Keysight Technologies

Laser Heated Tip and High Temperature Stage for G200 Nano Indenter

Data Sheet

KEYSIGHT TECHNOLOGIES

Overview

The Nano Indenter G200 from Keysight Technologies, Inc. is the world's most flexible, and user-friendly instrument for nanoscale mechanical testing. Now, to expand the already outstanding application utility of this state-of-the-art nanoindentation instrument, Keysight has developed a new G200 system solution that makes use of a stage and sample heated by a precise high-power diode laser.

Advantages include the ability to measure various nanomechanical properties at precisely controlled temperatures and to test a wide range of samples under highly dynamic temperature conditions. To ensure reliable data, the system minimizes drift associated with heating by using a heated tip and the laser as a heating source. The G200 also gives users the option to purge samples with various gases to avoid contamination and oxidation.

Features and Benefits

- Wide temperature range up to 500°C
- Ultrafast heating and cooling
- Minimizes thermal drift
- Easy, convenient operation
- NanoSuite interface for complete NanoSuite software integration
- Option to purge samples with various gases to avoid contamination and oxidation
- Dynamic measurements enabled by Continuous Stiffness Measurement (CSM) option

Figure 1. The G200 Laser Heater System

Advanced Laser Heating

Conventional heaters not only heat the substrate but the instrument as well, leading to excessive thermal drift. This common yet formidable problem greatly compromises the accuracy of nanoindentation measurements.

Keysight's new laser heater, however, implements the latest available diode laser technology to minimize the heat-generating area in the heater so that it precisely matches the substrate size. The energy is transferred directly to the substrate via a light fiber and optical components included in the sample holder. In addition to its adjustable laser spot size, the G200 uses function-optimized materials that reduce the thermal drift of the system.

The G200 system's substrate holder has been optimized to provide the highest mechanical and temperature stability. To ensure easy and convenient G200 operation, the transparent plate underneath the sample contains a built-in thermocouple. And when the absolute highest accuracy is needed (e.g., for nanoindentation applications involving thick polymer samples), users can mount a thermocouple to the sample surface.

Another new G200 system advantage is the high rate of its heating and cooling processes. Depending on the temperature, the rate can exceed 20 K/sec in either direction. (Note that 100 K/min is typically appropriate for everyday use.) This impressive capability affords scientists and engineers many new and intriguing opportunities for dynamic materials testing.

Laser-Heated Tip

Keysight's laser-heated indenter tip for the G200 prevents disturbance of the substrate temperature during measurement, which is critical for working with materials that have poor thermal conductivity and mechanical properties that are strongly affected by temperature. The tip is heated by a small laser transmitted via a thin light fiber through the hollow shaft of the indenter head. Therefore, the tip and the sample are kept at the same temperature as one another, allowing G200 users to perform highly precise high-temperature CSM as well.

The standard diamond tips are available with superior hardness and low wear. They are ideal for hard coated samples. Sapphire are offered for standard heating experiments. They are chemically inert and can be used in air for most metallic materials.

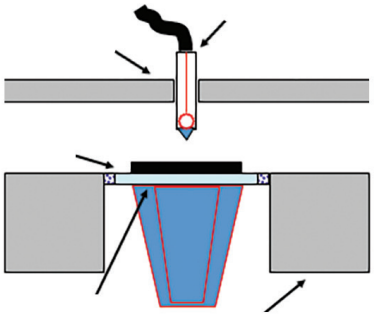


Figure 2. Diagram of the tip heater

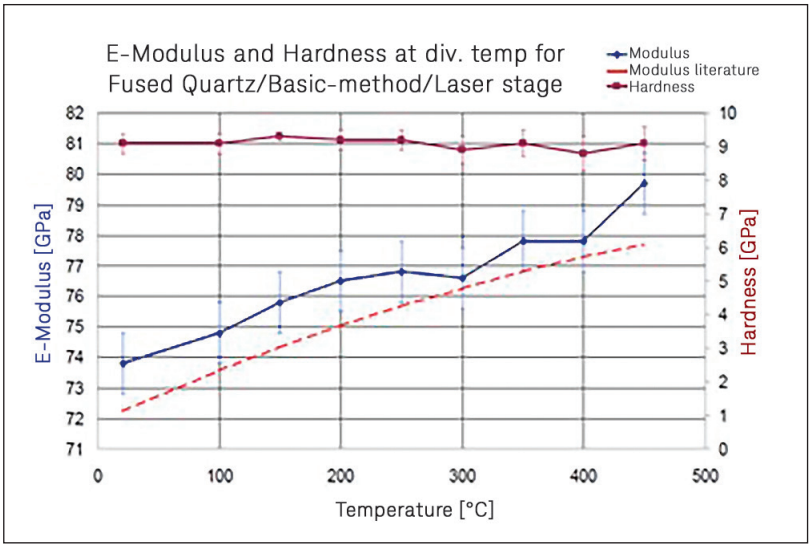


Figure 3. E-Modulus and Hardness at div. temp. for Fused Quartz/Basic-method/Laser stage.

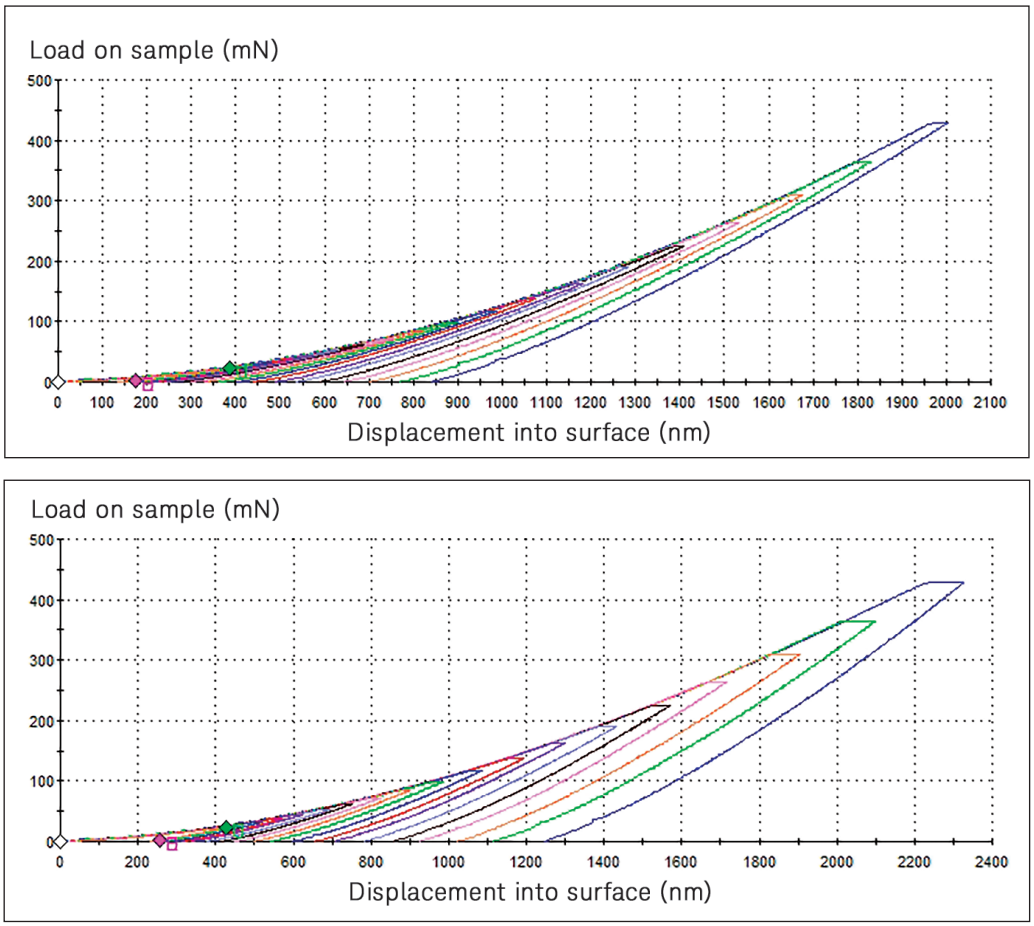
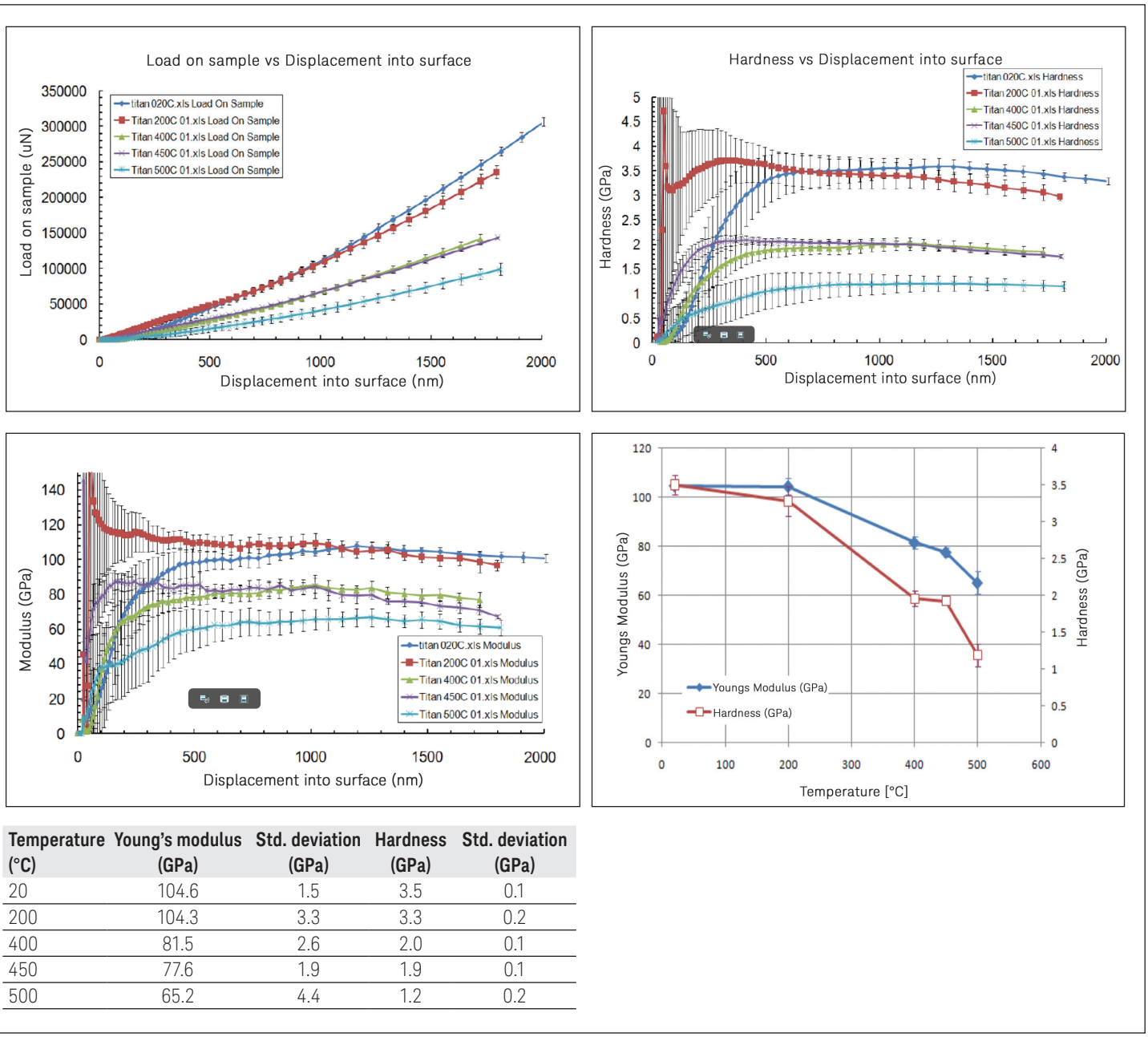


Figure 4. Nanoindentation on fused silica at 27°C (top) 500°C (bottom)



Temperature (°C)	Young's modulus (GPa)	Std. deviation (GPa)	Hardness (GPa)	Std. deviation (GPa)
20	104.6	1.5	3.5	0.1
200	104.3	3.3	3.3	0.2
400	81.5	2.6	2.0	0.1
450	77.6	1.9	1.9	0.1
500	65.2	4.4	1.2	0.2

Figure 5. Examples of Ti at high temperature. Depth dependent measurements with CSM

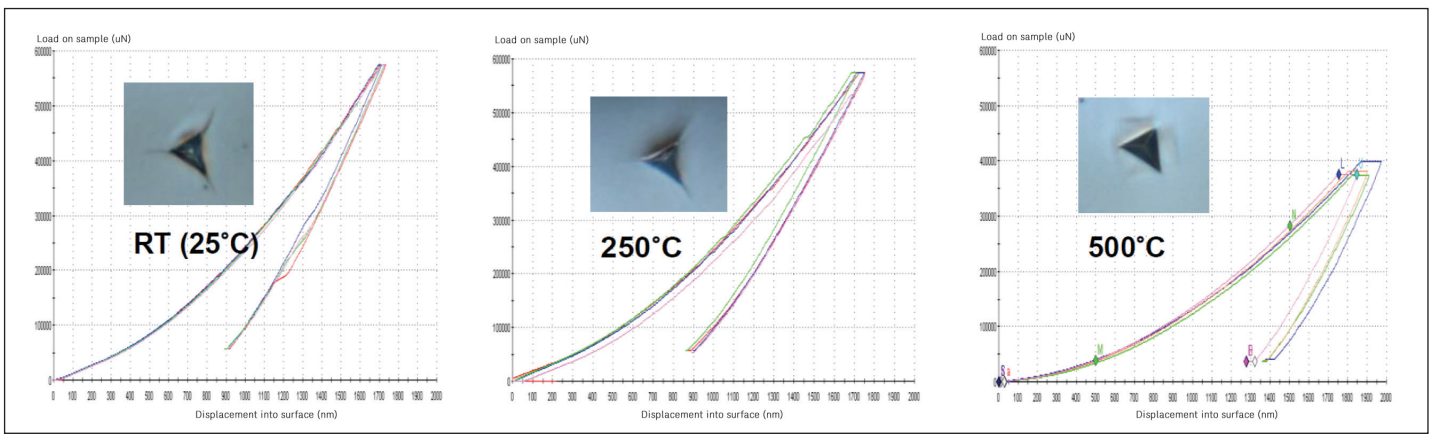


Figure 6. Silicon at high temperature. Brittle to ductile transition from RT to 500°C

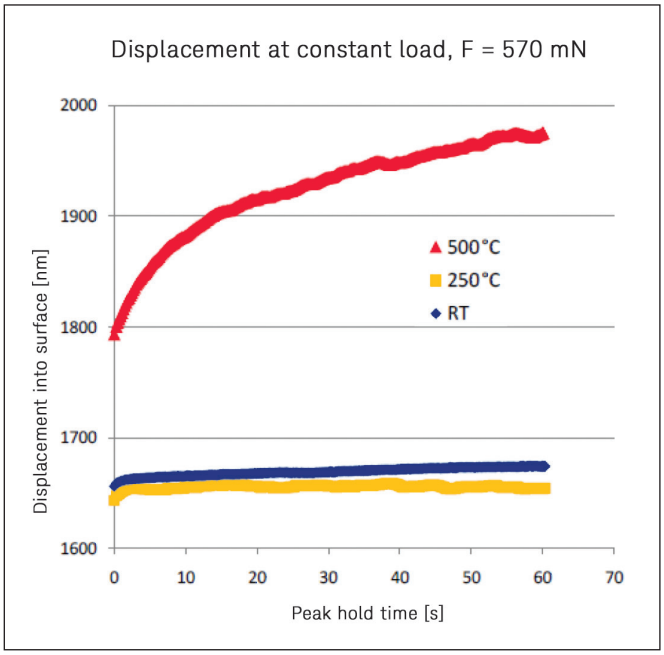


Figure 7. Displacement at constant load, F = 570 mN

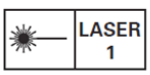
Laser Heater Specifications

Temperature range	RT to 500°C for stage and indenter tip (temperature limit imposed by tip material)
Wavelength	940 nm for 40 W laser diode808 nm for 4 W tip laser diode
Dual-loop PID controller	Designed to fit in G200 rack. NanoSuite software interface
Heating and cooling rates	20 - 25 K/sec achievable for several seconds
Cooling	Circulating bath chiller
Maximum substrate size	12 mm (length) x 12 mm (width) x 3 mm (thickness)
Light fiber (tip heating)	125 µm diameter; 1 m length
Heatable indenter tips	Various geometries for diamond, sapphire and conical cubic boron nitride are available.

Nano Mechanical Systems from Keysight Technologies

Keysight Technologies, the premier measurement company, offers high-precision, modular nanomeasurement solutions for research, industry, and education. Exceptional worldwide support is provided by experienced application scientists and technical service personnel. Keysight's leading-edge R&D laboratories ensure the continued, timely introduction and optimization of innovative, easy-to-use nanomechanical system technologies.

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.



per IEC/EN 60825-1:2014

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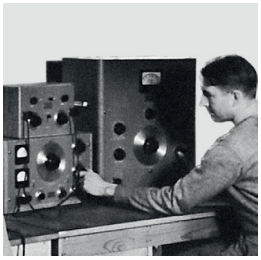

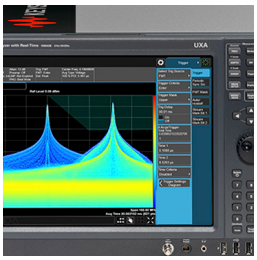

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