



## **Nano Analytical and Testing (NAT) Laboratory Services**

Exponential Business and Technologies Company (Ebatco™) is an international technology service and development company. Ebatco specializes in providing high-quality products and services for worldwide clients in the areas of testing instruments and equipment, advanced materials, and micro/nanotechnology. Ebatco is fully committed to provide you with world-first-class services that will satisfy your business and technology needs.

Ebatco's Nano Analytical and Testing Laboratory (NAT Lab) is established to perform a wide spectrum test and analysis of advanced materials and miniaturized devices, root-cause determination of failed parts, system and part performance verification, industrial and regulatory compliance tests. NAT Lab's expertise spans from material property testing and measurement to failure analysis. We have worked with a majority of material types such as steel, metal, ceramic, glass, polymer, existed in nanostructure, thin film, coating, composite, or bulk format. We are strong and have been recognized in data processing, analysis, interpretation, and correlation. In addition, NAT Lab has ready accesses to numerous advanced techniques and equipment within its own lab and through strategic alliances and partnerships, long-term contracts with many commercial, research, and national labs worldwide.

NAT Lab strives to provide you thorough and satisfactory solutions for your material related challenges in a timely and professional manner, and at market competitive prices.

### **Contract Lab Services**

#### **Nanomechanical and Nanotribological Testing**

- Nanocompression
- Nanofatigue
- Nanohardness
- Nanoimpact
- Nanoimprint
- Nanoindentation
- Nanolithography
- Nanomachining
- Nano pull off force
- Nano pull on force
- Nanoscale Creep Test
- Nanoscale Stress Relaxation Test
- Nanoscratch
- Nanotensile



- Nanotribology
- Nanowear
- Biological Sample Testing
- Correlation between Nanoindentation and Other Analytical Analysis
- Fracture Toughness Determined through Nanoindentation
- Friction under Extremely Low Load
- Mechanical Test on Micro Cantilever and MEMS Beam
- Nanoindentation in Liquid
- Nanoindentation under Environmental Control
- Nanoindentation under High/low Temperature
- Nanomechanical Property Depth Profile
- Nano/micro Feature Testing
- Nano Particle Testing
- Nanoscale Dynamic Mechanical Analysis
- Quantum Dot Testing
- Test and Evaluation of Miniaturized Devices
- Thin Film Interfacial Adhesion Measured using Nanoscratch
- Ultra Thin Film Testing
- Young's Modulus

### Microscale Contact Angle Measurement

- Droplets in Micron Size
- Drop Size Effect
- Dynamic Receding Angle
- Hydrophilicity of Microfluidics
- Hydrophobicity of MEMS Beams
- Interfacial Adhesion
- Liquid Repellence
- Liquid Solid Interfacial Phenomena
- Liquid Vaporization
- Lotus Effect
- Nano/micro Patterned Surfaces
- Oleophobicity and Oleophilicity
- Permeability of Ink to Its Medias
- Self Cleaning Paint
- Stain Resistant Fabrics
- Super Hydrophobicity
- Super Wetting
- Surface Chemistry
- Surface Cleanness
- Surface Contamination
- Surface Free Energy of a Head Slider
- Surface Roughness Influence
- Surface Uniformity
- Surfactant Efficiency
- Wettability of Color Resists to Each Cell of Flat Panel Displays
- Wettability of PCB Traces
- Wettability of Single Fiber, Wire, Catheter, and Small Tube



### **Mechanical Testing**

- Brinell Hardness
- Creep
- Fatigue
- Knoop Hardness
- Microhardness
- Stress Relaxation
- Tensile Testing
- Vickers Hardness

### **Metallurgical Analysis**

- Crystallization and Recrystallization
- Crystallography
- Grain Boundary
- Heat Treatment
- Ion Implantation
- Laser Alloying
- Laser Cladding
- Optical Microscopy
- Phase Diagram
- Phase Transformation
- Sample Grinding, Polishing and Other Preparation
- Surface Hardening
- Thin Film and Coatings

### **Tribological Testing and Analysis**

- Abrasive Wear
- Delamination Wear
- Wear
- Fatigue Wear
- Four-Ball Wear
- Fretting Wear
- Friction Coefficient
- Interfacial Adhesion of Coatings and Thin Films
- Lubrication Film
- Lubricity
- Oxidation Wear
- Pin-on-Disk
- Reciprocating Wear
- Solid Lubrication
- Scratch Resistance
- Tribochemistry



**Technical Consulting Services**

**Micro and Surface Analysis**

- AES (Auger Electron Microscopy)
- AFM (Atomic Force Microscopy)
- EDS (Energy Dispersive Spectrometer)
- Ion sputtering
- Nano Particle Size and Distribution
- Property Depth Profiling
- Property Distribution and Mapping
- Pull on and Pull off Force
- SEM (Scanning Electron Microscopy)
- Surface Adhesion
- Surface Morphology and Topography
- TEM (Transmission Electron Microscopy)
- XPS (X-ray Photon Spectroscopy)
- XRD (X-ray Diffraction)

**Thermal and Chemical Testing and Analysis**

- Corrosion
- Oxidation
- DMA (Dynamic Mechanical Analysis)
- DSC (Differential Scanning Calorimetry)
- TGA (Thermogravimetric Analysis)



### **The Materials Scientist**

Dr. Dehua Yang is the Founder and President of Ebatco. He holds a Ph. D. in Physical Chemistry. He is an internationally well-known nanotechnology expert and an award-winning materials scientist. Prior to founding Ebatco, he was the Vice President of Hysitron, Inc., a world-leading nanomechanical testing instrument designer and manufacturer.

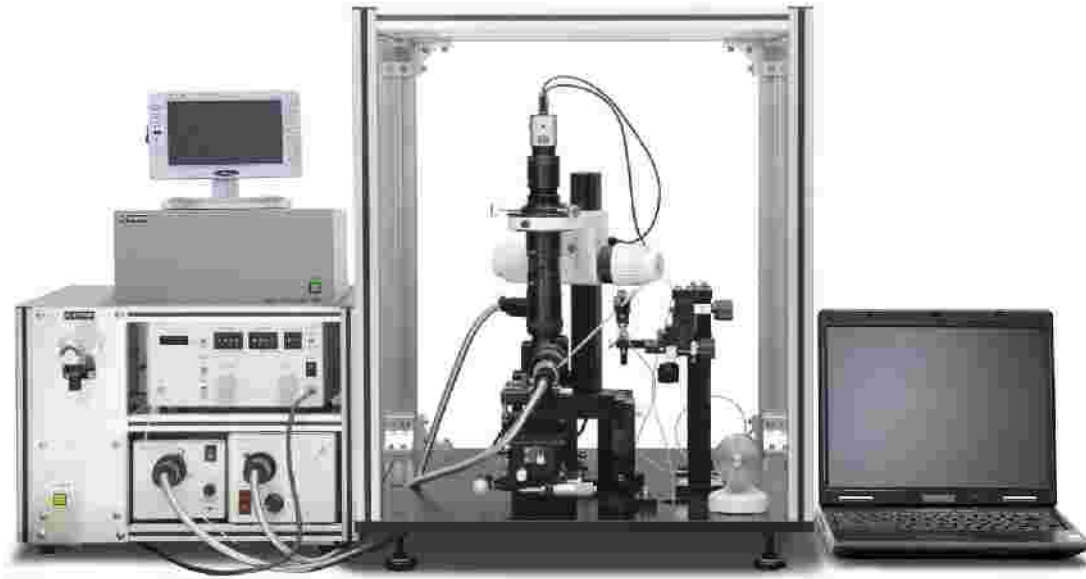
- 2007 Micro/Nano 25 Award
- 2005 Nano 50 Award
- 4 Issued and 2 Pending US Patents
- Over 100 publications and Presentations
- US NSF Grant Proposal Review Panelist
- International Conference Organizer and Session Chair
- MRS, ASME, TMS, STLE Member

### **The State-of-Art Testing and Measurement Instruments**

#### **Automatic Micro Contact Angle Meter**

The micro contact angle meter is specially designed for the pioneers in the micro/nano fields. The instrument is equipped with a unique capillary liquid dispensing system that has an inner diameter of 5-50 $\mu$ m, for making a liquid drop <30 $\mu$ m in size and picoliter in volume. In addition, the instrument comes with high magnification optics for accurately placing and measuring such small drops on micrometer features, and CCD cameras with a high capturing speed of 60 frames per second for studying dynamic characteristics of interaction of micron size liquids with solid surfaces. The technique is sensitive and capable of detecting monolayer molecules.

The unmatched instrument capabilities and usefulness for contact angle measurement at microscale have been exemplified through results obtained on fibers, medical guide wires, patterned organic light emitting display and microcircuits. Its advantageous high speed capturing capability is demonstrated by measuring the strong dependency of contact angles on time at millisecond intervals. The recorded feature-rich dynamics of contact angles of micron size drops is deemed valuable for investigating sensitive surface chemistry, vapor evaporation, wettability, and hydrophilicity/hydrophobicity changes at micro/nano scales.



Automatic Micro Contact Angle Meter.

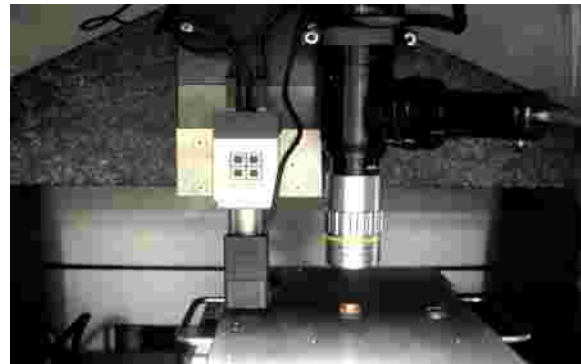
### **Full Feature, Multi-technique Nanoindenter**

Nanoscience and nanotechnology accelerate the proliferation of novel materials and devices possessing small sizes and low dimensions such as nanomaterials and ultra thin films. Mechanical testing and characterization of these materials have exposed challenges to the traditional hardness and tensile testing and measurement tools. Nanoindentation, also referred to as instrumented or depth-sensing indentation, is a promising technology for measuring nanomechanical properties of materials and miniaturized devices. To date, nanoindentation has been expanded to encompass a whole spectrum of testing techniques, well beyond the narrow indication of its name. While quasi-static nanoindentation has been broadly accepted as a method for determination of nanohardness and elastic modulus of materials, dynamic mechanical analysis of visco-elastic materials at nanoscale has seen steadily increasing interest. The nanoscale pulling and compression tests have also become a choice of tests.

The NAT Lab nanoindenter is a full-feature, multi-technique nanomechanical and nanotribological test system. It performs closed-loop controlled nanoindentation,



nanoscratch, nanowear, nanopulling, nanocompression tests with sub-nanometer and nanoNewton resolutions. Experiments can be conducted at room, elevated or reduced temperature, submerged in liquid, or under humidity control. The in-situ scanning probe microscopy (SPM) capability of the instrument enhances the nanoindentation function by enabling SPM imaging of the surface and positioning the indenter tip with nanometer precision over the feature to be studied. Examples of materials and devices that can be tested include thin films, coatings, nanoparticles, nanowires, bulk material surfaces and interfaces, MEMS, and electronic and biomedical devices.



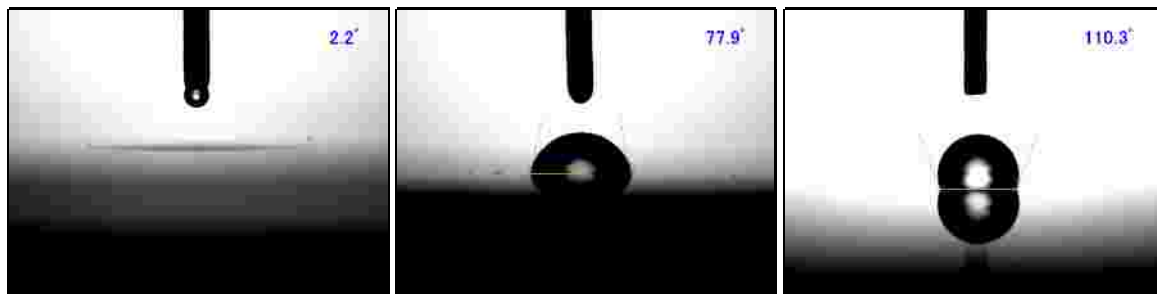
The full-feature, multi-technique nanoindenter; Left: main unit; Right: transducers mounted on a granite platform inside the environmental enclosure.



**Exemplary Testing Results**

**Microscale Contact Angle Measurement**

Contact Angle Measurement has been employed in numerous industries for measurement of surface wettability, hydrophobicity, hydrophilicity, surface energy, adhesion, surfactant efficiency, biocompatibility, etc. Microscale contact angle meter is designed to work with small or patterned surfaces such as fibers, small diameter tubes, micro-patterned surfaces, hairs, etc.

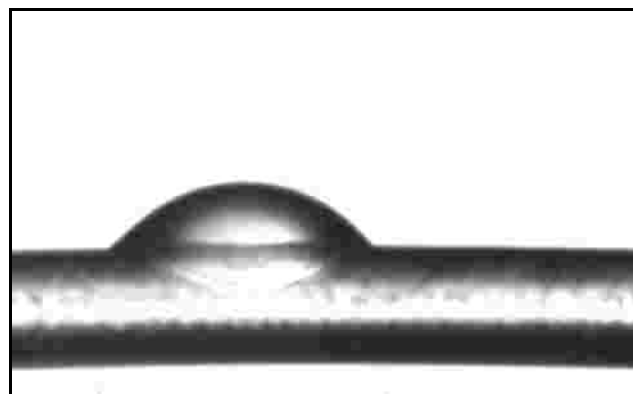


better wetting  
worse repelling

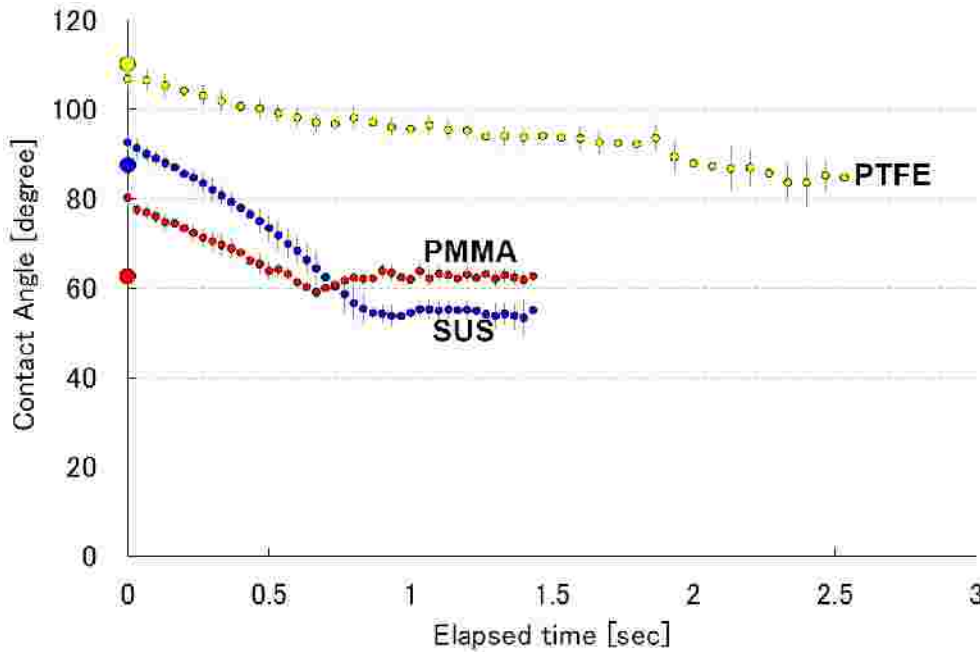


worse wetting  
better repelling

Contact angle measurement results and pictures on three specimens with different liquid wettability and repellency.



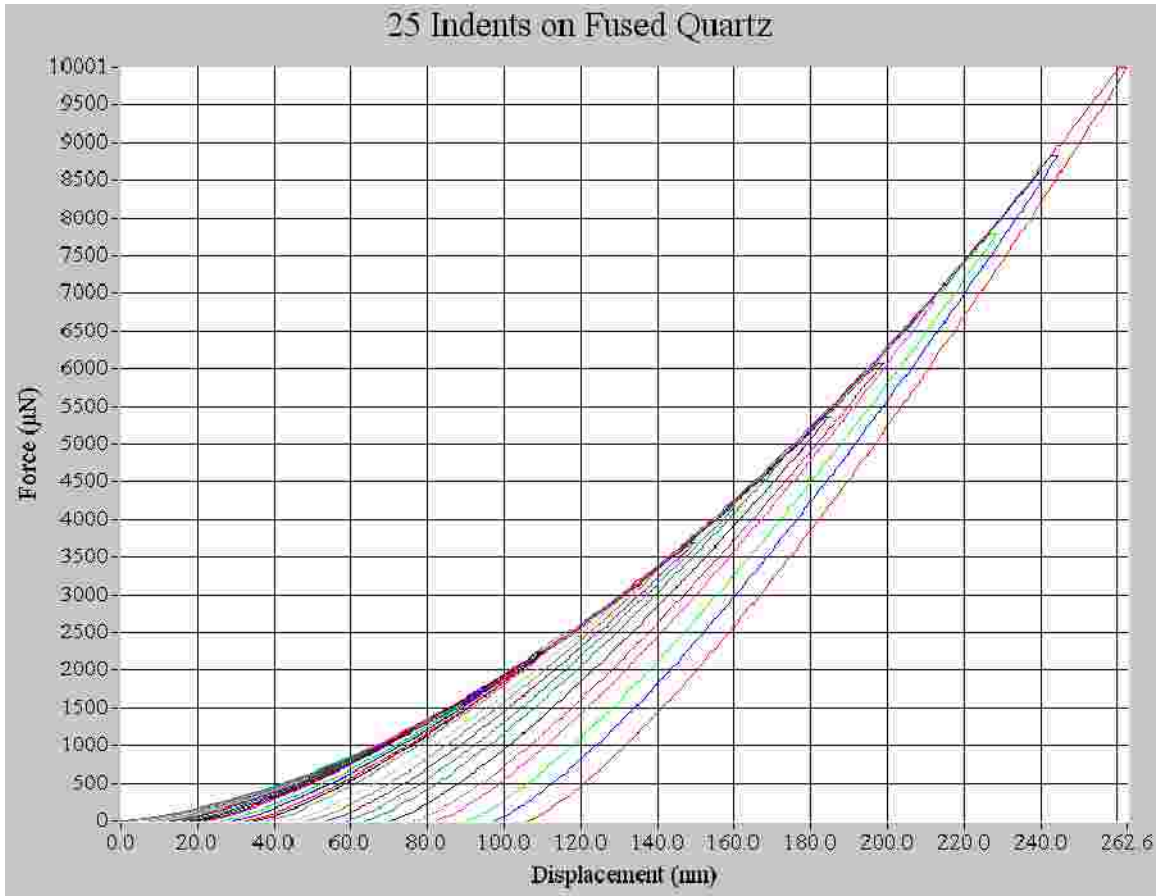
Optical micrograph showing a microscopic liquid drop made on a hair specimen; a typical hair possesses a diameter of 80 microns.



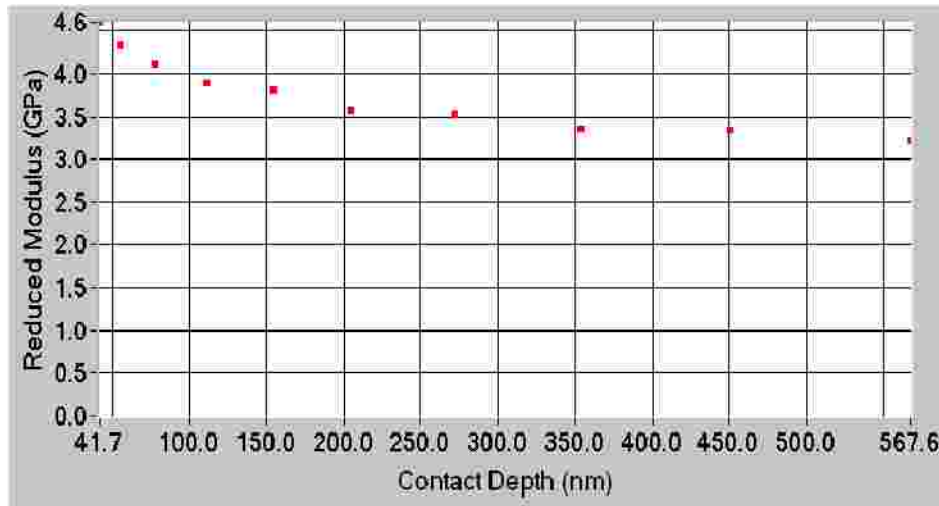
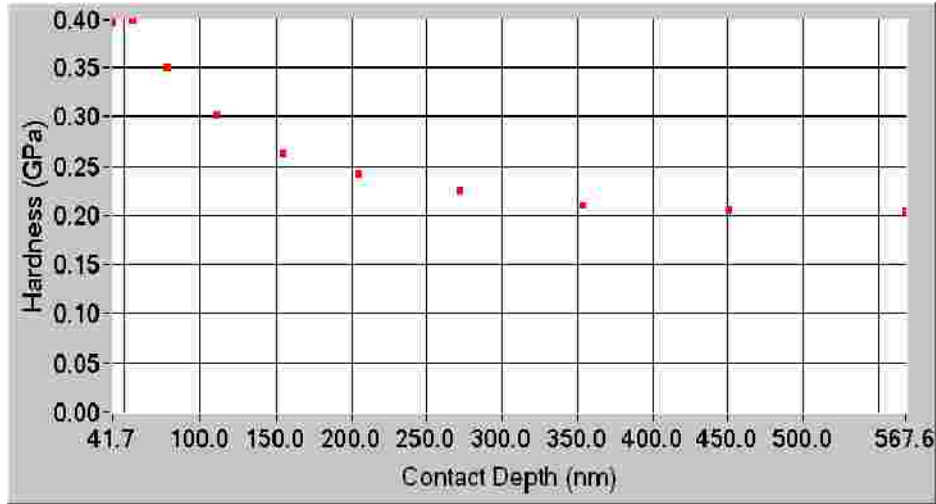
Microscale contact angle measurement results on three specimens, PTFE, PMMA and Stainless Steel. This graph shows that contact angle changes with time due to vaporization of liquid. The plateaus depict the receding angles of the surfaces for the liquid used.

### Nanomechanical and Nanotribological Measurement

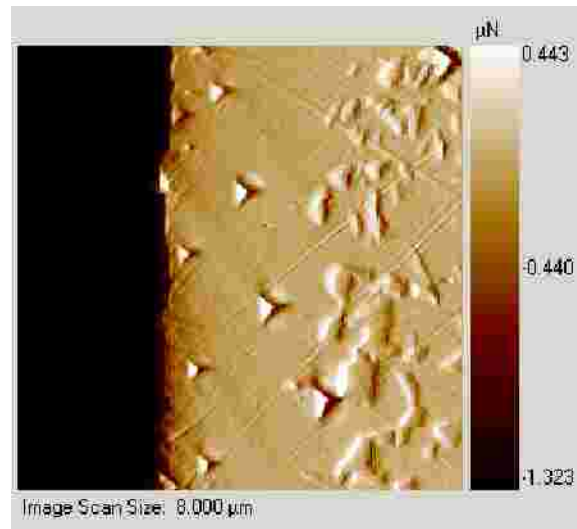
Nanoindentation measures the hardness and Young's modulus at nano/micro scale. It has broad applications in testing and evaluation of thin films, coatings, miniaturized devices and small volume bulk material such as single phases or grain boundaries.



Load versus displacement curves from 25 load-controlled indents on fused quartz using a Berkovich indenter probe. These indents show excellent repeatability.



Hardness and reduced modulus as a function of contact depth from the partial unload indent performed on a CD ROM disk specimen.



In-situ Scanning Probe Microscopy (SPM) image of nanoindentations on the surface of a metallic specimen after a cross-section profile test.



### **Specimen Submission**

In order for us to assist you in a more effective way, we request you to discuss with us on your testing and measurement needs in-depth. Sometimes we may ask for specimen submission prior to commitment and promise. When submit the specimens please fill out the Contract Lab Services Request Form completely and submit it with your specimens. Information on applications and other analyses that you have performed on the specimens may be helpful in selecting optimal testing methods and conditions. Please provide this kind of information as much as possible. If a non-disclosure agreement is required, please arrange it to be fully executed before submission.

### **Service Charge Rates**

Contract lab service fees are charged based on the scientist/engineer and instrument time spent on customer's project at predetermined hourly rates. The total time includes initial evaluation and planning of the project, test method development, specimen preparation and mounting, instrument calibration, experiments, data processing, result analysis, and report generation. The fee schedule is:

**Standard Schedule** (report due two weeks after receiving specimens): \$260/hour

**Expedite Schedule** (report due one week after receiving specimens): \$350/hour

**Priority Schedule** (report due three days after receiving specimens): \$400/hour

Consulting services fees are charged based on the scientist/engineer time spent on customer's project at predetermined hourly rates. The total time includes initial evaluation and planning of the project, data gathering and background investigation, experiments and analysis, discussion, communication, meeting, solution conceiving and proposing, and final report generation. The fee schedule is:

**Metro Schedule** (same rate applies for travel time from office to customer site and back to office): \$198/hour

**Outside Metro Schedule:** \$198/hour (50% rate for travel time, travel expenses extra)



### **Testing Results and Analysis Report**

Specimen testing and analysis report will be generated based the experiments. The report summarizes specimen characters as received, specimen preparation, testing method, testing instruments, testing conditions, testing data, testing results and analysis. Each report will be given a report number with finishing date and testing scientist/engineer name listed.

An electronic copy of the report will be sent via email and a hard copy via first class mail to customer on the due date. The report and testing results will be archived for record. Retrieval of the report within three month of testing finishing date can be arranged free of charge. After three months, an extra service charge may be applied.

### **Quotation, Purchase Order, Payment and Invoice**

After receiving the specimens and requirement of test and analysis from a customer, NAT Lab will issue a formal quotation specifying the tests, project scope and estimated cost. Normally a purchase order is required to commence the experiments for contract lab services or a consulting project.

After finishing a project, an invoice will be sent together with the analysis and test report. A prompt payment made to Ebatco will be expected and highly appreciated.

### **Specimen Return and Disposal Policy**

In general, customer's specimens submitted for test and analysis will not be returned after the tests are performed. The specimens will be stored in the normal lab environment for three months before disposal. Customers that want their specimens returned are required to specify this need clearly at specimen submission. Bulky, special, and expedited specimen shipment cost will be borne by customers.

### **Contact Information**

NAT Lab is proud to be able to support you in putting all the puzzle pieces together through our professional, thorough and satisfactory analytical, testing and consulting



Exponential Business and Technologies Company

Connecting the World

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services. Your technical expert and solutions are only a phone call away. For more information about the NAT Lab, or to start a project with us, please contact:

NAT Lab  
Ebatco  
7127 Shady Oak Road  
Eden Prairie, MN 55344  
USA

Tel: (952) 334-5486  
Fax: (952) 746-8086  
Email: [natlab@ebatco.com](mailto:natlab@ebatco.com)  
Web Site: [www.ebatco.com](http://www.ebatco.com)

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Address: 7127 Shady Oak Road, Minneapolis, MN 55344, U. S. A.  
Tel: +1 (952) 334-5486, Fax: +1 (952) 746-8086, Email: [natlab@ebatco.com](mailto:natlab@ebatco.com)

[www.ebatco.com](http://www.ebatco.com)

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