queensgate

Applications:
Atomic Force Microscopy (AFM)

Atomic Force Microscopy (**AFM**) or **Scanning Force Microscopy** (**SFM**) is a type of scanning probe microscopy (SPM) which scans a surface with a mechanical probe achieving resolutions of fractions of a nanometer.

AFMs can be used to measure the forces between the probe and the sample as a function of their mutual separation, producing a high resolution, three-dimensional topographical image of the sample surface. This is achieved by raster scanning the position of the sample with respect to the tip and recording the height of the probe that corresponds to a constant probe-sample interaction. The surface topography is commonly displayed as a pseudocolour plot.

In manipulation, the forces between tip and sample can also be used to change the properties of the sample. Examples of this include atomic manipulation, scanning probe lithography and local stimulation of cells.

Mechanical properties like stiffness, adhesion strength and electrical properties such as conductivity or surface potential can also be measured.

Sub-nanometer spacial resolution in AFM scanners

High performance piezoelectric stages are used in the specimen scanner of an AFM to provide sub-nanometer spacial resolution.

The stages are used to provide a three dimensional, X, Y and Z profile of the surface of the sample. The dynamic performance and accuracy of the Z stage is important as it adjusts to the topography of the sample. A fast response allows the x and y stage to scan quickly across the surface of the sample reducing drift due to the effect of temperature changes and increasing throughput.

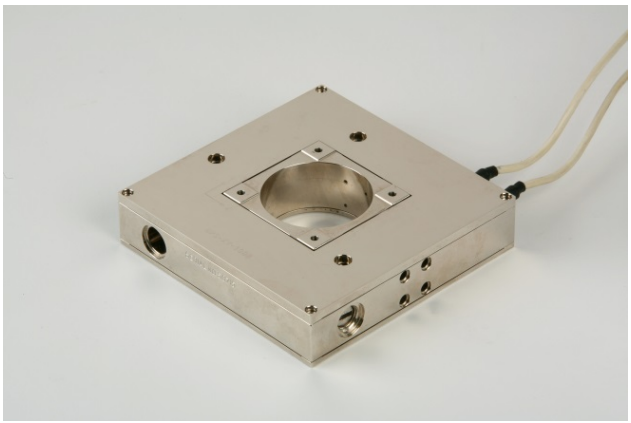
Precision motion. Precision measurement.

Queensgate provide high precision, high-speed piezo actuators and flexure driven stages using capacitive positioning sensors for use in 'close loop AFM'. Queensgate pioneered the use of capacitive sensors in high performance stages and actuators with the highest resolution and linearity of movement.

With options for travel ranges of 50, 100, 200um; the XY stages provide market leading positioning resolution; the 100um range provides resolution better than 0.25nm.

Finite element analysis of the flexure guidance mechanisms has reduced parasitic angular motions providing the smoothest, most repeatable scan with greatly minimised out-of-plane motion.

Decoupling the Z axis by using a separately mounted Z stage will usually provide the best dynamic performance and range. For example the NPS-X-25 operates over a closed loop range of 25um, with a sub-nanometer resolution of better than 0.1nm and resonant frequency of 6KHz.



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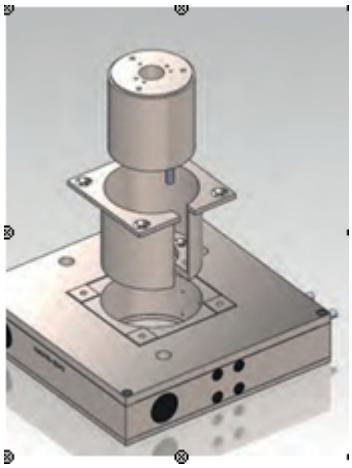
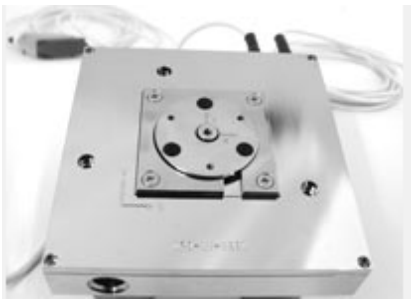


Integrated systems

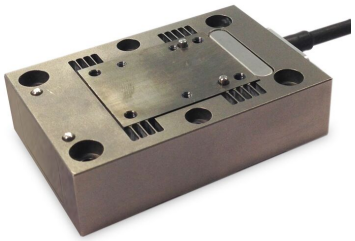
Where it is more convenient to use an integrated system the hollow NPS-Z-15H stage integrates with the NPS-XY-100 stage to provide an optical taper right into the focal plane of the sample under test. This arrangement offers accurate travel over 100µm of travel in X & Y axes and over 15µm travel in the Z axis.



Plug and play technology

All stages and actuators use plug and play technology, allowing stages to be swapped between controllers but maintain calibrated performance. For example, a controller can be replaced in an AFM instrument without disrupting the stages.

Stages are offered as standard in Aluminium and SuperInvar. Aluminium stages provide faster response times, whilst SuperInvar provides the best metrological performance. Super Invar (CTE 0.3ppm K-1, compared to Aluminium at 23ppm K-1) minimizes thermal drift, which on a nanometer scale can be important. The SuperInvar stage has a unique iso-static mounting system, ensuring that stresses from the mounting system are properly relieved and establishes the center of the stage as the co-ordinate reference point.



Control electronics

The NPC-D-6000 controller is designed to control multiple Queensgate stages and actuators. The system can be tuned using twin notch filters per channel to reduce the effect of both the first and second resonant frequency, improving dynamic positioning.

The controllers high power rating allows stages and actuators to be driven at higher maximum speeds, delivering the best dynamic performance. In addition to the standard PID (proportional integral differential) control a special algorithm minimises overshoot, allowing higher bandwidths to be achieved compared to conventional PID control.

Advanced control techniques developed by Queensgate provide a command resolution of 21 bits.

Special features include:

- USB and Ethernet interfaces. Analogue command and analogue position monitors.
- Function playback, per channel, where a pre-programmed waveform can be downloaded into the controller and played back using trigger inputs via the USB, Ethernet or TTL inputs. This would be useful for raster scanning.
- Programmable trigger output based on the function playback. The trigger points can be programmed at any point(s) within the function playback waveform.
- In-position TTL signal, per channel, to indicate that the stage/actuator position is with a pre-programmed tolerance from the commanded position. This signal is also available via the USB and Ethernet interfaces.
- Tuneable low pass and notch filters per channel for improved stability and reduced noise.
- Synchronisation allowing multiple controllers to be used together.