part
- c.The electronic unit
- d.Scanning heads
  - IAtomic force microscope
  - IIScanning tunneling microscope

4.Schematic diagrams of the microscope operating in different modes

- a.Atomic Force Microscopy
- b.Scanning Resistive Microscopy
- c.Tapping Mode Atomic Force Microscopy
- d.Tunneling Microscopy

5.Measurements in the scanning tunneling microscopy mode

- a.Preparation of the sample, providing ohmic contact with the sample
  - I.With the sample
  - II.With the special holder under the sample
- b.Installing the sample on the scanning stage
- c.Preparation of the needle
- d.Installation of the needle to the tunneling head
- e.Connecting the head to the mechanical part
- f.Installation of the head above the sample
- g.A preliminary approach of the needle to the surface
- h.Screening of the microscope from external noise
- i.The initial set of control parameters

- j.Approaching the surface
- k.The choice of operating point
- l.Surface scanning
- m.Measuring of the tunneling current dependence on the distance
- n.Measuring of the current-voltage characteristics of the tunneling contact
- o.Processing of the experimental data. Differential current-voltage characteristics of the tunneling contact.

6.Measurements in atomic force microscopy mode

- a.Preparation of the sample
- b.Cantilever installation in the holder
- c.Holder installation in the AFM head
- d.Tuning of the laser
  - I.Using diffraction pattern from cantilever
  - II.Search the edge of cantilever using the reflected spot
  - III.Tuning of the photodiod
- e.Installation of the sample on the scanning stage
- f.Installation of head above the sample
- g.The initial set of control parameters
- h.Surface approaching
- i.Measuring of the force-distance curve
- j.The choice of operating point
- k.Scanning of the surface

- l.Mode for measuring of the lateral force
- m.Determination of the elastic properties of the surface
- n.Image processing

7.Measurements in scanning resistance microscopy mode

- a.Preparation of the sample, providing ohmic contact with the sample
    - I.With the sample
    - II.With a special table under the sample
- b.Installation of the cantilever into the holder, providing the contact with the probe
- c.Resistance cable connecting
    - I.With the head
    - II.With the holder
    - III.With the sample
- d.Holder installation in the head
- e.Tuning of the laser
    - I.Using diffraction pattern from cantilever
    - II.Search the edge of cantilever using the reflected spot
    - III.Tuning of the photodiod
- f.Installation of the sample on the scanning stage
- g.Installation of head above the sample
- h.Checking the conduction signal
- i.Additional screening of the microscope against external noise

- j.The initial set of control parameters
- k.Pre-positioning of the scanner
- l.Surface approaching
- m.Measuring of the force-distance curve
- n.Measuring of the electrical current-distance curve
- o.The choice of operating point
- pScanning of the surface
- q.Image processing
- r.The calculation of contact resistance and the local conductivity of the surface

8.Measurements in tapping mode of atomic force microscope

- a.Preparation of the sample
- b.Installation of cantilever in the holder
- c.Connecting the excitation voltage cable
- d.Installation of the holder in the head
- e.Tuning of the laser
  - I.Using diffraction pattern from cantilever
  - II.Search the edge of cantilever using the reflected spot
  - II.Tuning of the photodiod
- f.Installation of the sample on the scanning stage
- g.Installation of head above the sample
- h.The initial set of control parameters
- i.Tuning in to the cantilever resonance

- j.Surface approaching
- k.Measuring of the oscillation amplitude - distance curve
- l.The choice of operating point
- m.Scanning of the surface
- n.Phase image
- o.Image processing

9.Basic knowledge of software

- a.Client program FemtoScan Online
- b.Program Fmboard to manage the server of the microscope
- c.Connecting to a microscope
- d.The toolbar for the control of the microscope
- e.The scan window (the main window)
- f.The main modes of the microscope operation
- g.Run scans
- h.Basic operations with images
  - I.color scales
  - II.averaging over the rows
  - III.surface leveling
  - IV.usage of different filters
  - V.Fourier spectrum of an image
  - VI.three-dimensional representation of the surface
  - VII.construction of cross sections and the measurement of objects heights

- VIII.function of the finding of objects