HYSITRON®

BIOPHARMACEUTICAL

NANOMECHANICAL TESTING FOR BIOPHARMACEUTICAL MATERIALS

DRUG/MEDICINAL CRYSTALS • BIOLOGICAL MATERIALS • BIOPOLYMERS & OTHER BIOMATERIALS • BIOMEDICAL DEVICE MATERIALS

Composites
Soft Samples
Drug Coatings
Porous Samples
Crystal Polymorphs
Viscoelastic Materials
Drug Loaded Micro Spheres

BIOPHARMACEUTICAL MATERIALS CHARACTERIZATION

- PERMEABILITY
- FORMULATION
- ABSORPTION
- DELIVERY

NANO-TO-MICRO SCALE MECHANICAL TESTING OF

Young's Modulus (*E*) Measurement (*GPa, MPa, KPa*)
Topography Mapping via *In-Situ* SPM Imaging (*nm, μm*)
Dynamic Modulus & Stiffness (*κ, E′, E″, Tan δ*)
Hardness (*H*) Measurement (*GPa, MPa, KPa*)
Quantitative Adhesion Testing (*N, mN, μN*)
Properties with Respect to Temperature
Testing in Solution

References

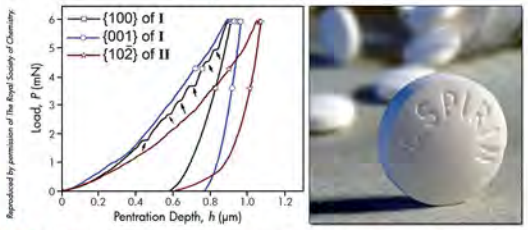
(1) Chem. Sci. 2 (2011) 2236.

(2) Journal of the Mechanical Behavior of Biomedical Materials 7 (2012) 60-68.

BIOPHARMACEUTICAL MATERIALS

DRUG OR MEDICINAL CRYSTALS TESTING

Aspirin Polymorphs[1]



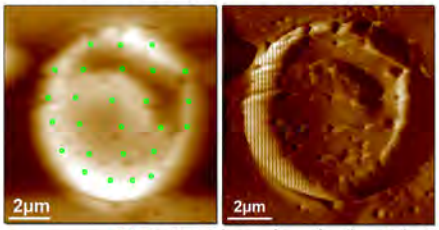
Testing Other Polymorphs

- Synthon
- Ritonavir
- Norfloxaan
- Zantac
- Gleevac
- Paracetamol
- Carbamazepine (CBZ)
- Saccharin
- Etc.

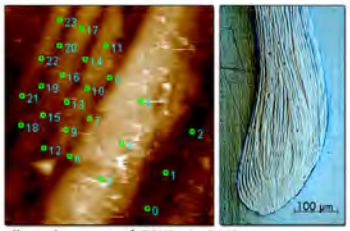
ISSUE: Polymorphic behavior or drug compounds impact product quality and performance. Study preliminary evidence from x-ray crystallography.
NANOINDENTATION ADVANTAGE: No need to grow large crystals.

BIOLOGICAL MATERIALS

Mechanical Properties of Living Cells



Bone



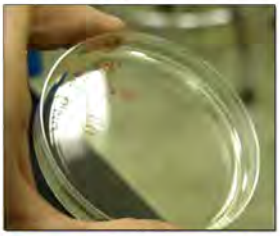
ISSUE: Materials are often soft with modulus (*E*,) generally in the range of 50KPa to 1MPa.
NANOINDENTATION ADVANTAGE: Minute sample volume requirement, ease of sample mounting, testing in realistic conditions, site-specific testing.

BIOMIMETIC MATERIALS

BIOPOLYMERS & OTHER BIOMATERIALS

Testing Viscoelasticity of Agar[2]

Concentration based properties determination of biopolymers, such as agar, that are used in tissue engineering and other applications.

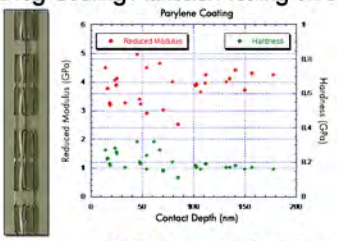


Mechanical Properties of Implants

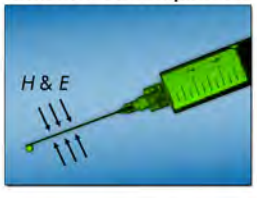
ISSUE: Materials are composites with sub-micron scale phase separations & viscoelastic in nature.
NANOINDENTATION ADVANTAGE: Ability to test dynamic mechanical properties with great spatial resolution & at varying temperatures.

BIOMEDICAL DEVICE MATERIALS

Drug Coating Adhesion Testing on Stents



Syringe Needle Mechanical Properties



Contact Lens Viscoelasticity Testing

[KPa to MPa Resolution + Testing in Fluid]

ISSUE: Conventional techniques are destructive, intricate geometries make sample mounting difficult.
NANOINDENTATION ADVANTAGE: Nano to microscale testing regime, ease of sample mounting.

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OTHER APPLICABLE TOPICS IN STUDY BIOPHARMACEUTICALS

Biopharmaceutical Materials

DRUG OR MEDICINAL CRYSTALS
- Drug Loaded Nanoparticles
- Other Polymorphic Crystals

BIOLOGICAL MATERIALS
- Lipids
- Proteins
- Catilage
- Cancerous Cells
- Non-Cancerous Cells

Biomimetic Materials

BIOPOLYMER & OTHER MATERIALS
- Hydroxyapetite
- Hydrogel
- Polymide
- Cellulose
- Proteins
- Starch

BIOMEDICAL DEVICE MATERIALS
- Cathater
- Pacemaker Materials

HYSITRON PRODUCT DETAILS

Hysitron is the world leader in developing nanomechanical test instruments and continues to design cutting edge technology and testing solutions for the scientific community since 1992.

TI Series TriboIndenter® & Ubi™ - Versatile Stand-Alone Nanomechanical Testing Platform

TI 950 TriboIndenter®
(**Fully Automated Testing**)

TI 750L Ubi™
(**Testing up to 12mN**)

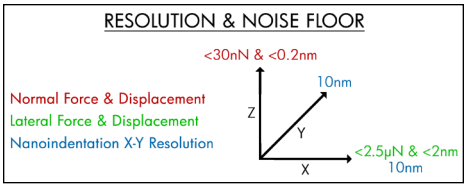
TI 750H Ubi™
(**Testing up to 10N**)

TI 750D Ubi™
(**Dynamic Mechanical Properties**)

Note: TriboScope® is available and a needed option for similar measurements with an AFM. Contact Hysitron for more information.

HIGHLIGHTING FEATURES TO SUPPORT BIOPHARMACEUTICAL RESEARCH

- Biopharmaceutical Nanomechanical Testing Package is a Modular Design to Support a Variety of Testing Options: High & low temperatures.
  - ▶ Advanced Controller: Industry leading and offers superior feedback loop rate.
  - ▶ nanoDMA: Dynamic mechanical analysis at nanoscale.
  - ▶ Fluorescence Microscopy
  - ▶ Adhesion Testing: 500µm stage.



  Patented Transducer Technology: Electrostatic actuation driven force & displacement sensor has low thermal drift and ultra low force & displament noise floor to accurately determinine quantitative mechanical (including coefficient of friction, scratch & wear testing for film failure & performance) properties of biopharmaceutical coatings & materials.

- *In-Situ* SPM Imaging Combined with Piezo Automation: Enables pre and post nanoindentation test morphological characterization with precise testing location selection & automation.

PUBLICATIONS IN BIOPHARMACEUTICAL MATERIAL RESEARCH INVOLVING NANOMECHANICAL CHARACTERIZATION

1. "Evaluation of the Compaction of Sulfathiazole Polymorphs", *Journal of Pharmaceutical Sciences* Vol. 96 No. 8, August (**2007**).
2. "Effect of calcium deficiency on the mechanical properties of hydroxyapatite crystals", *Acta Materialia* 58 (**2010**) 4841-4848.
3. "Mechanical Anisotropy in Crystalline Saccharin: Nanoindentation Studies", *Nanoindentation Studies* Vol. 10 (**2010**).
4. "Generation of wear during the production of drug nanosuspensions by wet media milling", *European Journal of Pharmaceuticals and Biopharmaceuticals.*
5. "Interaction anisotropy and shear instability of aspirin polymorphs established by nanoindentation", Chem. Sci. 2 (**2011**) 2236.
6. "Elastic and viscoelastic characterization of agar", *Journal of the Mechanical Behavior of Biomedical Materials* 7 (**2012**) 60–68.
7. "Nanoscale mechanical and tribological properties of fluorocarbon films grafted onto plasma-treated low-density polyethylene surfaces", *J. Phys. D: Appl. Phys.* 45 (**2012**) 095401 (9pp).

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