Introduction

Until now, quantitative high-resolution nanomechanical characterization of large areas on a material has been a tedious chore, producing less than desirable results. Hysitron has integrated nanoDMA$^\circledR$ testing with in-situ SPM imaging to provide the capability to quantitatively map the nanomechanical properties of a material surface.

Quantitative Imaging

The Modulus Mapping technique employs aspects of nanoDMA and in-situ SPM imaging to realize unprecedented characterization capabilities to oscillate the indenter tip with small forces while monitoring the resultant displacement and phase lag due to material response. This information is utilized to provide the storage and loss characteristics of the material. In-situ SPM imaging allows the indenter tip to be rastered across the material surface and is typically used to produce a topographic image of the material surface. The Modulus Mapping technique employs these techniques simultaneously, allowing a dynamic test to be performed at each point on the image. Each image has a 256 x 256 pixel resolution, which means that 65,536 tests can be acquired in only ten minutes. A single scan of an area provides topographic information, storage and loss stiffness, storage and loss modulus and tan delta maps. This large area characterization technique provides the information necessary to guide the user to areas that may require further investigation using the many techniques of nanoDMA, such as frequency or load sweeps.

High Resolution

The resolution of this mapping system provides far superior results to other nanoindentation mapping techniques. These techniques utilize single indents that require significantly greater time and require that these individual tests be placed well away from other testing locations in order to acquire meaningful data. This limits the resolution of these techniques to hundreds of nanometers. Modulus Mapping takes advantage of the small forces and precise tip control to provide greater than five-nanometer resolution of the mechanical property maps. Modulus Mapping allows more data to be taken with far superior resolution to other mapping techniques in a fraction of the time.
Advanced Software

An easy-to-use Modulus Mapping software package has been developed for data acquisition and analysis. Automated calibration routines ensure that reliable data is obtained every time. The analysis package utilizes the calibration to allow automated calculation of all stiffness and modulus values from the raw data. Image analysis routines allow cross-sectional analysis of the mechanical property maps to observe the change in properties across material interfaces. Coordinates of any position on an image allow precise selection of locations for further testing with a nanoDMA test. The software package has been developed to provide a complete toolbox for mechanical property mapping analysis.

SOFTWARE

- Seamless integration into Hysitron’s exclusive TriboScan software
- Control of dynamic forces ensures elastic contact
- Post-processing software package allows quantitative analysis of mapping results
- Automated calculation of storage/loss stiffness and modulus
- Section profiles reveal quantitative mechanical properties
- Multiple color tables for superior presentation grade images
- Tip-shape calibration for quantitative data

HIGHLIGHTS

- Quantitative maps of storage and loss stiffness and modulus
- High-resolution modulus mapping of material interfaces
- 65,536 nanomechanical tests in less than ten minutes
- Automated calibration of entire system
- Stand-alone software platform
- Image analysis software

APPLICATIONS

- Map mechanical properties across interfaces between multiphase or composite materials
- Identify delaminated or buckled areas of thin films
- Map the viscoelastic properties of a material
- Mechanically map polymer blends
- nanoDMA technique provides superior testing method for further characterization of biomaterials and polymers