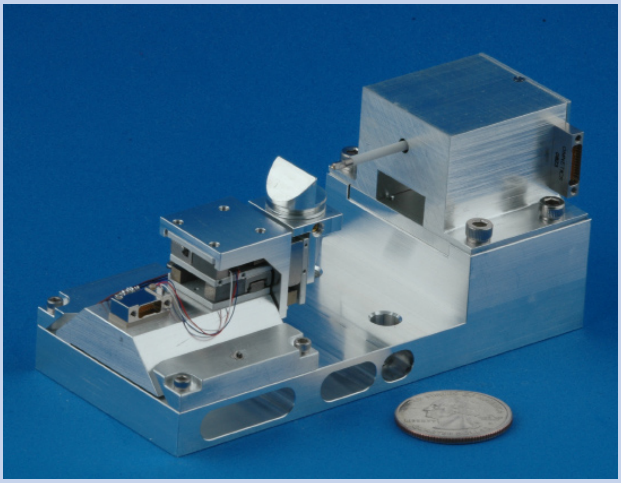
HYSITRON™

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.

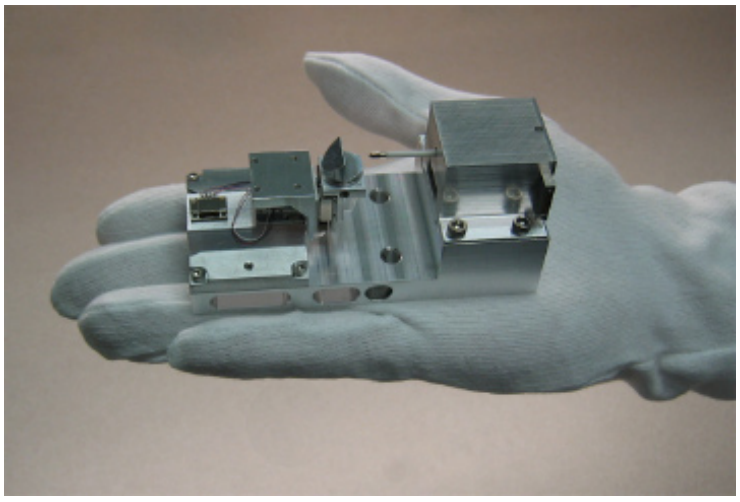
This system is designed for exceptional performance in the electron microscope, with a vacuum-compatible transducer and a conductive boron-doped diamond probe. With Hysitron's 3-plate capacitive transducer, force is applied electrostatically and displacement is measured capacitively. This low-current 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 rather than "*post mortem*." 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 installed through the specimen-exchange chamber of the SEM, without being a permanent fixture in the microscope. The compact platform of the instrument allows for maximum stage tilt for imaging during testing. The system is designed to accommodate samples up to 10 mm thick, with XYZ stages to provide precise sample positioning 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 an enhanced digital feedback routine. In addition, the mechanical coupling of the sample stage and the transducer provides a stable, rigid platform for nanomechanical testing.



The compact design of the **PI 85** can be interfaced easily with commercial SEMs.

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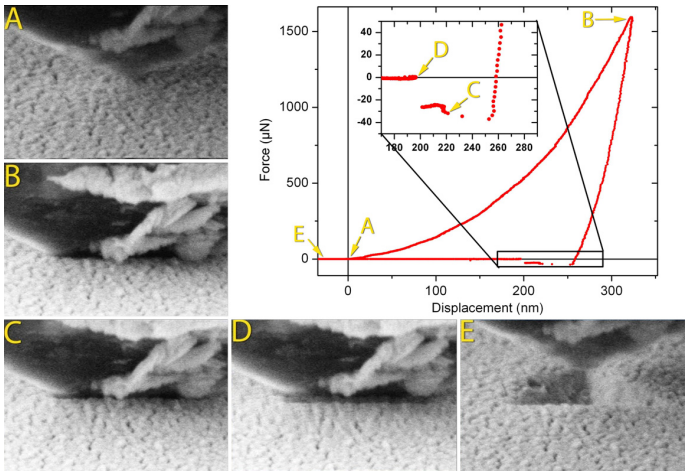
Applications

The **SEM PicoIndenter** is well 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. Consider, for example, the behavior of a thin Au film deposited on fused quartz.

The series of images below shows the indentation of the film as well as the corresponding load–displacement curve. If one were to examine only the curve and the before (A) and after (E) images, 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 that the Au film adhered to the diamond probe and pulled away from the substrate, then snapped back against the quartz.



Consecutive video frames showing the indentation of a Au film on fused quartz, and the corresponding load–displacement curve.
J. Mater. Res., vol 23, no 7, 2008

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 providing electrostatic actuation and capacitive displacement sensing
- Multiple control modes including closed-loop displacement control, closed-loop load control, and open-loop load control
- Proprietary Q-Control mode actively dampens transducer oscillations (patent pending)
- Transducer controlled using the new *performech*™ DSP-embedded controller operating at a high loop rate
- Interchangeable diamond probes available in a variety of geometries to meet the demands of different test types, doped for conductivity in the SEM
- Feedback control to allow testing techniques such as creep and stress relaxation measurements
- Compact platform for maximum stage tilt

Transducer specifications*

- **Load**
  Resolution: ≤ 3 nN
  Noise Floor: < 400 nN
- **Displacement**
  Resolution: ≤ 0.02 nm
  Noise Floor: < 1 nm

**Typical values. Actual transducer specifications will depend on the SEM environment.*

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