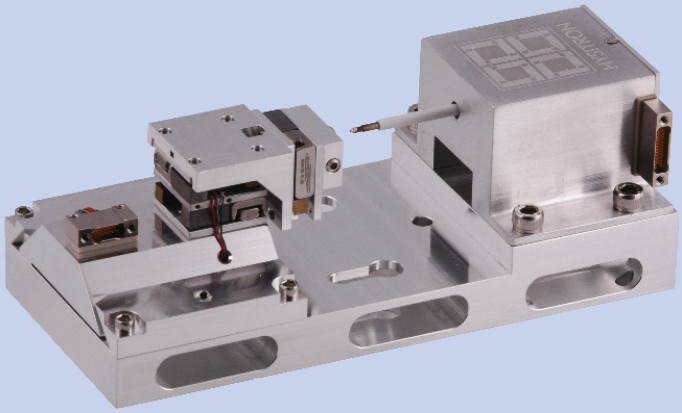
PI-SERIES

HYSITRON®

PI 85 SEM PicoIndenter®



PI 85 SEM PicoIndenter

Quantitative nanomechanical testing interfaced with your SEM.

The **PI 85** is a depth-sensing indenter that can be interfaced with a scanning electron microscope (SEM). With this system it is possible to perform quantitative nanomechanical testing while simultaneously imaging with the SEM. Coupling these two techniques allows the researcher to position the probe extremely accurately and to image the deformation process throughout the test.

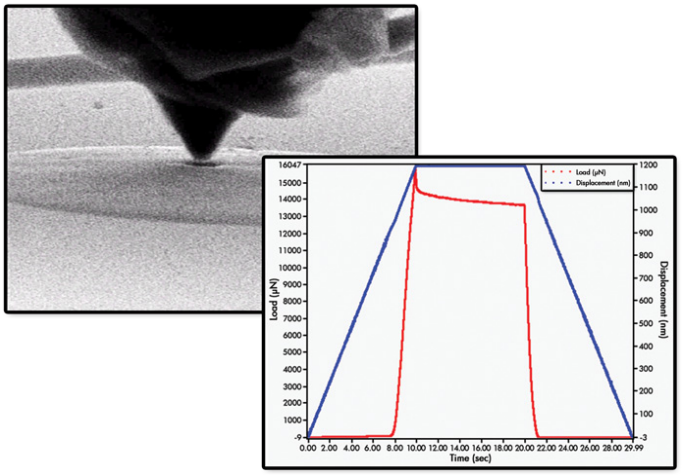
This system is designed for exceptional performance in the electron microscope, with a vacuum-compatible transducer and an electrically conductive probe. With Hysitron's capacitive transducer, force is applied electrostatically and displacement is measured capacitively. This low-current design provides low thermal drift and industry-leading stability and sensitivity.

The **PI 85** system is ideal for characterizing fracture onset and crack propagation, delamination, and pile-up. Also, time-sensitive phenomena such as viscoelastic behavior can be observed in real time. The pairing of these two high-resolution techniques provides unique insight into the mechanisms responsible for materials behavior.

Designed for Performance

With the compact design of Hysitron's capacitive transducer, the **PI 85** can be mounted directly onto the SEM stage without being a permanent fixture in the microscope. The compact platform of the instrument allows for maximum stage tilt and minimum working distance for imaging during testing. The system is designed to accommodate samples up to 10 mm thick, with XYZ translation stages to provide precise sample positioning with >3 mm range in three dimensions.

The **PI 85** instrument is driven by the newly designed ***performech***® DSP-embedded controller, which boasts an ultra-low noise floor and a 78 kHz digital feedback routine. In addition, the mechanical coupling of the sample stage and the transducer provides a stable, rigid platform for nanomechanical testing.



Mechanical data from the PI 85 is fully synchronized with the SEM video, providing a complete understanding of the deformation process.

The **PI 85** software package includes integrated test setup, data analysis, sample positioning, and synchronization of mechanical data with SEM video. Automated routines are also incorporated for the tip/sample approach and for hands-off execution of indent arrays.

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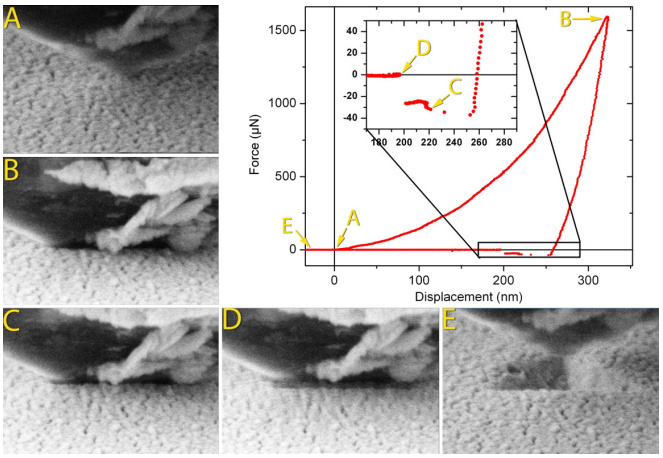
Applications

The **SEM PicoIndenter** is ideally suited for studying nano- and micron-scale materials, and can often reveal unexpected behavior. While the characteristics of a load–displacement curve are often attributed to specific phenomena, there can be more to it than meets the eye.

For example, the series of images below shows the indentation of a thin Au film deposited on a fused quartz substrate. If one were to examine only the load-displacement data, it might be assumed that the negative forces observed during retraction were caused simply by the probe adhering to the sample. However, close inspection of the intermediate images shows a delamination event where the Au film adhered to the diamond probe and momentarily separated from the substrate before snapping back against the quartz.



Consecutive video frames showing the indentation of a Au film on fused quartz, and the corresponding load–displacement curve.
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The mechanical measurements of the **PI 85** instrument can also be coupled with additional SEM capabilities such as **XEDS** and **EBSD**. On dual beam systems, Focused Ion Beam (FIB) milling can also be easily achieved for sample preparation or modification, with subsequent transition into mechanical testing.

Versatility of the PI 85:

The **PI 85** is suitable for a wide range of applications including:

- **Multi-phase materials** – SEM imaging facilitates accurate probe placement
- **Viscoelastic materials** – image the deformation while the material recovers
- **Particles** – when equipped with a flat-punch probe, individual particles can be compressed *in situ*
- **Interfaces** – identify and test across grain boundaries and other interfaces
- **Coatings** – observe when and how failure occurs

Highlights

- Quantitative measurement of nanomechanical properties including hardness, stiffness, and modulus
- Hysitron's patented transducer provides electrostatic actuation and capacitive displacement sensing
- Multiple control modes including closed-loop displacement control, closed-loop load control, and open-loop load control
- Modes of mechanical testing include indentation, compression, bend, and tensile
- Proprietary Q-Control mode actively dampens transducer oscillations (patent pending)
- Transducer controlled using the new ***performech*** DSP-embedded controller operating at a 78 kHz feedback rate
- Interchangeable probes available in a variety of geometries to meet the demands of different test types
- Feedback control to allow testing techniques such as creep and stress relaxation measurements
- Compact platform for maximum stage tilt and minimum working distance
- Extended force transducer also available - contact Hysitron for details

Transducer specifications

Maximum Load: 10 mN*
Load Noise Floor: <400 nN**
Load Resolution: ≤3 nN

Maximum Displacement: 5 μm
Displacement Noise Floor: <1 nm**
Displacement Resolution: ≤ 0.02 nm

**30 mN transducer available upon request.*
***Actual noise floors will depend on the SEM environment.*

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