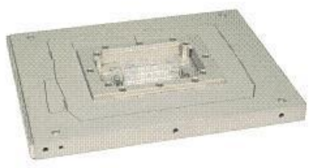  

Nano Positioning Overview

General Application

Nanopositioning systems are useful for any application which demands precision and reproducibility at the nanometer or sub-nanometer level. These applications include numerous types of microscopy, nano-alignment, optical scanning, nano-manufacturing, testing, and robotics.

Piezoelectric actuators

These nanopositioning systems are activated using multi-layered piezoactuators. These actuators are made from PZT ceramic which expands in response to an applied voltage. Expansion of PZT ceramic is nearly linear with voltage, but hysteresis (~8%) and creep (~1%) must be eliminated by precise electronic closed loop control. Piezoactuators, by themselves, are poor nanopositioning devices.

Flexure Guided Motion

To overcome the coupled motion problems associated with PZT piezoactuators, all these nanopositioning systems incorporate flexure stages. Flexure based stages have the unique attribute of zero mechanical friction. Carefully designed flexures restrict the motion of each axis to a single direction. This effectively decouples the unwanted motions in the PZT actuators and results in a pure, one-dimensional translation.

Resolution

Since there is no quantum principle effecting the lattice spacing in the PZT actuators, the step resolution of the nanopositioning stages are dependent only on the resolution of the input control signal (analog or digital) to the controller - limited by the fundamental noise floor of the system.

Closed Loop vs. Open Loop

In open loop mode, the output driver controls the motion of the nanopositioning stage simply by amplifying the input voltage. The position of the nanopositioning stage includes errors resulting from piezoactuator creep and hysteresis. In closed loop mode, the input voltage is compared to the voltage from an internal position sensor. Using a proportional-integral feedback loop, the driver output is continuously adjusted so that the sensor signal matches the input signal to the driver. Since the sensor signal is highly proportional to the absolute position, the position of the nanopositioner matches the driver input voltage. The effects of creep and hysteresis are eliminated. Closed loop systems are necessary in any nanopositioning application which requires stability, precision, and repeatability.

Piezoresistive Position Sensors

These positioners use temperature compensated semiconductor piezoresistive networks for absolute position measurements. This sensing system typically achieves positioning linearity better than 0.05% and is capable of position noise down into the picometer range (1 picometer = 0.001 nanometer).

Load Capacity

The primary impact of adding a large load to a nanopositioning stage is reduction of the system's resonant frequency. This is analogous to adding weight onto a mechanical spring and thereby reducing the "bouncing" frequency. Since it is important to prevent the nanopositioning system from actually reaching resonance, these positioners adjust the bandwidth of the controller to compensate for the anticipated mass. This means that every system is optimized for the actual experimental conditions and can be operated at the fastest practical speed. The specified maximum load for each nanopositioner is intended as an approximate guideline – we're happy to discuss the tradeoff between load and positioning speed for your actual application.