

## Unique Selling Points and Specifications for the Bruker JPK NanoWizard 4 XP AFM

### A) Combination AFM with Inverted Optical Microscope including Direct Overlay

- 1) The AFM must be mountable on an commercially available inverted optical microscope allowing for high numerical aperture optical imaging. Operation of AFM is possible while simultaneously performing light microscopy in all common transmitted light methods (phase contrast, DIC, fluorescence microscopy, etc.). The usage of a condenser is patented e.g. by **EP1430485**.
- 2) The system must allow to calibrate the optical image and to precisely overlay both the optical and the AFM images. Therefore, a direct read out of the camera image into the AFM software is indispensable. The calibration procedure is patented by **EP 1979913**
- 3) The system must have the ability to align the optical image and AFM scan, and select the AFM scan area directly from the optical image.
- 4) The system must provide optical access to the sample from both bottom and top.
- 5) The system must be designed for operation in air, fluids and gases. Hence, the scan head must be completely sealed against vapor and liquids. The scanning probe has to be fully submersible in fluid, and all parts of the fluid cell must be designed so that they can be thoroughly cleaned.

### B) AFM Instrumentation

- 6) The system must be equipped with an in-situ switch from air to liquid operation.
- 7) The system must have a tip-scanning design (X, Y, Z) in order to leave the sample static with respect to the optical axis during scanning. Tip scanning design offers highest flexibility with respect to sample size and weight.
- 8) The AFM head must allow a motorized approach with automatic tilt correction using three stepper motors to compensate for a possible tilt angle between sample and XY scan plane of the cantilever.
- 9) For Force Spectroscopy and Mapping experiments it must be guaranteed that the stepper motors of the AFM head can be used to adapt the scanning range in Z direction.
- 10) Provides an off-resonance intermittent contact imaging mode based on sinusoidal motion of the z-piezo with amplitudes of at least 0.001  $\mu\text{m}$  up to 2  $\mu\text{m}$ , permitting quantitative control of the normal force exerted by the tip on the sample (patented by US 8.739.309 und EP 2359148)

- 11) The system must allow a free sample space of up to 140 mm in diameter and up to 13 mm in height. The system must provide the option to add an extension for sample heights up to 80 mm or more.
- 12) The scanner must be capable of closed-loop operation. The guaranteed scan range must be at least  $100\text{ }\mu\text{m} \times 100\text{ }\mu\text{m}$  in XY and  $15\text{ }\mu\text{m}$  in Z. Sensor noise level must be better than 0.09 nm RMS in XY and 0.04 nm in Z
- 13) The scanner provides noise level of 0.030 nm RMS in z or better.
- 14) The noise level of the cantilever deflection detection system must be less than 2 pm RMS (0.1 Hz to 1 kHz bandwidth).
- 15) For all directions, the system must use scanners with capacitance position sensors.
- 16) The AFM must be able to operate in all standard modes such as contact, intermittent-contact and non-contact with Q-control, lateral-force, phase imaging, force mapping, force/distance spectroscopy, quantitative imaging with auto-setup of imaging parameters.
- 17) The system must come with built-in cantilever calibration capability. Thermal noise data acquisition for cantilever calibration must be feasible at least up to 3 MHz.
- 18) The bandwidth of the optical detector must extend from DC to at least 8 MHz.
- 19) The AFM head must provide a cantilever holder that can be autoclaved, sonicated or cleaned with solvents and disinfected entirely without disassembling.
- 20) The system must be capable of real-time panning and zooming of AFM images.
- 21) Data processing software must be available for both Linux and Windows OS. For better data handling the controller and system software must be Linux-based.
- 22) An unlimited number of data processing software licenses must be provided along with free upgrades.
- 23) The system/device offers a rapid force mapping mode (1000 curves/s), with a force-distance curve being recorded at each data point and analyzed in-situ.

## **C) Add-ons**

### **QI Advanced**

- 1) In addition to the sample topography, mechanical and electrical properties can be measured. Raw data (one force-distance curve per image pixel) can be stored.

## **D) Options**

### **PetriDishHeater**

- 1) The system must include a temperature controlled holder from room temperature up to 60°C for Petri dishes having a diameter of 35 mm and a height of at least 10 mm