Anderson Materials Evaluation, Inc.

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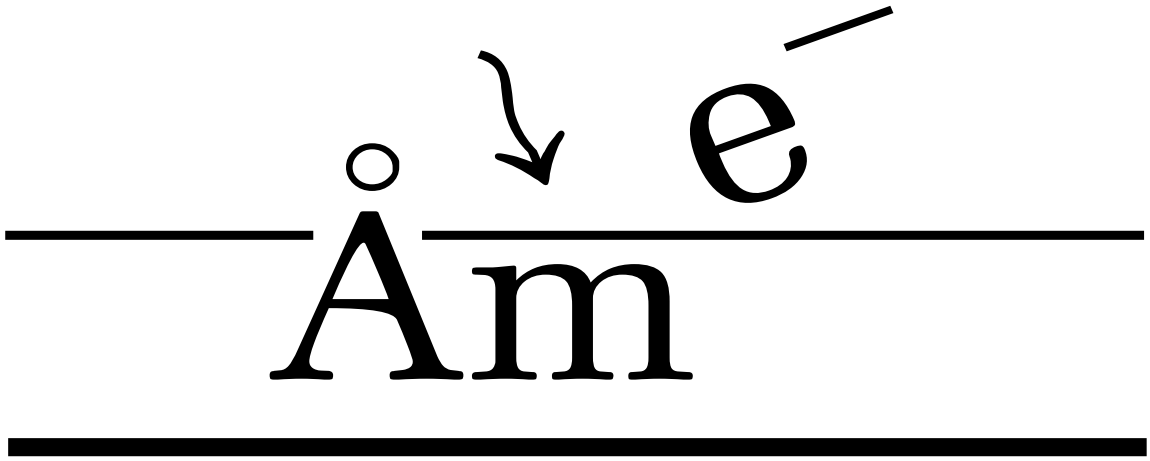
Intelligent, Rapid-Response, Collaborative Solutions to Your Applied Materials Problems



Mission - to improve your productivity

Åme⁻ offers a broad spectrum of materials analytical and testing services to help you shoulder the burdens of process and product development, quality control, and failure analysis. We also provide consultative and expert witness services. We collaborate with you to develop goal-directed solutions to your metal, semiconductor, glass, polymer, inorganic chemical, ceramic, mineral, composite, and contaminant material problems. We can simply perform an assigned analysis. Alternatively, our highly educated and experienced staff is delighted to discuss the background to your problem with you, help you define the tasks necessary to address your problem, produce the needed analyses, and discuss the solution pathway elucidated by the results obtained. After solving or better identifying the problem, we may suggest longer-term R&D for greater benefits, if you are interested.

We produce written reports to insure that you can fully understand and independently examine the analytical results and conclusions. This establishes a documented history for future process and product development and control. We can also serve to enhance your corporate memory of problems and their solutions, if you become a regular customer. Please call Dr. Charles Anderson, Dr. Lorrie Krebs, or Dr. Kevin Wepasnick to discuss how we can help you create value by addressing your materials issues. Our surface analysis, SEM/EDX, microscopy, thermal analysis, FTIR, electrochemical evaluations, RGA mass spectroscopy, and adhesive bond and corrosion failure analysis capabilities give us many powerful tools to apply to your materials and process evaluations. We are your path to replacing speculation with understanding, whether your problem is due to contamination, corrosion, process control, vendor error, unknown properties of new materials, a new property requirement, or the usual unruly suspects.

Anderson Materials Evaluation

Characterization, Failure Analysis, Quality Control, & Process & Product Development

Anderson Materials Evaluation, Inc.

Surface, Interface, Thin Film, Coating, & Bulk Materials Characterization

Analytical Services

Small-Spot X-ray Photoelectron Spectroscopy (XPS or ESCA) – with Focusing X-ray Monochromator, Differentially Pumped & Rastered Ion Gun Depth Profiling, Specimen Cooling & Heating, 200 amu Quadrupole Residual Gas Analysis in Ultrahigh Vacuum – *Provides quantitative elemental and chemical analysis of 8nm depth & with ion depth profiling to 2µm in analysis areas of 150 - 600µm dia. Correlation of surface properties with temperature and outgassed species. Unique multiple chemical phase analysis, including hydration. Quantitative analysis of all elements, except H, in all materials with sufficiently low vapor pressure.*

FTIR - with a spectral range of 7800 - 350 cm^{-1}, resolution of 0.5 - 16 cm^{-1}, signal-to-noise greater than 42000:1, Specac Golden Gate Mk II Single-Reflection ATR Accessory with Diamond Top-plate and KRS-5 Lense, Pike Technologies VeeMax II Variable Angle Specular Reflectance Accessory - *Ready analysis of many solid and liquid samples as-received using single-reflection ATR with detection depths of 1 - 2 µm and greatly enhanced surface sensitivity using variable angle specular reflectance. Primarily provides identification of polymers and organic materials while complementing the surface chemical analysis of XPS and the thermal analysis of polymers and composite materials.*

Scanning Electron Microscopy (SEM) with Digital Imaging and Energy Dispersive X-ray Analysis (EDX) – *Provides 7nm lateral resolution images in secondary electron imaging mode with excellent depth of field and measures the size of small features with image analysis. We do specimen cross sectioning and polish and etch of metals for metallographic inspection. We can also provide Robinson backscatter images, which distinguish light elements from heavy elements. EDX provides semi-quantitative analysis of elements for carbon and all heavier elements to depths of 1 to 2 µm with lateral dimensions of about 0.5 µm. We can provide elemental concentration maps or line scans for up to eight elements at a time.*

Metallographic Optical Microscopy – Used with relatively flat specimens, or with specimen polishing and cross-sectioning techniques – *Provides 37.5 - 400X optical images in bright field, dark field, polarizing, and Nomarski differential interference contrast observation modes*.

Inspection & Binocular Microscopy - Virtually all materials are examined prior to other analyses for insight into heterogeneities of chemical or physical phases and microstructure. *Documents the appearance of samples further analyzed by other means so future problems can better be identified as similar or different based on microscopic appearance.*

Thermal Analysis (Differential Scanning Calorimetry (DSC), Thermogravimetry (TG or TGA), Thermal Mechanical Analyzer (TMA) – with Operation in Glove Box and Mass Spectroscopy of Outflow Gas. DSC, TMA, and DMA can be cryogenically cooled. – *TG provides weight loss due to decomposition, outgassing, combustion; or weight gain due to absorption or reaction with environment, and yields quantitative composition and hydration information. DSC provides measurement of exothermic and endothermic reactions, melting and precipitation energies, degree of polymer cure, glass transition temperatures, and chemical reaction temperatures and quantization. TMA measures thermal expansion, glass transition or softening temperatures, crystalline to amorphous phase transitions, other phase transitions, and rheology. Operation in a glove box allows the handling of materials susceptible to water or air absorption or oxidation. Measurements can be made under a variety of gaseous atmospheres (TG, DSC) or under vacuum (TG).*

Electrochemical Characterization – Potentiostatic, galvanostatic, potentiodynamic polarization, and electrochemical impedance spectroscopy (EIS) techniques - *Evaluates materials compatibility, environmental corrosivity, potential methods for protection against corrosion, and coating breakdown. Allows the characterization of corrosion phenomena such as corrosion rate, localized attack (pitting, crevice corrosion), galvanic attack, and interfacial hydration.*

Quadrupole Mass Spectrometer Residual Gas Analyzers in XPS/ESCA with Heating, as Portable Atmosphere Sniffer, on TGA/DSC Outflow Gas, and with Fracture, Heating, and Puncture Capability in high vacuum – *Provides gas & vaporizable species identification 1 - 200 amu.*

CO_2 Snow Jet, Plasma (Microwave, Oxygen, or Hydrogen), UV, & Solvent Cleaning and Effectiveness Analysis – *Trial cleaning procedures performed on a material or device on a small scale and evaluated with surface analysis to determine the suitability for the customer's application.*

Coating and Film Thickness Measurements – using XPS on extremely thin films and coatings; interference microscopy, eddy current or magnetic probe metering, SEM/EDX imaging, and cross-sectioning or radial sectioning on thicker coatings.

3D Imaging Surface Structure Analysis (Scanning White Light Interference Microscopy) – *Provides surface roughness, peak-to-valley, peak-to-peak, step-height and other topographic measurements of opaque materials, measures step-heights to determine film thickness, complements AFM (smaller range) and contact profiler capabilities (larger range).*

Anderson Materials Evaluation, Inc.

Surface, Interface, Thin Film, Coating, & Bulk Materials Characterization

Applications of Surface Analysis, Thermal Analysis, FTIR, SEM/EDX, Optical Microscopy, RGA Mass Spectroscopy, & Electrochemical Analysis

Adhesion

- Determine location & cause of adhesive bond failure
- Identify cause of coating or thin film delamination
- Adhesive and primer curing or composition characterization
- Evaluate surface preparation cleaning or anodization processes
- Determine thickness of silane bonding agent film
- Check surface for plasticizer, excessive fire retardant, fingerprints, hand lotion, tape residues, or mold release agents capable of degrading bond
- Identify hydrated or laminated layer species on the surfaces of inorganic filler particles
- Determine whether surfaces are too alkaline (basic) for bonding

Chemical Identity

- Quantitative composition chemical analysis
- Quantitative multiple chemical phase identifications
- Identify outgassing species & rates
- Determine quantitative elemental compositions
- Multilayer coating structure identification
- Composite & ceramic materials fracture surface compositions
- Identify leached or adsorbed species
- Heated/etched/leached surface composition
- Stoichiometry of sputter-deposited, chemical vapor deposited, or reaction-formed films

Chemical Reactivity & Stability

- Determine powder surface chemistry
- Measure surface or bulk water content
- Determine weight & identity of thermal decomposition species
- Find chemical cause of film stresses
- Measure surface changes upon exposure to reactive environments of chemicals, UV or heat radiation, or plasma (RF or microwave)

Composite Materials

- Composition at fracture surface
- Composition at interfaces between components
- Particle or fiber surface properties affecting strength, pull-out, or degradation
- Development of surface preparation processes for adhesive bonding or degradation control
- Control and preparation of particle or fiber properties for improved adhesive bonding
- Evaluation of surface treatments to improve wear or hardness properties
- Examine surface for mold-release agents or contaminants

Contamination & Cleaning

- Identify and measure surface contamination
- Test efficiency of aqueous, solvent, or CO_2 SnowJet cleaning processes
- Determine suitability of plasma (RF or microwave), UV cleaning, & ultrasonic processes
- Identify residues from solvents/ qualify solvents
- Measure surface-segregated impurities & phases due to bulk-lattice instability, heating, or surface reaction-induced diffusion
- Qualify surfaces of high value-added components for further non-reversible processing
- Identify and measure surface or interfacial contaminants, oxide type, corrosion products

Corrosion & Degradation

- Corrosion product identification
- Improve protective coatings & surface treatments
- Determine chemical degradations due to radiation, (UV, x-ray, microwave), plasma, or kinetic particle
- Accelerated testing for corrosion susceptibility
- Identification of corrosive agent or mode of corrosion, even prior to visible corrosion
- Measure water penetration depth in polymer and

other coatings - detect presence at interfaces
- Determine compatibility of materials
- Measure corrosion rates
- Determine susceptibility to pitting or crevice corrosion

Electronics

- Determine cause of soldering, bond pad, and adhesive bond difficulties
- Find cause of electrical breakdown
- Evaluate PCB laminate interfaces & surface conformal coatings
- Identify photoresist or wax residues
- Depth profile TiN, WN_2, or other barrier films on Si or SiO_2 to determine barrier properties
- Measure surface segregated impurities from electroplated metals such as gold and copper
- Depth profile multi-film contact structures
- Evaluate cure of adhesives, potting compounds, thermal transfer agents, and sealants
- Measure outgassed species from component materials and contaminants & outgassing rates for applications in hermetically-sealed packages
- Characterize new low dielectric materials
- Evaluate the cleanliness of ceramic and plastic packaging materials and of gloves and tools
- Find cause of leakage currents in electrical connectors or between bond pads
- Determine polysilicon grain sizes
- Measure the thickness and precise stoichiometry of oxides, nitrides, and other film layers
- Develop new processes for implementation of new low dielectric materials

Metallurgical

- Measure thickness and chemistry of surface oxide or other reaction product films
- Identify cause of metallic intergranular failure
- Improve friction & wear properties
- Measure/distinguish surface & near-surface graphitic & carbidic inclusions affecting surface appearance, wear, hardness, corrosion properties
- Metal-matrix composite analysis for alloy or reaction product composition at interfaces
- Improve surface hardening coatings
- Characterize specialized surface coatings such as forsterite insulating coatings for transformer steel
- Examine surface composition of heat-affected zones near welds or brazed joints
- Determine composition of corrosion sensitive material and probable process or exposure cause of sensitization
- Examine surface properties of metal powders for sintered powder metallurgical products

Polymer

- Identification in bulk, near surface, & surface
- Determine degree of cure
- Fiber-reinforced or filled polymer composite characterizations, including fiber & particle interface properties
- High precision C, H, N, & O analysis of organic material mixtures to check for proper mixing, formulation, and curing
- Determine surface composition of copolymers
- Identify surface-segregated plasticizer component
- Determine outgassed species and rates
- Characterize surface degradation layers due to oxidation, hydration, or radiation exposure
- Examine surface/bulk concentrations of catalysts, cross-link agents, colorants, & plasticizers
- Measure the glass transition temperature
- Measure thermal expansion properties
- Determine rheological properties
- Measure reaction exotherms and endotherms in inert or reactive atmospheres
- Surface treatment characterization for improved wetting and adhesion for printing & painting
- Characterization of primers and adhesion promoter layers for chemistry, composition (mixture or interphases at interfaces), & thickness
- Weight-loss on heating, inorganic filler weight

Industries Supported

Adhesives, Aerospace, Automation Equipment, Automotive, Biomedical Devices, Building Materials, Ceramics, Chemical, Coatings, Communications, Composites, Construction, Defense, Electronics, Energy, Fasteners, Glass, Machine Tool, Marine, Metal, Optical Devices, Paint, Paper, Pharmaceutical, Pipeline, Plastics, Power, Surface Treatment, Semiconductor Equipment, Textiles, Thin Film, Transportation, & Welding and Joining Industries