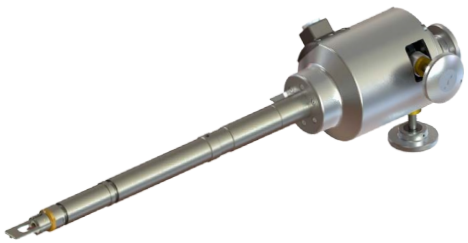
current

HUMMINGBIRD
SCIENTIFIC

voltage

› NanoManipulator TEM

Technical Specs



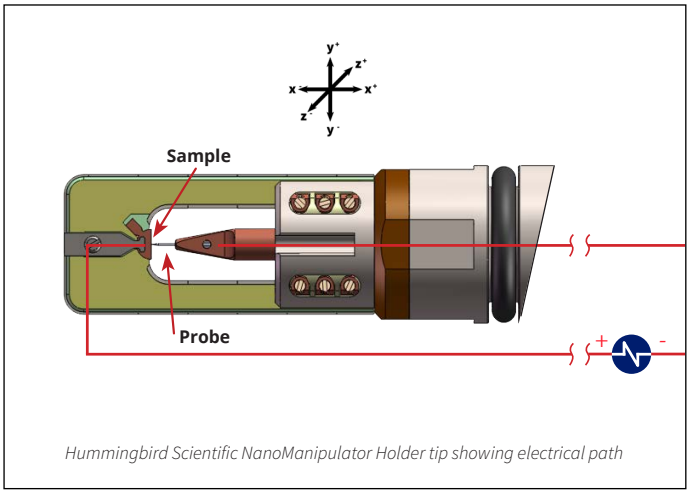
	1800 Series
Range of Motion	
X-axis (coarse, fine)	+/- 0.5 mm, 50 um
Y-axis (coarse, fine)	+/- 0.5 mm, 50 um
Z-axis (coarse, fine)	5 mm, 5 um
Number of Electrical Contacts	2 Standard (available up to 7)
Coarse Stage Positioning Resolution	1 µm
Fine Stage Positioning Resolution	< 1nm
Wiring	Individually shielded
Current Measurement Resolution	Down to 10pA (depending on measurement equipment)
Sample Geometry	3 mm half grid bulk, half grid FIB lift out or half grid membrane samples*

* Contact us about for custom configurations

How It Works

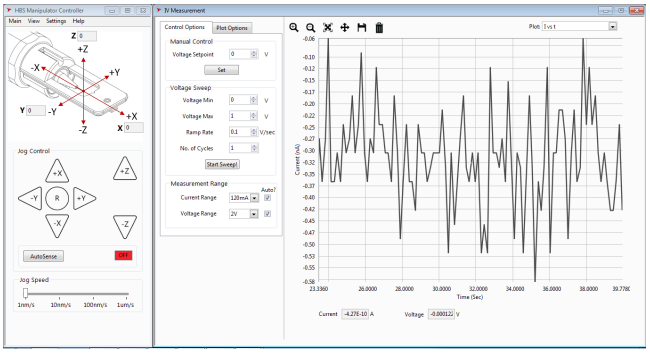
The manipulation and biasing probe tip in the Nanomanipulator TEM holder can be moved with sub-nanometer accuracy and a millimeter of range in three Cartesian axes. Positioning is done in two stages: coarse and fine. The coarse position is adjusted with ultrafine pitch screws and the fine positioning is piezo adjusted with the included controller and software interface. The probe can be manipulated to make electrical contact with a conductive sample thereby completing a circuit (see Figure on the right).

The system utilizes very low noise internal individual coax cables to optimize electrical measurement accuracy. The holder is setup standard for 3 mm half grid samples, either conventionally prepared bulk samples, FIB lift out samples on lift-out (half) grids or on a membrane chip substrates. Contact us about custom sample mounting solutions.



Hummingbird Scientific NanoManipulator Holder tip showing electrical path

Software



The **Nanomanipulator TEM** holder features fine motor control through a software interface. It also includes a built in Source Measurement Unit for electrochemical experiments. **Left:** Nano-Manipulator software interface for probe control, biasing settings and IV measurements.

The fine position control for the manipulator is provided via a simple and lightweight software interface (Figure Above). There are options for varying the motion speed, range, and resolution. Any parasitic motion in the axes can be compensated for with a novel compensation algorithm integrated with the software. A joystick or game-controller may also be attached to the host computer and used to manipulate the probe instead of the default on-screen buttons, granting increased flexibility and ease-of-use.

The built in source measurement unit is controlled through the same interface. Alter current or voltage as well as basic signal on-screen with full signal plotting and logging.

Accessories

Accessories available for your nanomanipulator holder:

- Conventional 3mm Half - Grids

Product Summary

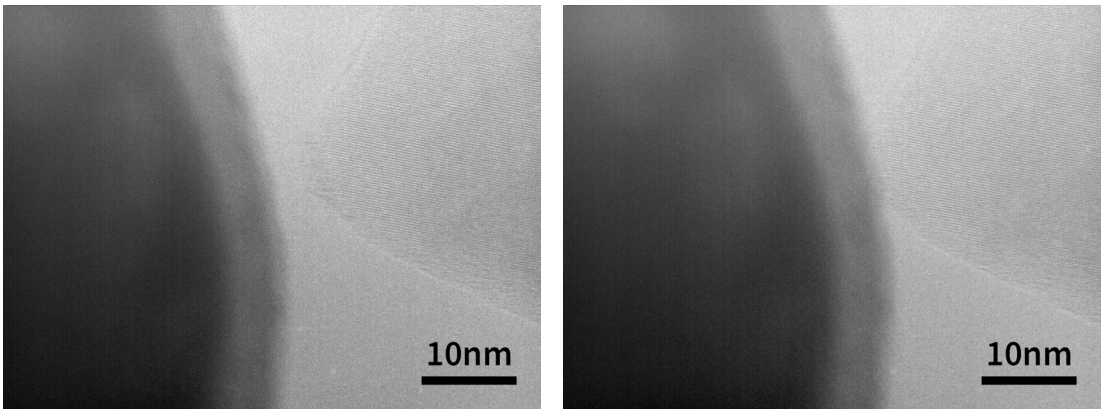
Fine position controlled by lightweight software interface, joystick, or game controller.

Hummingbird Scientific's in-situ TEM Nano-Manipulator Holder enables nanomanipulation of nano-scale materials in-site the TEM. It also enables in-situ electrical testing of materials while imaging the material microstructure. The three-axis movable electrical probe uses a combination of coarse and fine scale positioning that provides atomic resolution stability for the sample and electrical probe.

Our removable sample mounting mechanism allows for easy cross-sectional sample preparation and dedicated sample clamps for different sample geometries. The sample holder has two dedicated electrical contact points, one of which is the moving probe, the other the sample. Using individually shielded electrical wiring for both contacts, the TEM Nano-Manipulator Holder provides local probing of the electrical performance of an array of nanostructured materials and nanoscale electrical devices and correlating this with the material microstructure.

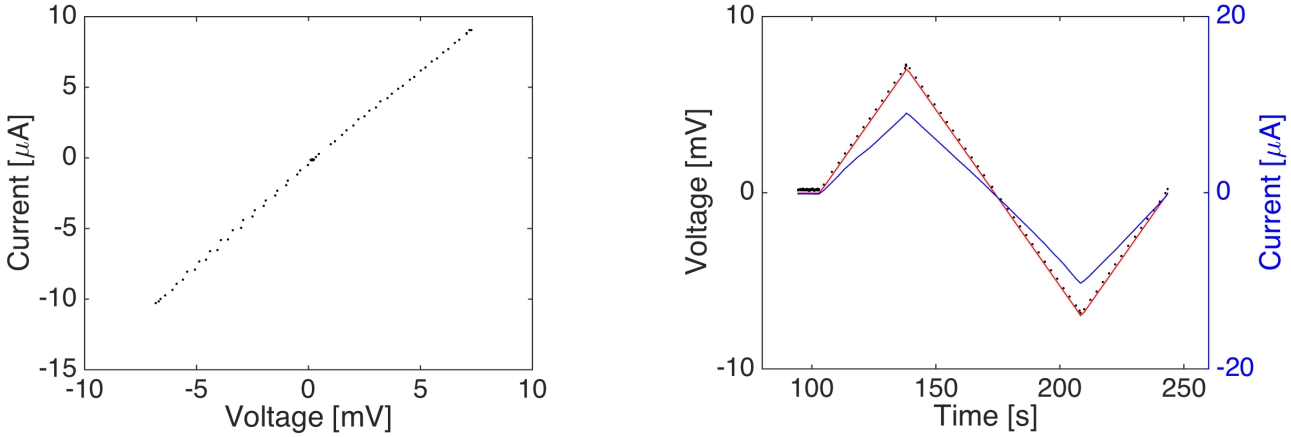
Application Example

Electrical biasing across a nano-scale contact interface



TEM holder movable probe approaching onto Si TEM sample. Left: Before contact, **Right:** Contact.

The Figure above shows an example application where the probe tip is approaching a silicon needle TEM sample. After the probe makes contact with the sample, electrical measurements can be conducted at the interface between the holder probe tip and the sample. Below the images are example curves of VI data of such an experiment. They show current and voltage as a function of time and current vs voltage and shows atomic behavior across the interface. The individual coaxial wiring in the holder for each contact gives pA noise levels during these measurements.



VI curves and V&I vs time while in contact with the Si TEM sample. **Left:** Black data points are V&I measurements. **Right:** Black data points are voltage measurements, red line is the voltage set point and the blue line is the continuous current measurement. Unpublished work: Tevis Jacobs, University of Pittsburgh, Siddharth Sood and Daan Hein Alsem, Hummingbird Scientific.

Selected Publications

Reference: A.N. Chiaramonti, L.J. Thompson, W.F. Egelhoff, B.C. Kabius, A.K. Petford-Long, **"In situ TEM studies of local transport and structure in nanoscale multilayer films"**, Ultramicroscopy 108 (2008) 1529-1535.

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