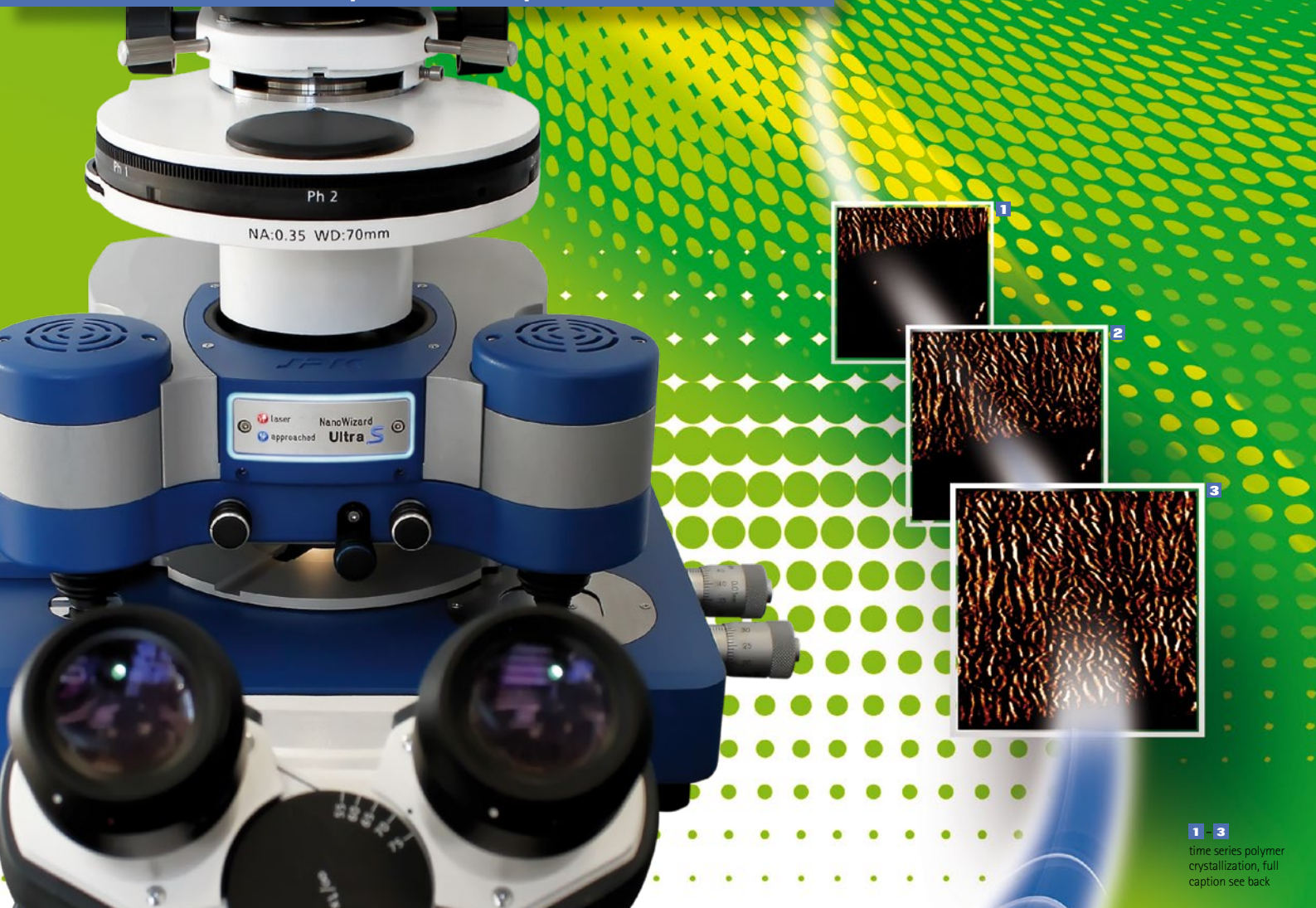


NanoWizard® ULTRA Speed AFM

Fast-Scanning and Super-Resolution AFM on inverted microscope from the pioneers of BioAFM



1-3
time series polymer crystallization, full caption see back



Fast scanning >300Hz line rate in air and liquid with excellent resolution

Atomic resolution in closed-loop mode by lowest noise scanner, position-sensor and detection-system

Comes with the easy-to-use Q1™ mode for quantitative material property mapping

Unique integration with optical microscopy by tip-scanning design and DirectOverlay™ mode for most precise correlative microscopy

Comprehensive force measurements from single molecules to living cells

Highest flexibility and upgradeability with a broad range of modes and accessories

JPK
Instruments

Nanotechnology for Life Science

Highest resolution and lowest noise level in the most flexible AFM system. Performance made in Germany.

Cutting edge technology for highest stability and best noise level for the most accurate data especially for experiments in liquid

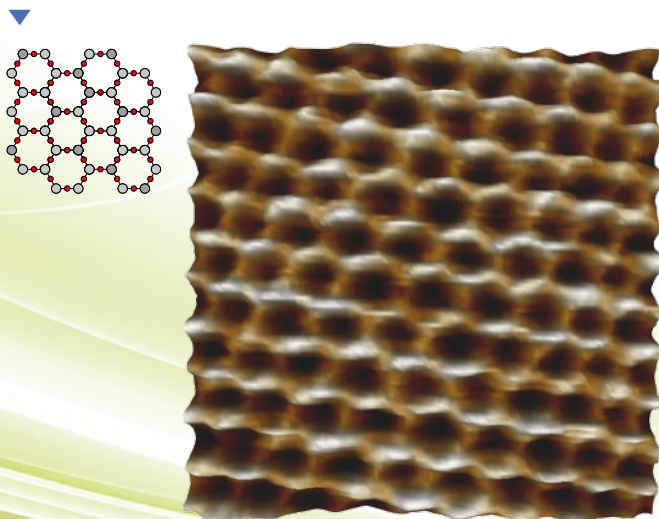
The NanoWizard® ULTRA Speed AFM system sets the new standard in terms of resolution paired with scan speed.

The optimized cantilever deflection detection system comes with lowest noise level of today's AFMs. The fast electronics with highest bandwidth as well as the rigid mechanics and the newly designed high-voltage amplifiers deliver most accurate force control even on delicate sample structures.

The use of customized flexure stage scanner technology leads to absolute flat scans without bow effects. The most advanced closed-loop control based on capacitive sensors delivers atomic resolution and completely eliminates all of the piezo inaccuracies.

The scan head is designed especially for work in fluid. The use of encapsulated piezos and the proven JPK technology for sealing the scan head with a water vapor barrier make the system perfect for samples immersed in liquid.

Crystal structure (left) and true atomic resolution image (right) of mica in liquid, 5 nm scan region, imaging in closed-loop mode. The hexagonal unit cell is clearly resolved.



Flexibility and upgradability for tomorrow's research projects

According to JPK's philosophy the system combines robustness with modularity for the highest level of usability. JPK's expertise in Liquid-AFM is demonstrated by the liquid proof system design as well as in a large variety of dedicated easy-to-clean liquid cells for any application.

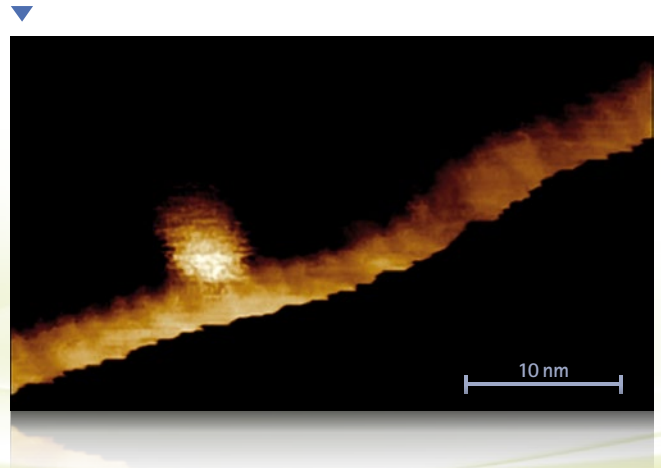
The cutting-edge high bandwidth Vortis™ control electronics guarantee a maximum degree of freedom in the choice of measurement modes, signal access, and accessories for environmental control, electrochemistry or optics. A large number of accessories such as different scan heads (ForceRobot®, CellHesion® 200) or sample stages (CellHesion® or TAO™) can be used with the system.

Optical integration is our main expertise

JPK has been pioneering the combination of AFM and advanced optical microscopy for more than a decade. The NanoWizard® ULTRA Speed system continues this path by combining AFM and inverted microscopy as well as upright optics (Upright Fluorescence Kit and the BioMat™ workstation).

In particular, advanced fluorescence methods such as confocal, spinning disc, FRET, TIRF, FRAP, FLIM, PALM/STORM, STED or similar can be used simultaneously to AFM thanks to our unique tip scanning AFM design. With the proprietary JPK DirectOverlay™ mode, users have a perfect match of both methods.

Lambda phage DNA, showing both the major and minor grooves in the DNA double-helix. Imaging in closed-loop xy in liquid.



Fast scanning AFM combined with inverted optical microscopy or as stand-alone system

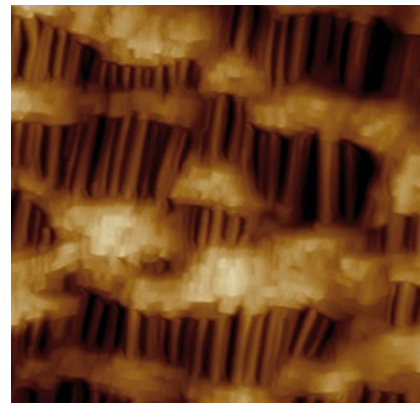
Fast AFM scanning to see dynamics from single molecules to living cells

To see dynamics in-situ with highest spatial resolution is a current challenge for AFM. With the NanoWizard® ULTRA Speed AFM combined with standard inverted optical microscopy with condenser optics, fast scanning in-situ AFM experiments are now possible. Fast AFM scanning on living cells in a Petri dish or single molecule dynamic studies can be performed. Experiments can be triggered or sample properties can be controlled with simultaneous environmental control (temperature, gas or fluid exchange etc.). Experiments involving polymer phase transitions, crystallization, enzymatic reactions, film or fibril growth or electrochemical reactions can all be performed in-situ.

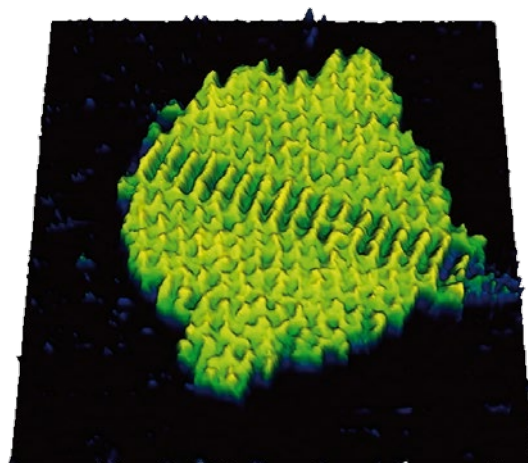
Correlative microscopy of AFM and optical microscopy

Multiparameter microscopy from single molecules to living cells is a key technology today. Modern optical super-resolution methods such as STED or PALM/STORM have now reached sub 100 nm resolution. The NanoWizard® ULTRA Speed AFM has the scanning speed that allows to further close the gap of speed and resolution between those methods. Here, JPKs unique DirectOverlay™ mode plays an essential role for perfect data correlation unmatched by any other commercial AFM system. Software tools for video capture and processing are implemented. All of these advantages lead to high productivity and make the system perfect for advanced research or routine work in multiuser facilities.

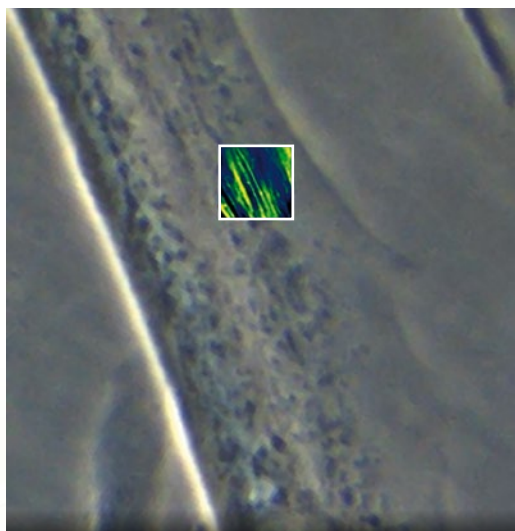
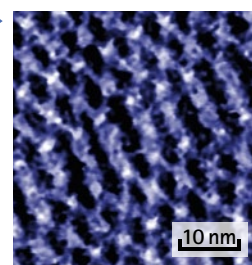
To obtain quantitative data maps the system comes with the easy-to-use QI™ mode. High resolution data for adhesion, stiffness, dissipation, conductivity or molecular recognition are acquired even on delicate and difficult samples.



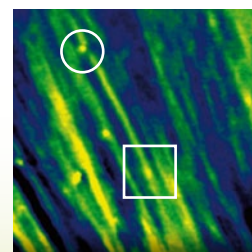
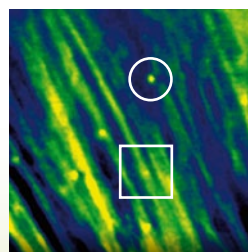
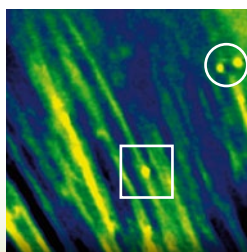
▲ Image of Celgard® (Celgard, USA) with scan size 1 μm, z scale 100 nm, 23 Hz line rate, closed-loop xy. (Celgard is a trademark of Celgard, Inc.)



▲ DNA origami imaged in TAE-Mg buffer using closed-loop xy. Overview scan region is 130nm. The image of the central part of the origami was measured using 105 Hz line rate, after 40 scans of the same region (continuous scanning with the same settings). DNA Origami courtesy of Dr Meyer and Prof. Niemeyer, Karlsruhe Institute of Technology (KIT).



◀ Living cells imaged in the JPK PetriDishHeater™ at 37 °C. DirectOverlay™ combination of optical phase contrast and AFM phase images. Series of 10 μm AFM phase images using closed-loop xy, 40 Hz line rate, 3 frames between images, showing structures that remain fixed (square) and others that move (circle). Sample courtesy of Prof. A. Herrmann, Humboldt University, Berlin.



Specifications for the NanoWizard® ULTRA Speed AFM

System specifications

- Atomic resolution in closed-loop on inverted microscope (< 0.025 nm RMS z noise level)
- Ultra-low noise level of cantilever deflection detection system < 2 pm RMS free (0.1 Hz - 1 kHz)
- Best closed-loop AFM on the market for reproducible tip positioning and long time position stability
- Tip-scanning stand-alone system, the only choice for simultaneous AFM and laser scanning experiments
- IR deflection detection light source with low coherence for interference-free measurements
- NanoWizard® ULTRA Speed can be operated:
 - On top of an inverted research microscope for AFM simultaneously with optical microscopy
 - Find a measurement spot optically on your sample by fluorescent labeling
 - Combine AFM with advanced optical techniques such as confocal, FCS, FRET, FLIM, TIRF, STED, PALM/STORM or others
 - Exact positioning and overlay of optical and AFM data with the JPK DirectOverlay™ software module
 - Stand-alone based
 - Maximum flexibility even if no fluorescence is required (the sample stage can be mounted on an optical microscope within a minute)
 - Free access to the sample area for micropipettes or electrical connections
 - TopViewOptics™ optional
 - BioMAT™ option
 - For high-NA optics combined with AFM on opaque samples

NanoWizard® ULTRA Speed head

- Rigid low-noise design and drift-minimized mechanics
- High detector bandwidth of 8 MHz for high speed signal capture
- Liquid-safe design with integrated vapor barrier, special encapsulated piezo drives and tip-moving design
- Intelligent and automated approach with user defined parameters for soft landing even with functionalized tips
- Transmission illumination with standard condensers for precise bright-field, DIC and phase contrast
- Built-in optical filters for fluorescence without crosstalk
- Scanner unit
 - Flexure stage scanner design with decoupled, low mass z scanner
 - 30 × 30 × 6 μm³ scan range in closed-loop mode for the head
 - > 300 Hz line rate
 - z resonance frequency > 70 kHz
 - Position noise level better 0.1 nm RMS in xy (in closed-loop) and 0.04 nm RMS sensor noise level in z (3 kHz bw)

Vortis™ SPMControl electronics

- State-of-the-art digital controller with lowest noise levels and highest number on signal channels
- High speed 16 bit AD conversion with 60 MHz for the photodetector signals
- 24 bit ultra precise ADC with 2.5 MHz
- High speed Lock-in amplifier technology for precise amplitude and phase detection
- High-speed data capture with optional burst mode
- Modular hybrid analog/digital design with latest FPGA/PPC technology
- Gigabit Ethernet interface for fast data link
- Number of data points that can be captured continuously: restricted only by HDD
- Thermal noise acquisition up to 3.25 MHz
- Optional Signal Access Module (SAM) with analog and digital connectors for maximum experimental freedom

SPMControl software

- Fully automated sensitivity and spring constant calibration using thermal noise method
- Patented DirectOverlay™ for picture-in-picture functionality combined optical and AFM information
- Outline™ mode for precise selection of a new scan area even in the optical image
- Improved ForceWatch™ mode for force spectroscopy and imaging for cantilever-drift free measurements
- Advanced oscilloscope functionality and online measurement of distances, cross sections etc.
- True multi-user platform
- User-programmable software
- Unlimited pixel resolution for imaging or force curves
- Comprehensive force measurement with TipSaver™
- JPK ExperimentPlanner™ for designing a dedicated measurement workflow
- JPK RampDesigner™ for custom designed force curve segments
- Advanced spectroscopy modes such as various force clamp modes or user-defined ramp designs, e.g. for temperature ramps, pulling speed or force feedback
- Powerful batch processing of images and force curves without events

- Powerful Data Processing (DP) functions with full functionality for data export, fitting, filtering, edge detection, 3D rendering, FFT, cross section etc.
- DataProcessing Image-Viewer for picture-in-picture display and export, including calibrated optical images
- Powerful batch processing of force curves including WLC, FJC, step-fitting, filtering according specific events or a combination of those and other analysis

Stages

- Liquid-safe, robust and drift-minimized design for highest stability
- Motorized precision stage with 20 × 20 mm² travel range with joystick or software control
- Manual precision stage with 20 × 20 mm² travel range
- Independent positioning of tip and sample with respect to the optical axis
- Stages are available for all major inverted optical microscope manufacturers (see below)

Sample holders

- Holders for Petri dishes, coverslips, microscope slides or metal SPM stubs
- Special holders and liquid cells available
- Ø 140 × 18 mm³ free sample volume

Optical configurations

- Fits to inverted microscopes from
 - Zeiss (Axio Observer, AxioVert 200)
 - Olympus (IX line)
 - Nikon (TE 2000, Ti)
 - Leica (DMI line)
- Fully simultaneous operation with optical phase contrast and DIC, using standard condensers
- Compatible with commercial confocal microscopes and fluorescence techniques such as TIRF, FRET, FCS, FRAP, FLIM, PALM, STORM, STED
- Upgradeable for scatter-type SNOM, Raman, TERS measurements
- AFM and upright high-NA optics combination with the JPK BioMAT™ workstation (see BioMat™ brochure)
- Upright Fluorescence Microscope (UFM) kit enables co-localization experiments on opaque substrates
- Large variety of high-end EM-CCD cameras supported
- TopViewOptics™ video optics for opaque samples

Temperature control options

- RT - 300 °C temperature range with 0.1 °C precision with the JPK High Temperature Heating Stage (HTHS™)
- 30 °C - 120 °C temperature range with 0.1 °C precision with the JPK Heating Cooling Module (HCM™)
- All heaters and heating/cooling solutions are software-controlled

Fluid cell options

- Cantilever holders for experiments in droplets or custom fluid cells
- JPK's patent-pending BioCell™ for high-NA immersion lenses and high-resolution AFM down to the single molecule level
 - allows temperature control between 15 - 60 °C,
 - perfusion and gas flow
 - for standard cover slips
- JPK CoverslipHolder offers the same capability as the BioCell™ for ambient temperature experiments
- JPK's temperature controlled electrochemistry cell ECCell™ with transmission illuminations
- JPK's PetriDishHeater™ perfect for living cells
 - accommodates 35 mm Petri dishes even with coverslip bottom
 - ambient to 60 °C temperature range
 - perfusion and gas flow possible
- JPK SmallCell™ small volume version for aqueous solutions
 - Closed fluid cell for minimized volumes (< 60 μl)
 - 3 easily accessible sample ports, 2 for buffer exchange and 1 for adding chemical

Optional accessories for maximum flexibility

- (see accessories handbook)
- Different sample holders, cantilever holders and stages for every application
- Large choice of add-ons such as temperature controls, liquid cells even for aggressive solvents
- JPK's ForceWheel™ handheld accessory for most sensitive experiment control
- Full experimental control by scripting functionality and access to all signals
- CellHesion® module with extra 100 μm closed-loop z range
- TAO™ module with 100 × 100 μm² or 100 × 100 × 10 μm³ closed-loop sample scanning stage
- Vortis™ Advanced SPMControl station for maximum flexibility
- Electrical measurement modes
- Cameras and light sources for video imaging or fluorescence
- Vibration and acoustic isolation from leading suppliers

Standard operating modes

Imaging modes (air or liquid)

- Contact mode with lateral force microscopy (LFM)
- AC modes with phase detection
- Quantitative Imaging with QI™ mode (air or liquid)

Force spectroscopy (air or liquid)

- Static and dynamic spectroscopy

Optional modes

- Quantitative Imaging with QI™ Advanced mode (air or liquid)
 - Mechanical properties such as adhesion, elasticity, stiffness, deformation
 - Conductivity mapping
 - Contact point imaging (CPI™)
- HyperDrive™
- Advanced AC modes such as FM and PM with Q-control
- Advanced force spectroscopy with force clamp & ramp
- Higher harmonics imaging
- MicroRheology
- KPM and SCM
- MFM
- EFM
- Conductive AFM see also QI™ mode
- STM
- Electrical spectroscopy modes
- Piezo-Response Microscopy (PFM)
- Electrochemistry with temperature control and optical microscopy
- NanoLithography and NanoManipulation
- NanolIndentation
- Scanning Thermal AFM
- JPK ExperimentPlanner™ for designing a dedicated measurement workflow
- JPK RampDesigner™ for custom designed force curve segments
- Environmental control options
- DirectOverlay™ for combined AFM and optical microscopy
- Additional xy or z sample movement stages available with CellHesion® or TAO™ module

Cover images: Time series polymer crystallization showing crystallization of the biodegradable copolymer poly(hydroxybutyrate-co-valerate), PHBV. Sample courtesy of Prof. J. Hobbs, University of Sheffield, UK. Scan region 1.5 microns, imaging in closed-loop xy, 17 frames between images shown.

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AFM on a
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