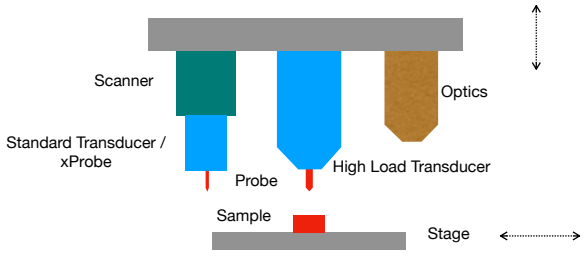
Bruker/Hysitron TI 950 TriboIndenter

- A Nanomechanical Test Instrument in (MC)2

The TI 950 TriboIndenter is a highly automated nanomechanical test instrument equipped with numerous nanomechanical characterization techniques, such as indentation, compression, nano-scratching, in-situ electrical measurement, in-situ heating, dynamic testing, scanning probe imaging. Its dual head capability provides force range from 30nN to 10N. Modulus, hardness, stiffness, and other nanomechanical properties can be measured from various type of samples: metals, ceramic, thin film, dental materials, polymers, in air or in liquid. High sensitivity MEMS based transducer is available for quantitative nanomechanical characterization of very thin films or soft materials at high spacial resolution and nanonewton level contact force.

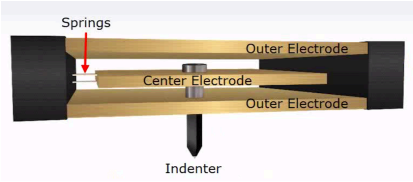
Indenter Setup



- High load transducer is installed on slot 1.
- A standard transducer (DMA, 2D, ECR) or a MEMS based xProbe transducer is attached to the bottom of the scanner on slot 2.
- The scanner is used for *in-situ* SPM imaging by raster scanning the indenter probe on a sample surface.
- The optics provides sample observation and coarse test positioning.
- A motor will drive all the attached transducers and optics up and down along Z direction.
- Sample is mounted on a X-Y stage that will transfer the sample back and forth between optics and probes.

Transducers

- **High load** transducer, also called MultiRange NanoProbe(MRNP), has maximum load/displacement 12N / 97um.
- Standard transducers (2D, DMA, ECR) have a three plate capacitive force/ displacement design with normal load/displacement < 10mN/5um.



- In addition to vertical load, **2D** has additional transducers to apply lateral force for nanoScratch test with lateral load/displacement < 2mN/15um.
- **DMA** utilizes sinusoidal loading concurrent with standard indentation loading to measure complex moduli including both storage and loss modulus. With nanoDMA and *in-situ* imaging, modulus mapping is possible.
- **ECR** provides *in-situ* electrical and mechanical measurement utilizing conductive probe and a special conductive stage. Micro-volt and pico-amp measurement is achievable. The input voltage range is ±10 VDC.
- **xProbe** is MEMS-based transducer with a very sharp integrated probe that is good for low force (<1mN), high strain rate (as fast as 500nm/8ms) and high resolution (2nN, 0.006nm) mechanical measurement and imaging of thin films and some nano scale structures.

Probes

- Berkovich, cube corner, cono-spherical, flat ended conical probes are available for different applications needs.

Stages

- The x-y move has a resolution control of 500nm.
- There are two sample holding plates: one for single transducer, and one for dual heads. A sample already on a standard SEM sample holder can be mounted on the dual head stage directly.
- A xSol temperature control stage with maximum 600 ˚C is available.

In-situ SPM Imaging

- The scanner will drive the probe attached to the standard transducer to scan over the sample surface to obtain a topography image.
- SPM imaging provides 10nm resolution for probe positioning.
- Automated testing could be set up through SPM imaging.

Sample

- Usually sample with flat and smooth surface is ideal for nano mechanical measurement.
- The sample should be secured rigidly on the stage. Usually superglue is used to bond the sample on a round AFM sample disk and let it set for at least four hours. Then put the sample on top of the stage that has a few embedded magnets in it to hold the sample tight.
- For thin film sample, the maximum indentation depth should be limited to approximately 10% of the film thickness to reduce the influence from the substrate.
- A sample in liquid in a glass bottom dish could also be tested. A fluid cell Berkovich probe should be used in this case.
- Testing soft sample can be difficult. Soft samples (hardness < 500MPa) should always be tested from SPM imaging mode and a larger probe diameter should be considered.
- ISO 14577 is an international standard that governs instrumented indentation.

Software and Data Analysis

- TriboScan 9 is used to set up load function and run all the nano mechanical tests.
- Hysitron TriboView is used to review and process SPM image.

References:

- W.C. Oliver and G.M. Pharr, An improved technique for determining hardness and elastic modulus using load and displacement sensing indentation experiments, *J. Mater. Res.*, Vol.7, No.6, (1992) 1564.
- W.C. Oliver and G.M. Pharr, Measurement of hardness and elastic modulus by instrumented indentation: Advances in understanding and refinements to methodology, *J. Mater. Res.*, Vol.19, No.1, (2004) 3.