MTS makes it possible to characterize mechanical properties (such as modulus of elasticity, loss modulus, and fracture behavior) in the nanometer range using both quasi-static and dynamic methods.

NANO CSM continuous stiffness measurement

dynamic characterization of surfaces, interfaces, and thin films

EXTENSIONS

NANO INSTRUMENTS

MTS

NANO **CSM** continuous stiffness measurement

FEATURES AND BENEFITS

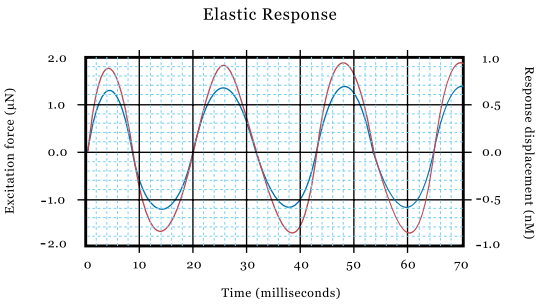
- Quantitative mechanical properties data may be obtained at multiple depths from a single indentation test. Obtaining the same data would require tens or even hundreds of tests using the conventional method.
- Since the contact stiffness is determined directly, no assumptions (such as "mechanical equilibrium") are required to correct for elasticity. As a result, property measurements are inherently more accurate using **CSM**.
- The point of initial surface contact may be accurately determined during the test.
- Indentation tests using **CSM** may be controlled with a constant strain rate, a critical test parameter for material systems such as polymer films and film/substrate systems, pure metals, or low-meltingpoint alloys. This level of control is impossible with the conventional method.
- By measuring both the amplitude and phase relationships between the load and displacement oscillations, it is possible to determine the loss modulus for viscoelastic materials.

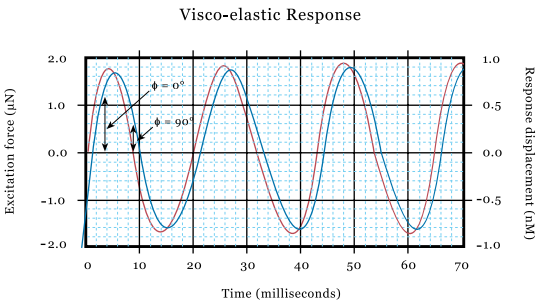
Until recently, acquiring mechanical data in the nanometer range has posed a technical challenge. But, nanoindentation systems from **MTS** now make it possible to characterize mechanical properties (such as modulus of elasticity, loss modulus, and fracture behavior) in the nanometer range using both quasi-static and dynamic methods.

The accuracy and reliability of mechanical properties depend on more than the accuracy of the tip geometry and the force and displacement measurements. To accurately calculate the contact area and mechanical property values, the stiffness of the contact between the indenter tip and the sample material must also be accurately determined.

QUASI-STATIC AND DYNAMIC METHODS

MTS NANO **Indenter** systems support both quasi-static and dynamic depth-sensing indentation methods. In quasi-static indentation testing the stiffness of contact is determined by analyzing the force vs. displacement curve during unloading. This conventional depth-sensing method provides a single measurement for the given indentation depth.





While the quasi-static method is suitable for many applications, an enhanced method is needed for applications that must take into account dynamic effects, such as strain rate and frequency. To address these needs, **MTS** provides dynamic nanoindentation methods, through the patented Continuous Stiffness Measurement (**CSM**) technique.

With the **CSM** extension, the NANO **Indenter** system applies a load to the indenter tip to force the tip into the surface while simultaneously superimposing an oscillating force with a force amplitude generally several orders of magnitude smaller than the nominal load. The CSM instrument extension offers a means of then separating the in-phase and out-of-phase components of the load-displacement history, providing an accurate measurement of the contact stiffness at all depths. Material properties are determined continuously as the indenter moves into the surface, eliminating the need for unloading cycles.

The state-of-the-art **CSM** instrument extension provides the only means available to fully characterize dynamic properties in the nanometer range for virtually any material of interest.

MTS NANO **Indenter** systems are carefully designed to account for the dynamics of indentation testing. Each system is individually calibrated and characterized over its full dynamic range of operation to assure maximum accuracy and reliability.

To learn more about NANO **Indenter** systems contact an **MTS** sales engineer or view our website at www.**mtsnano**.com.

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