



Georgia Tech Research Institute Materials Analysis Center General Capabilities

Contact: Dr. Lisa Detter-Hoskin
Office/Mobile: (404) 407-7777
Lab: (404) 407-7001
Email: lisa.detter-hoskin@gtri.gatech.edu

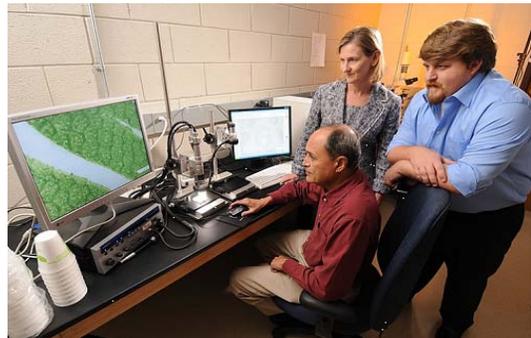
I. Overview - Expert Research Testing Facility

The Materials Analysis Center (MAC) of the Georgia Tech Research Institute (GTRI) has provided more than 59 years of research support and project leadership in the area of materials characterization. This group has a wide range of experience and varied expertise and, as such, is well qualified to select the proper analytical tools and methodology for most materials characterization problems. Our research staff consistently strives to produce the most accurate data utilizing cutting edge methods and state-of-the-art instrumentation. The MAC annually evaluates samples and manages research projects for hundreds of corporations and agencies.

The senior staff of the MAC has a combined total of over 142 years of applied experience in the following specialty areas:

- **Precision Sample Preparation**
- **Electron Microscopy**
- **Failure and Corrosion Analysis**
- **Particle & Dimensional Analysis**
- **Mechanical Testing**
- **Light & 3D Microscopy**
- **Polymer Analysis/Deformulation**
- **Materials Analysis**
- **Surface Analysis**
- **Environmental & Corrosion Testing**

The MAC takes a team approach to all our research materials characterization problems. Our combined research expertise, modern equipment and facilities, and our total commitment to accuracy ensure that our clients receive dependable research results. Our problem solving and diagnostic abilities clearly distinguish the MAC as a leader in providing full-service quality research services in a wide variety of fields.



Total Commitment To Accuracy!

II. Analytical Research Instrumentation:

- Microtomy: Room Temperature and Cryogenic
- Ion Milling
- Differential Scanning Calorimetry, Thermomechanical Analysis,
- Dynamic Mechanical Thermal Analysis, Differential Thermal Analysis, and
- Thermogravimetric Analysis
- Atomic and Magnetic Force Microscope
- 3D Microscopy
- Electron Spectroscopy for Chemical Analysis (X-ray Photoelectron Spectroscopy)
- Fourier Transform Infrared Spectroscopy (Attenuated Total Reflectance, Diamond Thin Film, TG/FT-IR)
- GC and Mass Spectrometry Techniques
- Optical Microscopy and Metallography (Qualitative and Quantitative)
- Particle Size and Shape Determinations
- Precision Measurement by Optical Interferometry
- Ultra-high Resolution Scanning Electron Microscopy (with full X-ray Analysis, including Mapping, Quantitative Software, Image Processing, Particle Size Analysis, and Color Display). Bright field and dark field STEM also available on one of two SEM systems.
- Scanning Transmission Electron Microscopy (with full X-ray Analysis, Including Mapping, Quantitative Software, Image Processing, Particle Size Analysis, and Color Display)
- Transmission Electron Microscopy
- Transmission Electron Diffraction
- X-ray Diffraction (Bulk and Thin Film); Micro-XRD
- X-ray Fluorescence (Elements F and higher)

III. Mechanical and Environmental Research Services:

- Mechanical and environmental testing can be performed according to ASTM, MIL, ISO or customer specified standards. Some capabilities include:
 - Plastics (Tensile, Compressive, Flexure and Sonic Modulus/Poisson's Ratio)
 - Metals (Tensile, Compressive, Flexure, Sonic Modulus/Poisson's Ratio, Impact [Charpy], Hardness and Microhardness)
 - Ceramics (Compressive, Flexure, Sonic Modulus/Poisson's Ratio, and Porosity)
 - Environmental testing including High/Low Temperature, Humidity and Moisture Resistance, Immersion, Salt Fog, Ultraviolet Radiation Exposure, SO₂ and NO₂ Exposure
 - High Temperature Testing

IV. MAC Personnel - A dependable, tenacious team fully committed to achieving customer satisfaction

Lisa D. Detter-Hoskin is a Principal Research Scientist and Head of the MAC. Dr. Detter-Hoskin received her undergraduate degree in Chemistry from Susquehanna University, her Ph.D. in Inorganic Chemistry at Purdue University, and June 1995 earned her M.S. in Management of Technology from the Southern Polytechnic State University. During her graduate studies, she developed expertise in the synthesis of air-sensitive organometallic complexes and their characterization by an array of analytical techniques, emphasizing desorption ionization mass spectrometry and electron microscopy. Her current interest is solving research and industrial problems in the areas of corrosion science, materials forensics, surface analysis, materials characterization and failure analysis.

Dr. Detter-Hoskin has 26 years of diverse failure analysis and testing experience with a variety of materials, including electronics, polymers (analysis and deformation), graduated metal surfaces (ion nitriding), minerals, ceramic composites, thin films, paper, metals, and corrosion products. She is experienced with chlorine/chloride and other aggressive chemical mechanisms of corrosion. She has lab and field experience with chloride decontamination and restoration procedures and reliability testing. To date she has authored 17 publications and a chapter in a book entitled "Surface Analysis of Paper."

Gautam R. Patel is a Senior Research Scientist at GTRI. Mr. Patel received a B.S. and a M.S. degree in Metallurgy from M. S. University of India and the Stevens Institute of Technology, respectively. He has 29 years experience in various areas of metallurgy, including thermo-mechanical treatment, casting, and hot/cold working. He also has extensive knowledge of chemical and mechanical testing, characterization of metals, corrosion testing, failure analysis, and tribology of metals. He has participated and/or directed research programs in synthesis and process optimization of ceramic hot pressed disks, continuous casting, rolling and drawing of copper and aluminum alloys, evaluation of gold and copper wires for chip-package interconnections, and establishing QC testing procedures for several industrial sponsors.

Walton Collin is a Research Engineer within the GTRI MAC. He completed his formal training in mechanical engineering at the Georgia Institute of Technology Atlanta, Georgia in 2008. Immediately upon graduation, he joined the MAC where he performs materials testing, forensics, failure and corrosion analysis. His skills include optical microscopy; material metrology; high resolution SEM imaging, X-ray microanalysis, x-ray diffraction, metallurgy evaluations and related sample preparation.

Dr. Robert Hochman is an emeritus professor of metallurgy with the Georgia Institute of Technology and a semi-retired principal engineer with GTRI. He is presently engaged in a broad range of fracture and failure analyses, general corrosion, localized corrosion, and stress corrosion studies in a broad range of materials. He has performed in-depth studies of property enhancement of metals and alloys by ion

plating and implantation. In addition, he has worked with gray iron, structural steels, aluminum and magnesium. His graduate work dealt with order-disorder transformations, metal physics, the metallurgy of semiconductors, and semiconductor physics. His is a sought after consultant on quality control, heat treatment, forming, casting, welding, machining and corrosion of aluminum, magnesium, titanium and its alloys, copper and nickel alloys as well as stainless, alloy and plain carbon steels.

Erin C. Prowett is a Research Scientist I. Combes received her undergraduate degree in Textile and Fiber Engineering from the Georgia Institute of Technology in June 2002. Her specialties are polymer analysis, deformulation, and competitive product testing. Her skills include analytical techniques and method development using transmission electron microscopy, thermal analysis, Fourier transform infrared spectroscopy, microtomy/cryomicrotomy, XPS, Auger spectrometry, optical microscopy, rheology and solvent/soxhlet extractions.

Kathy Silver is a Research Engineer II. She received her B.S. and M.S. degree in Materials Science and Engineering at the Georgia Institute of Technology. Her skills include forensic characterization of materials using optical microscopy, atomic force microscopy, FTIR and XRF analysis; thermal measurements of materials using thermal transmittance, TGA and DSC analysis; and electromagnetic measurements of materials using ambient and variable temperature impedance analyzers and focused beam systems. Silver also is trained in micro-fabrication techniques including atomic layer deposition, CVD and etching techniques.

Caitlin Curtsinger (Chemical Engineering) and Bradley Smith (Mechanical Engineering) are GT students serving as student assistants within the MAC. Caitlin and Brad assist with all daily MAC operations, sample preparation and testing under the direction of Dr. Detter-Hoskin. Both perform optical microscopy, gravimetric ashing, dimensional analysis, Fourier transform infrared spectroscopy, solvent extractions, and x-ray diffraction. These students also handle all sample log-in and chemical safety functions for the MAC.

V. Facilities and Instrumentation: *DoD Cleared Facility*

The MAC occupies 6,750 sq. ft. of modern research space. An overview of our equipment follows:

Scanning Electron Microscopes:

****NEW 2012**** Hitachi HU-S8030 ultra-high resolution (<1nm) field emission scanning electron microscope (fully automation, critical dimension measurement tool, with bright and dark field STEM capability), a Noran thin-window light element X-ray spectrometer, and a Noran 7 data management system with all available chemical assay and dimensional measurement software.

Hitachi S4100 high Resolution (2 nm) field emission scanning electron microscope, with Noran thin-window light element X-ray spectrometer, and NT-based *Vantage* data management system. Equipped with backscatter electron detector, quantitative software, and full-color display.

Transmission Electron Microscopes:

High resolution (0.2 nm) cold field emission Hitachi HF-2000, equipped with a thin window energy dispersive X-ray spectrometer, a Gatan parallel-detection electron energy loss spectrometer, and a 180° rotational electrostatic biprism suitable for electron holography. Jeol 100C TEM

Auger Electron Spectrometer:

Perkin-Elmer Physical Electronics Model 600 Multiprobe

ESCA (X-ray Photoelectron Spectrometer):

Surface Science Laboratories SSX-100 small spot ESCA spectrometer

X-ray Units:

Rigaku Ultima IV Fully Automated X-ray Powder Diffraction System with full upgrades for particle size analysis, thin film measurements, residual stress, and auto stage sampling. Fully quantitative experiments performed

Rigaku Primini X-ray fluorescence spectrometer for elements fluorine to uranium; equipped to test liquid and solid samples

Thermal Analysis:

Seiko Instruments Simultaneous TG/DTA 320

TA Instruments Q100 MDSC

TA Instruments Q400 TMA

FTIR Units:

Nicolet FTIR 6700 Spectrometer with Near, Mid and Far IR detection and thin film capability; three dimensional spatial mapping software

Nicolet iN10 MX Infrared Imaging Microscope

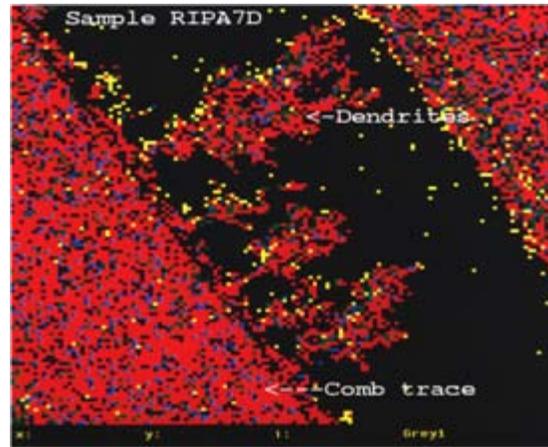
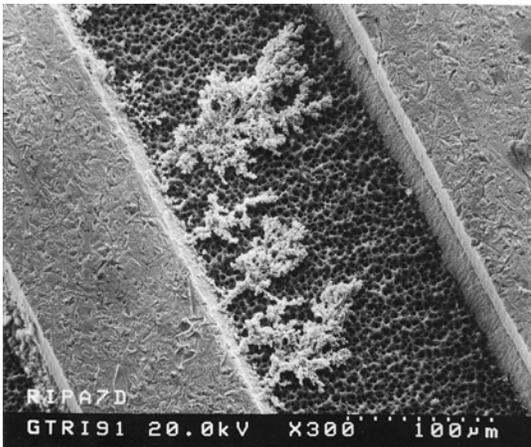
Nicolet Magna-IR 550 with MCT-B detector

Bruker IFS 66/S with TGS, MCT-B, and Step-Scan detectors

AFM/MFM Units: Digital Instruments 3100 AFM/MFM

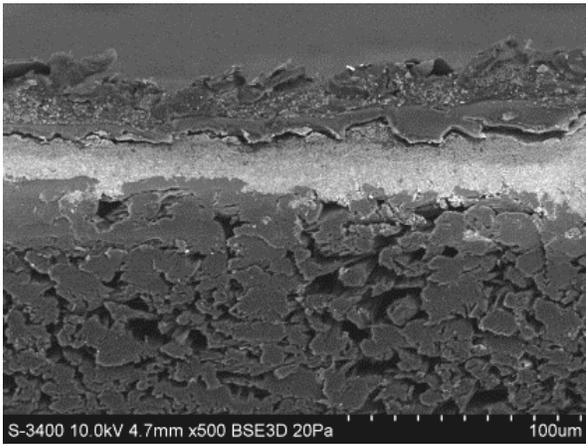
Rheology

Haake RheoStress 600 rheometer with multiple geometries for determining the viscoelastic properties of liquids including normal forces. The rheometer also has UV curing accessory with disposable plates for curable polymers and coatings

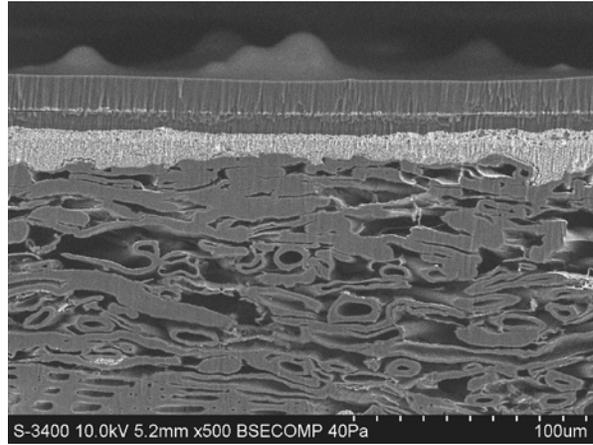


** New 2012** Hitachi Ion Milling System IM4000 with Zoom Stereomicroscope Viewing Assembly. Precision Cutting Tool.

High precision flat sample polishing and cross-sectional cutting; 5mm wide cuts; cold finger attachment to increase cutting time while reducing thermal affects.



Razor Blade Cut Lottery Ticket @500x



IM4000 Ion Mill Cut Lottery Ticket @500x

The MAC laboratories are also well stocked with optical microscopes, 3D imaging systems, two Leitz metallographs, a Denton vacuum evaporation chamber, a Hummer VI sputter coater, microtomes, laminar flow and regular hoods, a Struers Tenupol electrolytic jet-thinning device, polishing and wood shop facilities, laser micrometer, and numerous other support equipment and specialized attachments for the major equipment. In addition, the MAC has access to related modern analytical, thermal and mechanical test equipment within Georgia Tech.

VI. Research Projects

The following is a partial list of past and present research interests of the Materials Analysis Center.

PROJECT NAME/ SPONSOR	SYNOPSIS
Special Engineering Services -- Tennessee Valley Authority	Furnish special engineering services and equipment to perform metallurgical testing and failure analysis
Evaluation of Non-Acid Papermaking Processes-- Akzo Eka	Determine the quality of alkaline papermaking processes. Evaluate the distribution of fillers, sizing agents, and coating on paper. Particle size determinations and size effects in papermaking.
Organic Permeation into Plastics -- The Coca-Cola Company	Investigation of organic permeation into various plastic materials; recycling implications.
Analytical Testing of Fiber Media -- Murex Corporation	Provide materials characterization support for the design of AIDS testing devices
Methodology Development for Electronic Components -- Motorola	Development of Testing Methods (on & off-line) to identify and minimize electronic contamination.
Methodology Development for Microscopy-Based Novel Fiber Media -- Owens Corning	Development of characterization methods for identification of a dual phase glass fiber. Fiber morphology evaluation.
Reliability Aspects of Ozone Depleting Substances (ODS) Alternatives for Electronic Repair -- Warner Robins ALC	Reliability assessment of non-ODS materials. Materials characterization of electronic contaminants and determination of failure degradation mechanisms.
Reliability Evaluation of Alternatives to Ozone Depleting Substances (ODS) in DoD Manufacturing – ARPA	Electronic test assembly design/reliability assessment of non-ODS materials. Materials characterization of failure products and mechanistic studies.
Materials Research Support Services to the Pulp and Paper Industry -- Institute of Paper Science and Technology	Development of analytical test methods and characterization services to the pulp and paper industry.
Methodology Development for Evaluation of Powder Samples – Amerex and Kaydon Corporations	Develop the chemical protocols to isolate, separate, and measure powder constituents: fertilizers and flame retardants
Advanced Carbon Fiber Reinforced Materials Development – ARPA	Development of cost effective CVD materials processes. Testing of mechanical and physical properties
Development of New Waste Fiber-Based Commercial Building Products – Advanced Textile Recycling	New waste fiber-based product development and materials characterization. Indoor air and field application assessments of new products. Economic feasibility study.

PROJECT NAME/ SPONSOR	SYNOPSIS
Environmentally Conscious Manufacturing/Recycling of Fibrous Waste Center of Excellence – Georgia Research Alliance	The goal of this center is to: 1) develop and commercialize viable products from fibrous waste (carpet and textiles); 2) fibrous waste pollution prevention; and 3) technology development and remediation of fibrous waste storage or incineration in landfill. This program is a State of Georgia, Federal Government, University, and Industry partnership.
Specialized Engineering Services -- Nissei ASB	Metallurgical and failure analysis research services.
Specialized Product Support Services -- The Kimberly-Clark Corporation	(1) Investigate the Performance of Adsorbents and Chemical in Paper Related Products. Development Test Methods To Monitor the Effect of Alternative Bleaching Processes. (2) Healthcare product test support.
Failure Determination of Steel Belts – United Parcel Services	Investigate the source(s) and remedy to steel belt failures. Assistance with repair welding and life cycling modeling
Polymer Development and Evaluation – Kimberly-Clark Corporation	Cryomicrotomy preparation and high resolution examination of research polymers
Power Module Failure Analysis -- Lockheed-Martin Corporation	Evaluated the integrity of humetic coatings on power module. Also determine source of failure.
Examination of Polymer Coatings on Paper – Institute of Paper Science and Technology	Studied the effects of novel oxidation methods of polymer coatings on paper by surface analysis techniques (XPS, AES)
Evaluation of Aluminum Mold Defects – Little Tikes Corporation	Studied aluminum mold defects to determine source. Work included defect size/shape distributions, metallographic microstructure testing, and chemical analysis. Recommendations for aluminum processing parameters were made to rectify problem
Testing of Window Slats for Chemical and Mechanical Performance – Levolor	Project included evaluating numerous window slats for composition, dimensional analysis, and mechanical properties. Recommendations were made to improve design and manufacturing of existing processes
Testing of a large variety of materials for corrosion in the aftermath of the January 2005 chlorine spill in Graniteville, SC. – Avondale Mills	Project included the evaluation of metal, concrete, polymers, paint, and populated circuit boards that were exposed to chlorine gas. Lisa Detter-Hoskin is lead expert witness for Avondale Mills and their insurer FM Global.
Coloration of Anodized Aluminum – Newell Rubbermaid Corporation	Provided materials characterization support in the R&D of pigmented anodized aluminum components with polymer coatings.
Testing of Polymers with EcoPure Biodegradation Additive Package – CE TECH LLC	Provided an array of analytical test support to evaluate polystyrene, polypropylene, polyethylene and PET products with and without EcoPure® biodegradation additive. Testing includes FTIR, TGA, GPC, Purge and Trap Mass Spectrometry, gravimetric ash, DSC, DI/Mass Spectrometry. Mechanistic studies of EcoPure® biodegradation evaluated.