Agilent Dynamic Contact Module (DCM) Option

Data Sheet

Agilent DCM option.

Features and Benefits

- Fully dynamic indentation head for ultra-low-load mechanical properties characterization
- Powerful option enables researchers to study the first few nanometers of an indentation into the surface of a material as well as the pre-contact mechanics
- Lowest noise floor of any instrument of its type ensures best indenter resolution available
- Seamless compatibility with Agilent Nano Indenters

Applications

- Semiconductor, thin films, MEMs (wafer applications)
- Hard coatings, DLC films
- Composite materials, fibers, polymers
- Metals, ceramics
- Biomaterials, biology

Overview

The Agilent Dynamic Contact Module (DCM) option extends the range of load-displacement experimentation down to the surface contact level. With this option, Agilent Nano Indenter users can study not only the first few nanometers of an indentation into the surface of a material, but even the pre-contact mechanics.

Physical Properties

To be precise and widely applicable, nanoindentation testing must be dynamic. Static and quasi-static approaches limit the types of samples and mechanical properties that can be determined. The DCM option is a fully dynamic indentation head for ultra-low-load (10mN max load) mechanical properties characterization. When applying the Agilent Continuous Stiffness Measurement (CSM) technique, the DCM delivers the full benefits of dynamic nanoindentation testing.

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Displacement Resolution

At this scale, the noise level of the indentation system also must be optimized to enhance its actual displacement measurement capability. Using standard methods, the displacement resolution of the DCM is determined to be 0.0002 nm (0.2 picometers). The sensor has a motion of 15 µm. More importantly, real-world testing shows that the noise levels are typically less than an angstrom, ensuring the best resolution of any indenter on the market today. The DCM has the lowest noise floor of any instrument of its type.

Indenter Column Mass

With an indenter column weighing in at a mere 100 milligrams, the system is sensitive to surface forces and dynamics, since it carries very little inertia of its own. The combination of low mass and high resonant frequency has a direct beneficial effect on performance — the DCM is very sensitive to the surface of the sample under test. As a result, surface contact determination, one of the most important factors in ultra-low-load indentation testing, is extremely accurate and reproducible.

High Resonant Frequency

Because the DCM's nominal resonant frequency of 180 Hz is well above normal floor-vibration and other environmental frequencies, the DCM gives clean, reliable data in virtually any laboratory environment.

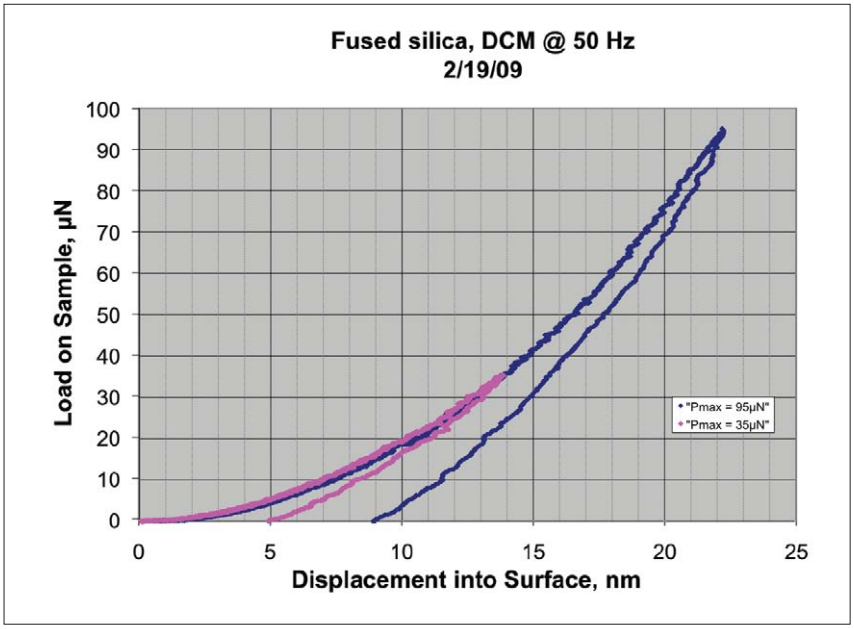

Figure 1. This plot shows two force-displacement curves for two different tests on fused silica.

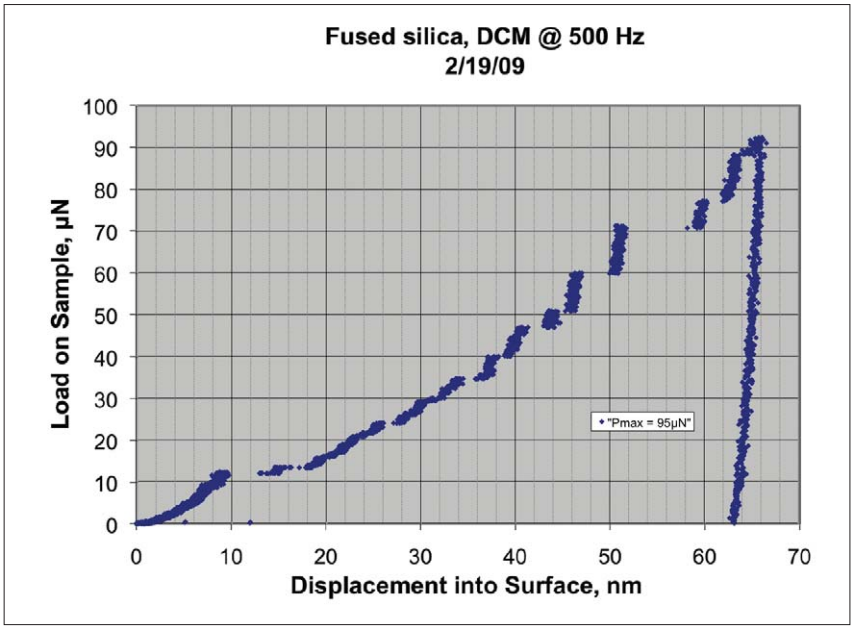

Figure 2. High-resolution measurements at 500 Hz reveal discrete "pop-in" events in single-crystal aluminum. Initially, the aluminum responds elastically, but at 12 µN, the first event occurs, revealing plasticity due to dislocation motion. Subsequent deformation is accommodated by alternating periods of elastic strain then plastic strain by dislocation motion.

Flexibility

The DCM is an indentation head that can be flexibly configured as an addition to new or existing Agilent Nano Indenters. The DCM's flexible mounting bracket provides multiple mounting options so that the DCM can be configured to specific applications.

Nano Indenters

The culmination of decades of research and development, Agilent Nano Indenters are the world's most accurate, flexible, and user-friendly instruments for nanoscale mechanical testing. Electromagnetic actuation allows Nano Indenters to achieve unparalleled dynamic range in force and displacement. These advanced instruments not only enable users to measure Young's modulus and hardness in compliance with ISO 14577 and ASTM 2546 standards but also enable measurement of deformation over six orders of magnitude (from nanometers to millimeters).

Agilent Nano Indenters are capable of characterizing even the most compliant materials. Nano Indenters 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 ensure maximum accuracy and reliability.

Every Nano Indenter is backed by highly responsive Agilent Technologies customer service personnel. Knowledgeable and experienced regional applications engineers are available to guide users through more advanced testing, provide outstanding technical support, and offer unmatched applications expertise.

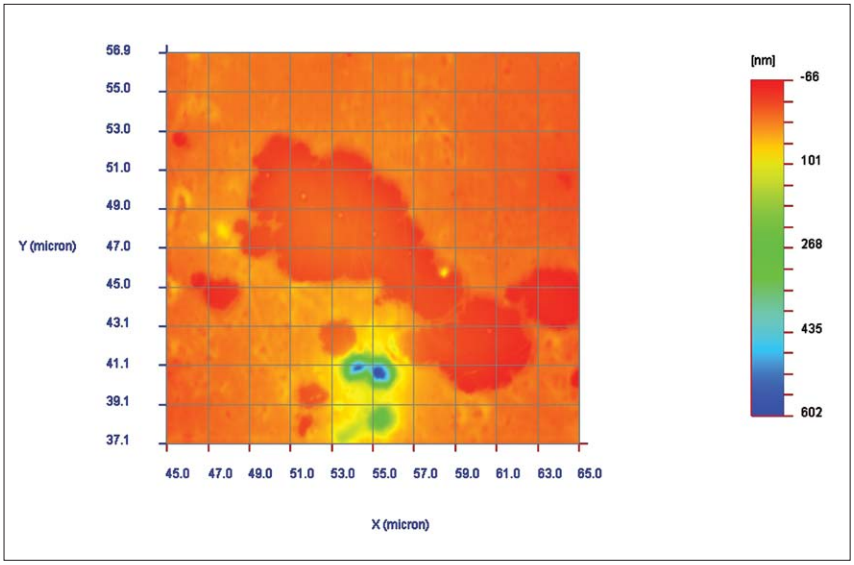

Figure 3. A polished nickel particle (orange-red), embedded in epoxy (orange), tested on the NanoIndenter G200. The small yellow dots in a line traversing the length of the particle are residual indentation impressions of less than 75 nm deep. (Note: the sixth dot is larger than the others, because it landed in the epoxy, which is softer than the nickel.) Indentation and topology measurements were accomplished using a DCM head and Nanovision software options, enabling atomic-scale testing with nanometer-scale spatial resolution. (Image size: 256 x 256 µm.)

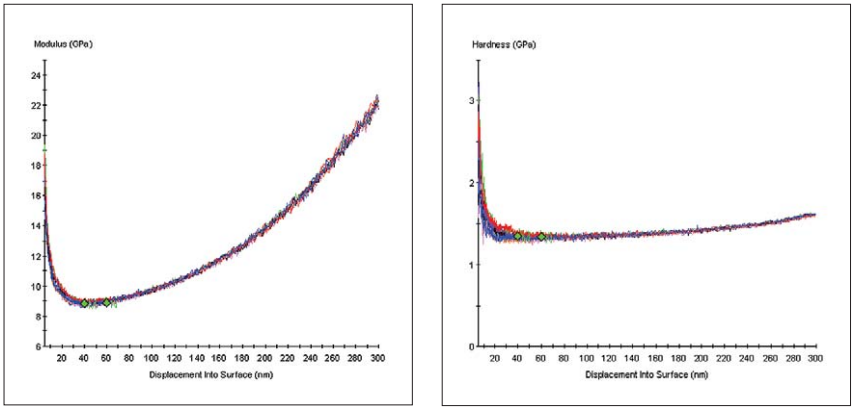

Figure 4. In order to accurately characterize thin films and coatings it is best to evaluate the materials at or near 10% of the film thickness. In some cases this means that the desired testing depth is on the order <50 nm! The DCM head with its high frequency response enables the indenter to respond to material changes instantly to give accurate and repeatable data.

Nanoindentation instruments from Agilent Technologies conform to ISO 14577 and ASTM 2546 standards, delivering confidence in test accuracy and repeatability. These state-of-the-art solutions ensure reliable, high-precision measurement of nanomechanical properties for research and industry.

Agilent DCM Indentation Head Option Specifications

Displacement resolution	0.0002 nm
Maximum indentation depth	>15 µm
Loading column mass	<100 mg
Load application	Coil / magnet assembly
Displacement measurement	Capacitance gauge
Typical leaf spring stiffness	~100 N/m
Typical damping coefficient	0.02 Ns/m
Typical resonant frequency	180 Hz
Loading capability	
Maximum load	10 mN (1 gm)
Load resolution	1 nN (0.1 µgm)

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