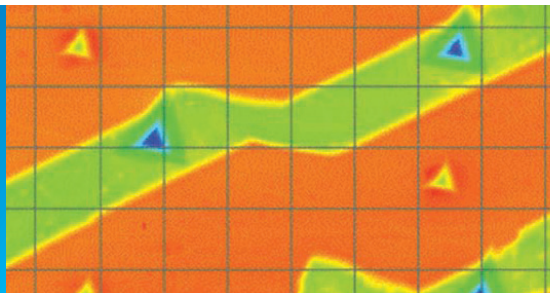
Express Test Option for the Nano Indenter® G200



Express Test Overview

The Express Test option is a novel, fast way to conduct high-precision nanomechanical tests. A recipient of the R&D 100 Award, the Express Test option performs one complete indentation every second, meaning that 100 indentations can be performed at 100 different sites in 100 seconds. The Express Test option is compatible with all Nano Indenter G200 DCM II and XP indentation heads and all stages. Versatile, easy-to-use Express Test methods are ideal for applications involving metals, glasses, ceramics, structural polymers, thin films and low-k materials. One Express Test method for thin film measurements incorporates a thin-film model that automatically accounts for the substrates' influence on the measurement, allowing rapid, accurate measurement of Young's modulus.

Users can run multiple Express Test arrays on multiple samples in one batch, automatically generating histograms and 3D maps of mechanical properties. User-created 2D and 3D graphs can be exported to Microsoft Excel with plotting options intact.

The Express Test option allows the Nano Indenter G200 to be operated in controlled-force or controlled-displacement mode. Testing is simple: just "point" and "shoot." Area-function calibration can be performed in minutes, Young's modulus and hardness can be rapidly evaluated with robust statistics, and quantitative maps of mechanical properties can be generated quickly. Thermal drift is negligible.

Features and Benefits

- High-speed Express Test option compatible with all Nano Indenter G200 DCM II and XP heads and all stages
- Fast testing capabilities (up to 100 indents at 100 different surface sites in as little as 100 seconds)
- True mechanical-properties maps
- Controlled-force or controlled-displacement mode
- Fast area-function calibration
- Rapid evaluation of Young's modulus and hardness with robust statistics
- Automatically generated histograms
- Simple "point-and-shoot" testing
- Negligible thermal drift

Applications

- Metals
- Glasses
- Ceramics
- Structural polymers
- Thin films
- Low-k materials

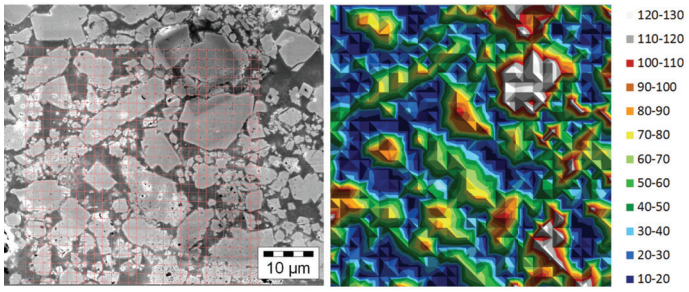


Figure 1. (Left) Surface of a Lithium/polymer battery cathode; grid identifies indentation sites. (Right) Express Test modulus, in GPa. Testing via DCM II and NanoVision (1 indent/s)

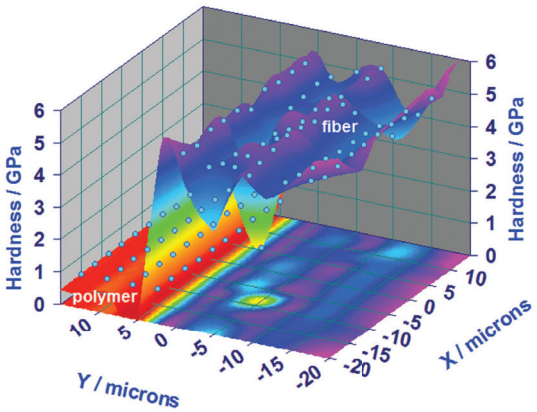


Figure 2. Hardness of fiberglass via Express Test. Purple striations distinguish three individual fibers in the bundle. Testing done with DCM II head and NanoVision (1 indent/sec)

Nano Indenter G200 Heads and Stages

Express Test is compatible with all Nano Indenter G200 indentation heads and stages. The Nano Indenter G200 design includes convenient access to the entire sample tray, excellent sample positioning accuracy, easy viewing of the sample position and sample work area, and simple sample height adjustment to speed throughput.

The standard Nano Indenter G200 configuration uses an XP indentation head. To extend the range of load-displacement experimentation to the surface contact level, the system can be equipped with the Dynamic Contact Module II (DCM II) indentation head. The DCM II offers Nano Indenter G200 users loading capability up to 30mN, easy tip exchange for quick removal and installation of application-specific tips, and a full 70µm range of indenter travel. The DCM II also provides the ability to measure deformation over four orders of magnitude — from nanometers to tens of microns. The DCM II option has a low noise floor and testing shows that its noise levels are typically less than an angstrom.

The Nano Indenter G200 can also be configured with either a standard stage or the NanoVision option, which integrates a high-precision closed-loop positioning system and image-analysis software. The NanoVision stage moves the sample quickly and accurately from one position to the next under the indenter with minimal change in elevation. Over its range of motion (100µm x 100µm) the NanoVision stage maintains planarity to within 10nm. Because of the flatness of stage travel, the indenter can hover just over the surface, thus minimizing surface-approach time.

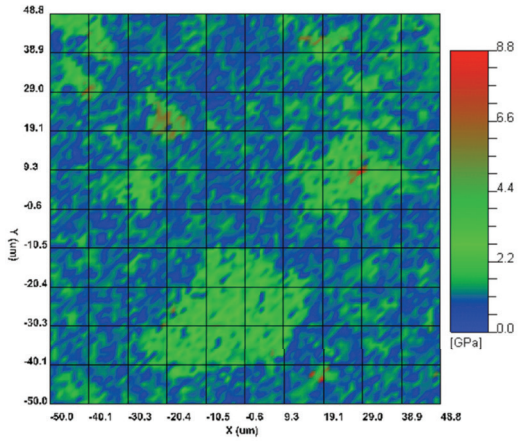


Figure 3. Hardness map of cement paste done with Express Test, using DCM II head and NanoVision (1indent/s)

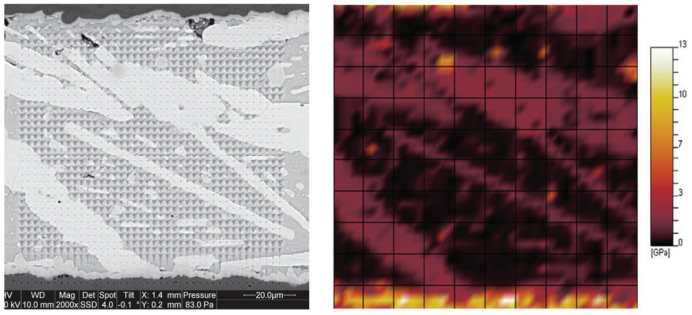


Figure 4. (Left) Aged SAC 305 solder with Au plating, manifesting bulk and boundary intermetallic compounds. (Right) Hardness map via Express Test, using XP head and NanoVision (1 indent/3s)

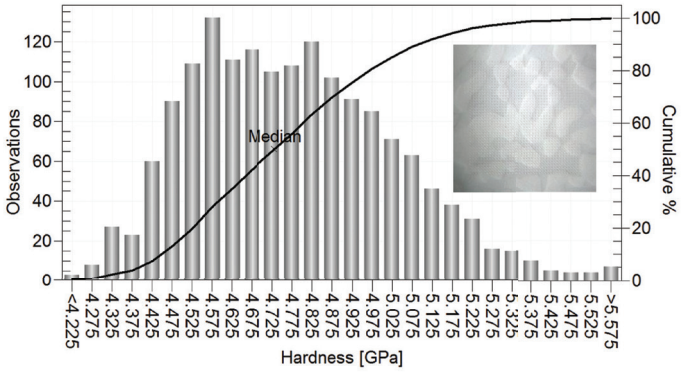


Figure 5. Express Test histogram of 1600 hardness measurements on 2205 duplex steel, tested with DCM II head and NanoVision. Data was captured at one indent per second. Insert shows residual indentation array. Bimodal distribution manifests austenitic (dark) and ferritic (light) grains

Material	Force	No. of Valid Indents (of 100)	Testing Time*	Displacement (1 Std. Dev.)	Hardness (1 Std. Dev.)	Modulus (1 Std. Dev.)	Modulus Reference
	mN		Seconds	nm	GPa	GPa	GPa
Polycarbonate	1	94	322	517 (7.2)	0.223 (0.007)	3.18 (0.07)	2.6
Pyrex	1	97	359	92.5 (0.7)	7.33 (0.18)	62.8 (1.1)	63.3
Fused Silica	1	100	316	84.2 (0.8)	9.54 (0.29)	70.8 (1.3)	72.1
2205 Stainless Steel	4.5	97	342	211.2 (6.7)	4.47 (0.31)	201.5 (9.5)	200
Nickel	5	92	349	175.5 (1.0)	7.57 (0.10)	215.8 (6.5)	200
Silicon <111>	5	95	302	153.4 (0.8)	11.3 (0.17)	185.0 (4.3)	188
Sapphire (C-Axis)	5	96	327	95.4 (0.4)	33.28 (0.54)	454.6 (9.6)	500**

Table 1. Typical results for a 10 x 10 array of indents done with Keysight Express Test with DCM II head and NanoVision.

*** Time elapsed between user-initiation and the completion of the 100th indent. ** C-axis direction. Modulus in orthogonal direction is 400GPa.**

Express Test Specifications

Sample Requirements

+ Surface roughness: <200nm
+ Minimum Young's modulus: 1GPa
+ Maximum Young's modulus: 500GPa

System Configuration

DCM II head, NanoVision stage

+ Maximum array size: 200 x 200indents
+ Maximum test area: 100µm x 100µm
+ Time per indentation, standard: <1.0s

XP head, NanoVision stage

+ Maximum array size: 200 x 200 indents
+ Maximum test area: 100µm x 100µm
+ Time per indentation: <3.0s
+ Indentation depth: >200nm

DCM II head, standard stage*

+ Maximum array size: 200 x 200 indents
+ Maximum test area: 250µm x 250µm
+ Time per indentation: <5.0s

XP head, standard stage*

+ Maximum array size: 200 x 200indents
+ Maximum test area: 500µm x 500µm
+ Time per indentation: <5.0s
+ Indentation depth: >200nm

KLA SUPPORT

Maintaining system productivity is an integral part of KLA's yield optimization solution. Efforts in this area include system maintenance, global supply chain management, cost reduction and obsolescence mitigation, system relocation, performance and productivity enhancements, and certified tool resale.

KLA Corporation
One Technology Drive
Milpitas, CA 95035
www.kla.com

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