

**APPLICATION NOTE**

PUBLICATION

04/26\_04

DATE

000203\_APP

NUMBER

**DATA ACQUISITION & CONTROL**

APPLICATION

j. hay

AUTHOR

**INTRODUCTION**

**TestWorks®**, the software platform for all NANO **Indenter** systems, offers real-time experimental control that is unparalleled in the industry. This application note briefly explains how the **TestWorks** platform facilitates such control and addresses various implications for the user.

**DATA ACQUISITION VS. CONTROL**

While data acquisition rates govern the number of data points collected per second, the most important factor of consideration in instrument selection is the available level of control. Powerful experimental utilities are achieved via the level of control afforded to the user. Constant strain rate experiments, creep experiments, and constant rate of displacement experiments are made possible on our NANO **Indenter** systems by the combined capabilities of the NANO **Swift™** Controller and the **TestWorks** platform. With 500 Hz of fully-functional control, the user can manipulate experimental progress using real-time inputs (figure 1) or utilize PID feedback control to easily design even the most novel experiments.

**POWER THROUGH TESTWORKS METHODS**

A **TestWorks** method is a software file that contains a recipe for performing a test, analyzing the data, and generating an easy-to-read printed report. Through the method, **TestWorks** allows the user to interpret and use each recorded or calculated data point for real-time experimental control. For example, a **TestWorks** method may contain instructions to:

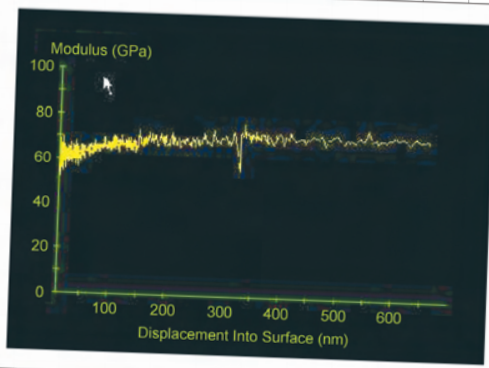


figure 1: **TestWorks** allows the real-time use of any basic or calculated channel.

**TWO LEVELS OF TESTWORKS**

The Professional version of **TestWorks** allows the user access to a wide variety of pre-written **TestWorks** methods. Our flagship instrument, the NANO **Indenter xp**, currently comes with up to 20 pre-written methods, each one designed to perform a specific type of test. Currently available methods for the NANO **Indenter xp** are listed on the reverse of this page. We continuously add to this list, so be sure to contact us for updates and ideas for new methods.

The EXPLORER version of **TestWorks** allows you to write your own **TestWorks** methods using exactly the same software tools used by the engineers at **MTS** NANO Instruments.

- Control the force application such that the loading rate divided by the load on the surface remains constant; i.e. when the absolute load is small, the loading rate is small and vice versa.
- Control the force application such that the indenter penetrates the sample at a constant displacement rate.
- In an indentation creep test, control the force application such

- that the hardness remains constant, and terminate the experiment when the indentation strain rate falls below a threshold value.
- Apply a sinusoidal force with a given frequency and amplitude to a micro beam, and terminate the test when the calculated stiffness falls below a threshold value that is indicative of beam failure.

With this smattering of examples, it is easy to see that the variety of tests that can be designed within the **TestWorks** environment is limited only by the imagination!

**I NEED NEW METHODS, BUT I DO NOT HAVE THE TIME TO DEVELOP MY OWN METHODS**

For a very reasonable fee, our engineers are able and willing to do the development for you! Custom development of a new method usually takes 1-2 weeks.

RELATED PRODUCTS:



table 1:

**TestWorks** methods for the NANO **Indenter XP** as of 01/20/03. Each method comes with a 1-2 page description of what the method does and how to use it. (Note: some methods are only appropriate for particular hardware options.)



**TESTWORKS:  
THE MOST POWERFUL;  
EASY-TO-USE  
NANOMECHANICAL  
TESTING SOFTWARE  
AVAILABLE.**

| Method Name                                                     | Function and Features:                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 <b>XP CSM Standard Hardness, Modulus, and Tip Cal</b>         | Uses our patented Continuous Stiffness Measurement ( <b>CSM</b> ) option to return hardness (H) and elastic modulus (E) as a continuous function of penetration into the test surface. Loads using a constant strain rate. User specifies dynamic frequency, amplitude, strain rate, and maximum penetration depth. This is our most popular method. |
| 2 <b>XP CSM Easy Hardness, Modulus, and Tip Cal</b>             | Similar to (1) with fewer user inputs. Good for first-time users.                                                                                                                                                                                                                                                                                    |
| 3 <b>XP CSM Hardness, Modulus for Thin Films</b>                | Similar to (1) with default inputs optimized for testing thin films; especially good for testing dielectric materials on Si wafers.                                                                                                                                                                                                                  |
| 4 <b>XP CSM H and E using Const Disp Rate</b>                   | Similar to (1) but loading occurs at a constant displacement rate.                                                                                                                                                                                                                                                                                   |
| 5 <b>XP CSM NP Auto Indent and Scan</b>                         | With nanopositioning accuracy, method automatically indents, scans the impression, then repeats for the next test. No user interaction required from test to test. Indentation is performed using the same algorithm as for (1).                                                                                                                     |
| 6 <b>XP CSM NP Interactive Scan</b>                             | With nanopositioning accuracy, allows interactive 3D surface imaging scans. Used to tune scan settings before using (5).                                                                                                                                                                                                                             |
| 7 <b>XP CSM NP Interactive Indent</b>                           | With nanopositioning accuracy, method performs an indentation using the same algorithm as for (1).                                                                                                                                                                                                                                                   |
| 8 <b>XP 3D Profilometry</b>                                     | Similar to (6) but allows imaging of much larger areas.                                                                                                                                                                                                                                                                                              |
| 9 <b>XP Basic Tip Cal</b>                                       | Returns H and E vs. penetration depth using a series of test in which peak force is reduced at each new test site. Constant loading rate force application. User sets loading time, max loads, and hold times. (Originally for tip calibration; use has broadened.)                                                                                  |
| 10 <b>XP Basic Hardness, Modulus, Tip Cal, Load Control</b>     | Returns H and E vs. penetration depth using multiple load/unload cycles at each test site. Constant loading rate force application. User sets load time, max load, and number of cycles.                                                                                                                                                             |
| 11 <b>XP Basic Creep</b>                                        | Returns the stress exponent for creep using a long hold segment.                                                                                                                                                                                                                                                                                     |
| 12 <b>XP Basic H and E at a Series of Displacements</b>         | Similar to (10) but unloads occur at evenly-spaced displacements.                                                                                                                                                                                                                                                                                    |
| 13 <b>XP Edge Deformation Test Step Load</b>                    | Applies a pre-load, full load, then returns to pre-load (post-load). Returns the difference in penetration between pre- and post-load. Popular for testing razor-blade edges. User sets all load targets.                                                                                                                                            |
| 14 <b>XP High Load Basic Hardness, Modulus, Load Control</b>    | Similar to (10) but uses high-load option for max load up to 1kg.                                                                                                                                                                                                                                                                                    |
| 15 <b>XP High Load CSM Hardness, Modulus</b>                    | Similar to (1) but uses high-load option for max load up to 1 kg.                                                                                                                                                                                                                                                                                    |
| 16 <b>Standard Scratch with Cross Profile</b>                   | Performs a controlled scratch with pre- and post-test profiling.                                                                                                                                                                                                                                                                                     |
| 17 <b>Standard Scratch with Cross Profile and Lateral Force</b> | Like (16) but LFM option gives lateral force during scratch.                                                                                                                                                                                                                                                                                         |
| 18 <b>XP ISO 14577 Berkovich or Vickers</b>                     | Test and analysis according to ISO 14577 – Part 1                                                                                                                                                                                                                                                                                                    |
| 19 <b>XP Basic Beam Deflection</b>                              | Cyclically deflects a micro beam to a series of displacements                                                                                                                                                                                                                                                                                        |
| 20 <b>XP Feature Shear</b>                                      | Used to determine the lateral force required to break a MEMS feature.                                                                                                                                                                                                                                                                                |



MTS Nano Instruments  
+1 800-844-6266  
www.mtsnano.com  
nano@mts.com

## Inspired science.

Characterizing surfaces down to the level of a few nanometers has become increasingly important for a wide range of manufacturers and researchers. Properties at the nano scale can affect the performance of a variety of scientific and consumer products. NANO **Indenter** systems from MTS NANO INSTRUMENTS use the most advanced technology available to acquire fast, accurate mechanical data on a variety of surfaces at the submicron scale.