



World Leader in Nanomechanical Test Instruments
Hysitron Incorporated



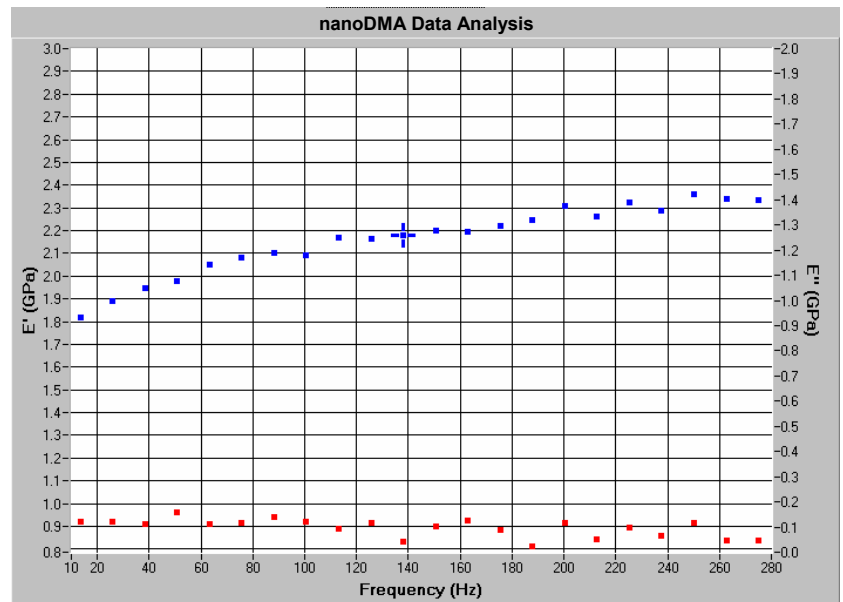
nanoDMA[®]

Nanoscale Dynamic Mechanical Analysis for Viscoelastic Materials

Introduction

Polymers and biomaterials have recently become the subject of vast amounts of research. As this research and development progresses to the nanoscale, macroscale characterization techniques are no longer sufficient for the demanding materials research required for many applications. Nanomechanical characterization techniques have become the standard for gaining understanding of material behavior at the nanoscale and have been utilized for thin film, as well as bulk material analysis. However, the standard analysis techniques assume elastic-plastic material behavior and have many shortcomings for viscoelastic materials.

Viscoelastic materials, such as polymers and biomaterials, exhibit time-dependent properties. An understanding of the viscoelastic properties of these materials is essential to successful realization of the desired mechanical properties. Therefore, quasistatic techniques designed for elastic-plastic materials are not adequate for characterization of viscoelastic materials. Hysitron has developed nanoDMA as a solution to the quandary of obtaining the desired information from polymers at the nanoscale. This testing method provides a nanoscale analog to DMA testing, revolutionizing the ability to characterize the mechanical properties of small volumes of viscoelastic materials.



Frequency sweep measurement of the dynamic properties of a polymer.

Testing Modes

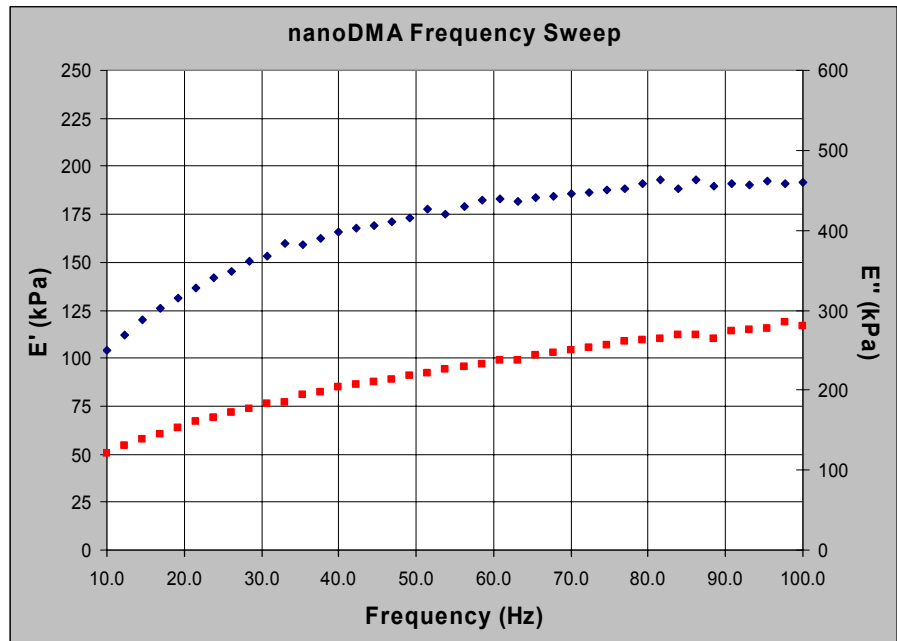
A software package has been developed for nanoDMA that includes a versatile testing function editor. This feature provides the capabilities to perform a plethora of test types. The basic types of tests that are run are shown above. They allow testing as a function of frequency, quasistatic load or dynamic load. Each type of test allows procurement of how the material properties change as a function of the test variable. Frequency tests are extremely useful and are most similar to DMA testing, in which data is obtained concerning the strain-rate dependence of the materials. Testing as a function of load is often used for depth

profiling, as this technique yields material property measurements as a function of load or depth of penetration. Load amplitude tests maintain a constant ratio of AC to DC load and can be utilized to determine the linear viscoelastic region, which is crucial to obtaining meaningful viscoelastic material information.

The versatility of this product provides a range of capabilities that make it ideal for nanomechanical characterization of viscoelastic materials in innumerable applications. The nanoDMA option offers the capability for scientists and engineers to gain previously unattainable quantitative information on the nanoscale.

Software

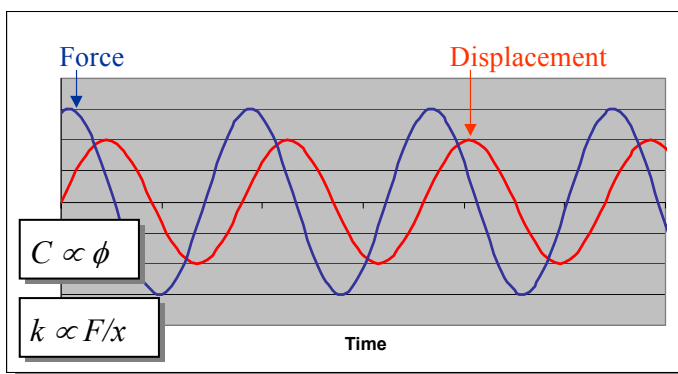
The nanoDMA software has been developed to automate and simplify a test technique and analysis that is potentially very involved and time-consuming. Dynamic test data is actually a convolution of the dynamic mechanical properties of the testing system and the sample. The software automates a calibration process that allows a real-time correction of data for the characteristics of the testing system. The test results are displayed real-time during the testing and are available for post-test processing. The data analysis tools calculate and display stiffness and loss data or storage and loss moduli as a function of load, load amplitude, displacement, frequency or time. With the nanoDMA technique and software, scientists and engineers can quantitatively obtain viscoelastic property measurements at the nanoscale in minutes.



Frequency sweep on a water-based Pressure Sensitive Adhesive material.

Applications

- Biomaterials
- Paints
- Contact lenses
- Low-k dielectrics
- Rubbers
- Elastomers
- MEMS testing
- Fatigue testing



$$E' = \frac{k_s \sqrt{\pi}}{2\sqrt{A_c}} \quad E'' = \frac{\omega C_s \sqrt{\pi}}{2\sqrt{A_c}}$$

Analysis of sinusoidal force/displacement data.



10025 Valley View Road
 Minneapolis MN 55344
 Tel: (1) 952-835-6366
 Fax: (1) 952-835-6166
 info@hysitron.com
 www.hysitron.com