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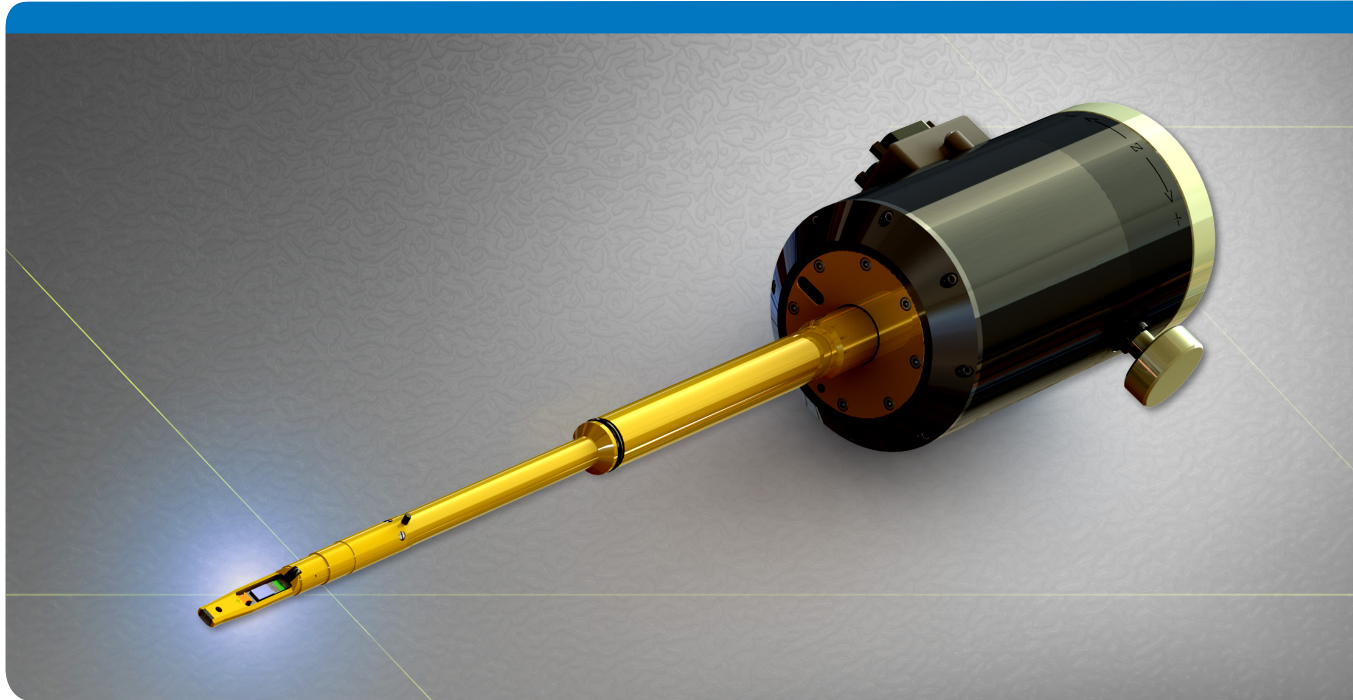


Hysitron PI 95 TEM PicoIndenter Sample Mounts

Multiple Designs for Nanoscale Materials

Bruker's Hysitron® PI 95 TEM PicoIndenter® is the first full-fledged depth-sensing indenter capable of direct-observation nanomechanical testing inside a transmission electron microscope (TEM). With this side-entry instrument, it is not only possible to image the mechanical response of nanoscale materials, but also to acquire load-displacement data simultaneously. Bruker's different types of sample mounts allow users to conduct high-performance experiments on a wide variety of samples.

Hysitron PI 95 TEM PicoIndenter

Mounts Featuring

- Mounting designs to enable high-performance experiments on nanostructured materials, thin films, and electron-transparent specimens prepared from bulk materials
- Support of different modes of mechanical testing, including indentation, compression, bending, and tensile
- Brass screws to provide strong mechanical coupling of the mounts to the Hysitron PI 95 frame
- High structural stiffness with minimum thermal drift
- Sample mounting in close proximity to heating element and sensor for better temperature accuracy with the MEMS heating upgrade option

PicoIndenter Front Ends

The sample mounts are attached to the front part of the Hysitron PI 95 holder. The front end is removed from the outer-tube for tip exchange for JEOL TEM Hysitron PI 95 or for MEMS transducer exchange for FEI/Hitachi/Zeiss TEM Hysitron PI 95.

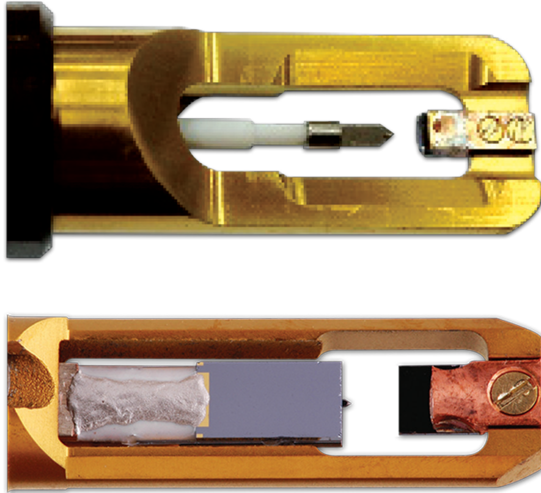


Figure 1. JEOL compatible front end (top) and front end with MEMS transducer (bottom).

PicoIndenter Advanced Front Ends

The advanced four-screw designed front end was developed for multiple contact sample mount geometries. This front end is compatible with the bulk sample mount, Si wedge mount, PTP mount, Electrical Characterization Module (ECM) mount, and 400°C MEMS heater.

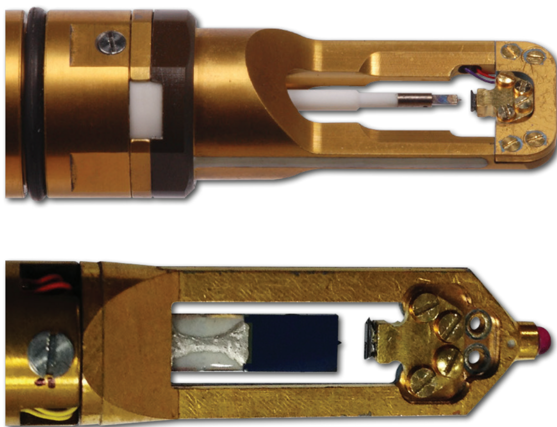
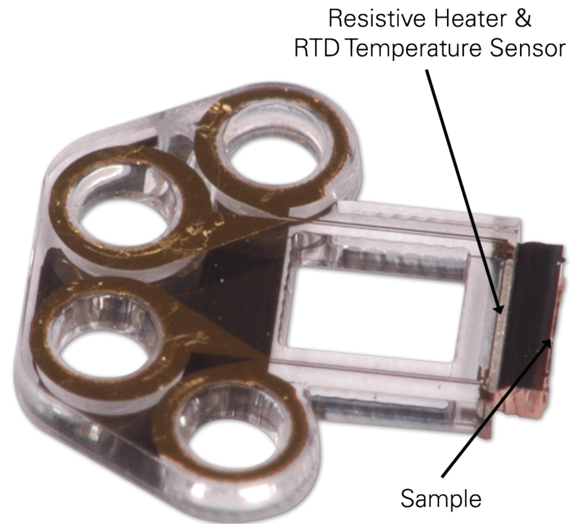


Figure 2. JEOL compatible front end (top) and Hitachi compatible front end (bottom).

Figure 3. (A) Bulk sample mount, (B) Si wedge sample mount, and (C) PTP sample mount for advanced front end.

MEMS Heater

In-situ heating is accomplished through the use of a resistive MEMS heater that facilitates temperature measurement up to 400°C.



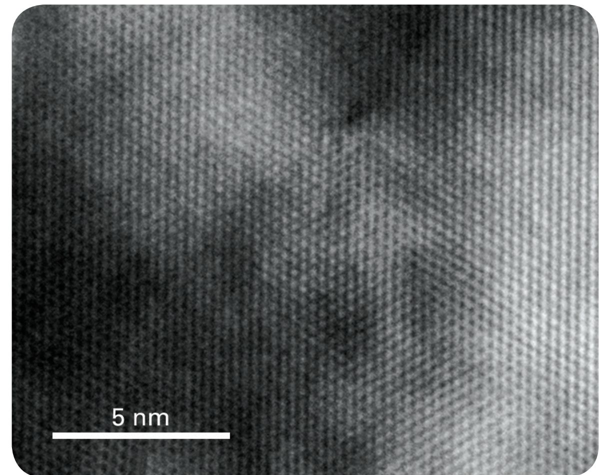
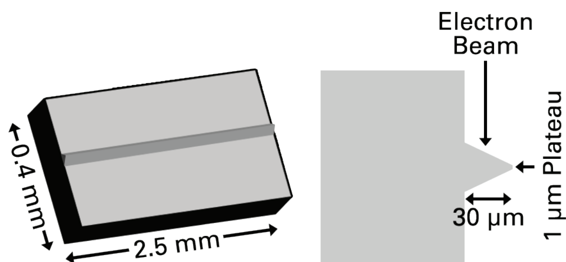


Figure 4. Optical image of a MEMS heater showing different components (top). High-resolution TEM image of Si taken with H9500 TEM at 381°C (bottom); Si was mounted on MEMS heater. Si lattice fringes are clearly visible.

Convenient Sample Mounting

Bruker provides various types of user-friendly Cu sample mounts for nanostructured materials, Push-to-Pull (PTP) devices, and electron transparent samples:

- Bulk sample mounts are used for mounting bulk specimens and commercially available half-grids.
- 150 nm narrow Si wedges are used as templates for thin film deposition. As the wedge is electron transparent, 50–100 nm thick films should also be electron transparent. The film is structurally supported by the wedge (see schematic below).
- 1 micron plateau Si wedges are used as substrates for nanoparticle deposition. Nanoparticles can be added to ethanol or water, ultra-sonicated for 10-15 minutes, and then dispersed on 1 micron plateau.
- PTP devices are designed to conduct quantitative in-situ tensile testing of nanostructured materials inside the TEM. PTPs are mounted on specially designed PTP mounts.



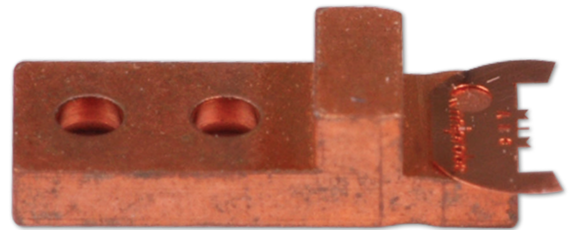
Schematic of narrow Si wedge (left) and 1 micron plateau (right).

Hysitron PI 95 Sample Mounts

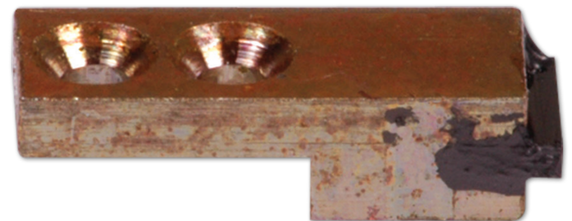
Several different types of sample mounts are available for the Hysitron PI 95:

- Standard Sample Mounts (Cu)
  - Bulk sample or half-grid
  - Si wedge
  - Push-to-Pull device
- ECM Sample Mounts
  - Bulk sample
  - Si wedge
  - Electrical Push-to-Pull device
- 400°C MEMS Heater

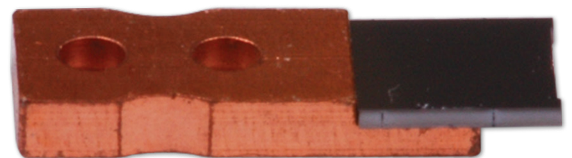
Contact Bruker for more information about sample mounting procedures.



Bulk sample or half-grid sample mount.

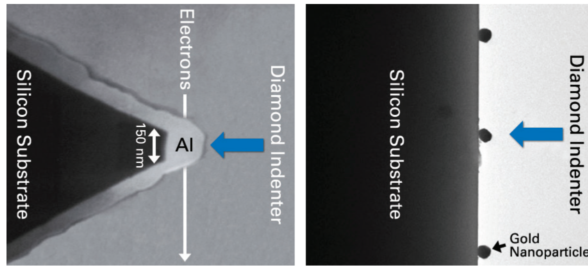


Silicon wedge sample mount.

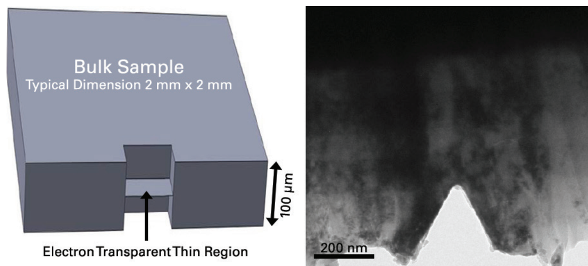


Push-to-Pull (PTP) sample mount.

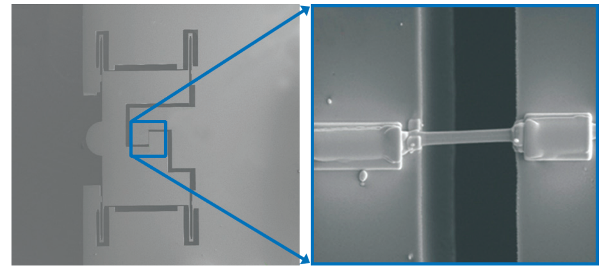
Example Applications:



Thin Al film on narrow Si wedge (left) and
Gold nanoparticles on 1 micron Si wedge (right).



Electron transparent regions for indentation can be prepared from bulk samples by focused ion beam. The bulk sample can be polished to 100 micron thickness before milling the trenches with FIB. Schematic showing typical size, shape and orientation of the H-sample; not in scale (left). H-pattern multilayer TiN/TiAlN thin film sample was prepared by focused ion beam and indented with a Hysitron PI 95 (right).



SEM images of full PTP device with mounted ZnO sample (left), and close-up of PTP device gap with ZnO sample mounted using FIB Pt deposition (right).

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