

Laboratory Workplace Safety Practices and Sampling and Analysis Considerations



Keith Rickabaugh, Technical Director

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About RJ Lee Group

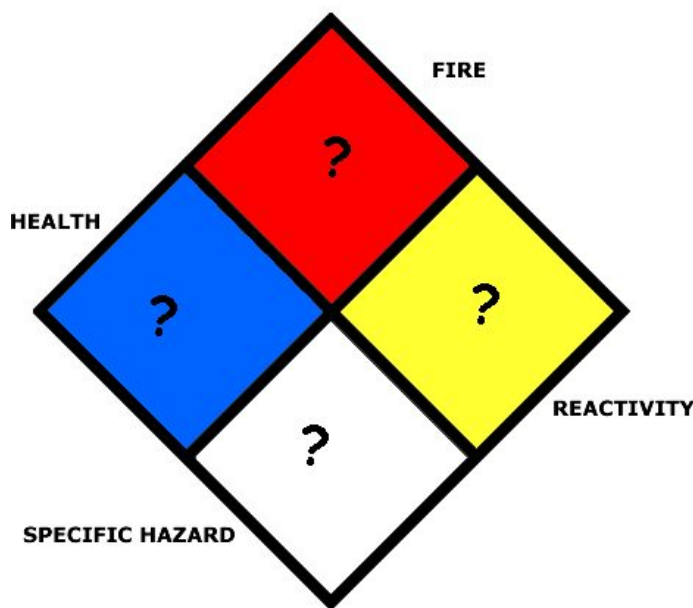
- Commercial Laboratory and Consulting Services
- AIHA Accredited Laboratory
- 80,000 + square ft. facility
- Optical and Electron Microscopy Capabilities
- Located in Monroeville, PA

Nanotechnology Hype

- Why all of the Hype?
 - Nanotechnology is a “How”
 - Infrastructure and Technology Advances
 - Broad Range of Industries and Use
- Engineering materials at the molecular level

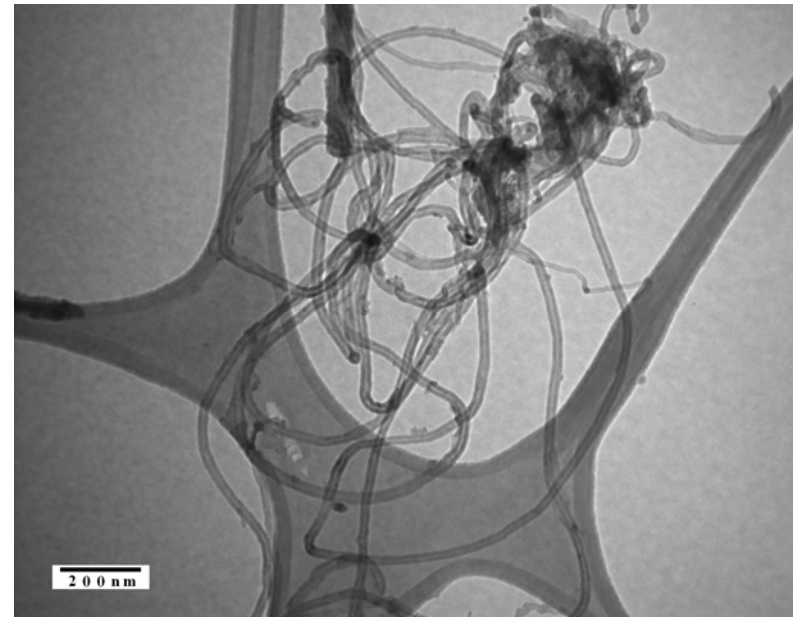
Nanomaterials Safety: The Industrial Hygiene Approach

- Recognition
- Evaluation
- Control

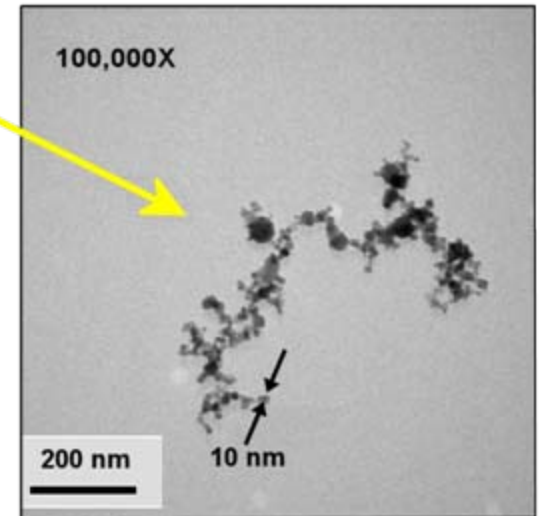
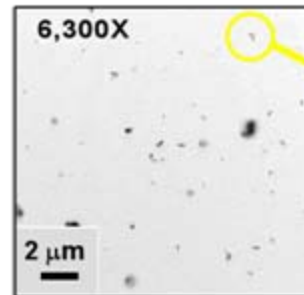
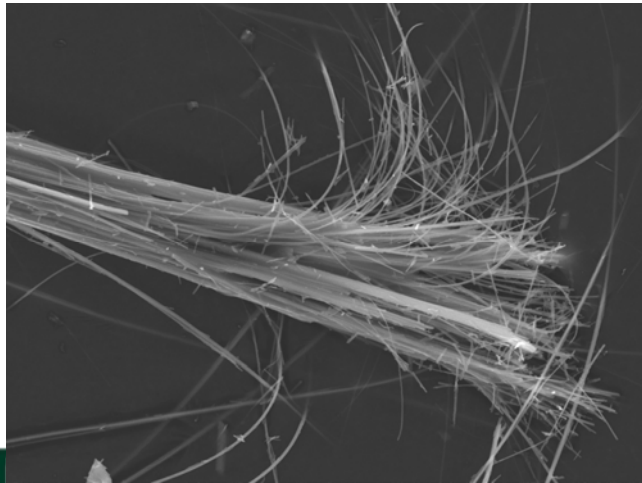
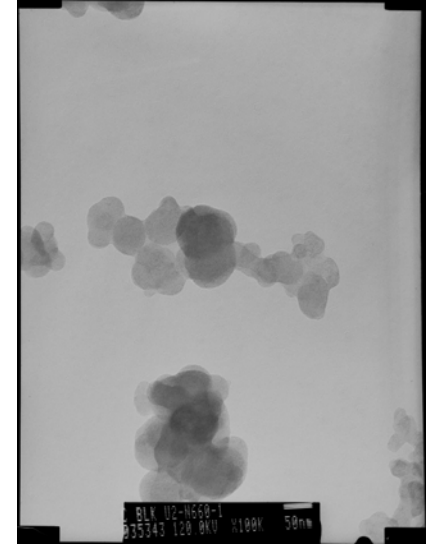
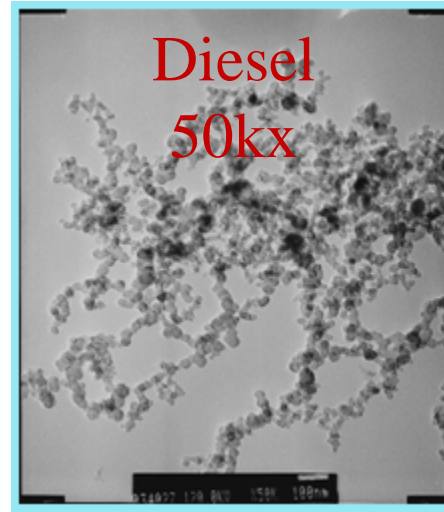
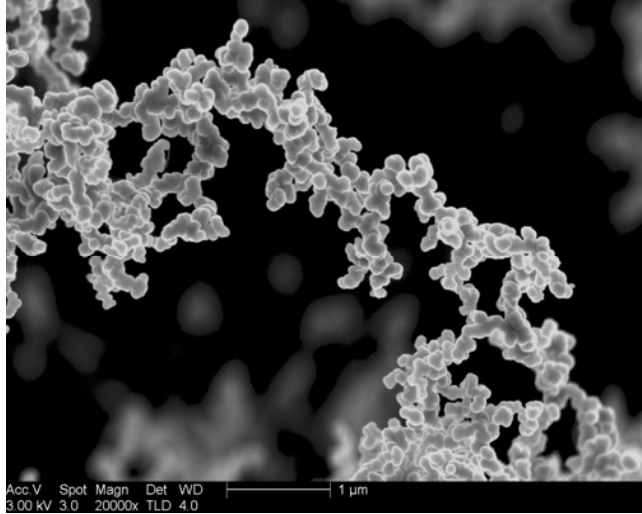


Nanotechnology Questions

- Uncertainties
 - Short/Long Term Health Effects
- Historical Analogies
- Analytical Issues
 - Sampling
 - Analysis Protocols
 - Reference Values



Similar Experience – Ultrafines “Nanosized” Particles



RJLG Nanotechnology Safety Issues

- Variety of Different Materials
 - MWCNTs
 - Silver and Gold precipitates
- Potential Laboratory Worker Exposure??
 - Inhalation, Ingestion, Dermal Absorption, or Injection
 - Engineering Controls
 - Work Practices
 - Personal Protective Equipment
- Social Responsibility
 - Air Emissions
 - Disposal

Nano-particle Laboratory Safety

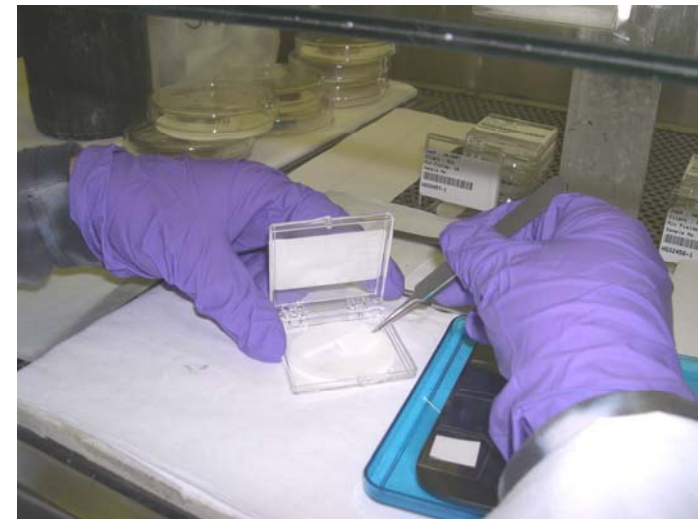
- Provide Safety Awareness Training
- Laboratory Worker Guidelines
 - Handle Limited Bulk Sample Amts. (e.g., only enough for testing)
 - Request Bulk Material be Submitted in Suspension
 - Properly Label and Containerize Samples
 - Immediately Clean-up “Spills”
 - Wet Methods
 - HEPA Filtered Vacuum

Nano-particle Laboratory Safety

- Laboratory Worker Guidelines (cont.)
 - Maintain Clean Facility (ref. “Tack Mats”)
 - Use disposable lab supplies when possible
 - Use Engineering Controls (appropriate ventilation)
 - Wear Lab Coats and Gloves when Handling
 - On-going Monitoring (when applicable)
 - Do not discharge into environment (i.e., air or water)

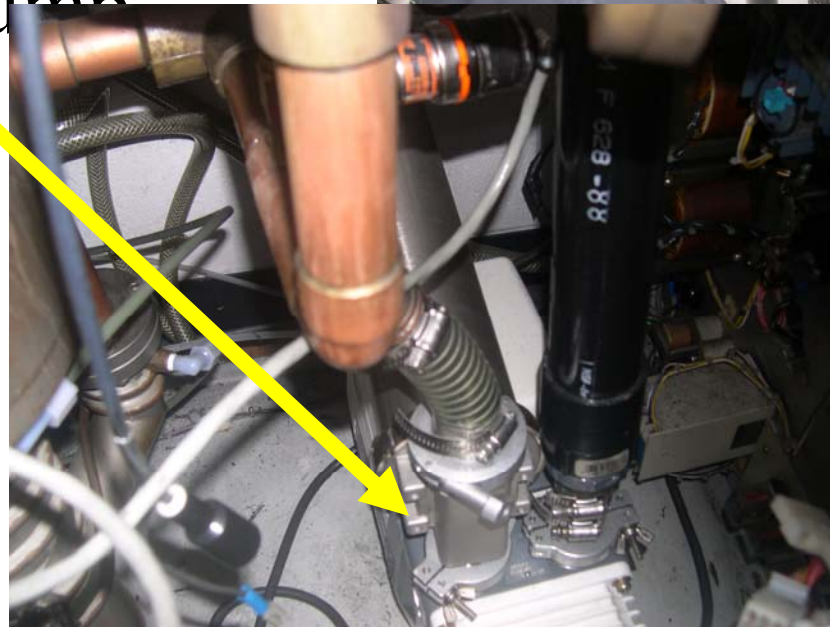
Laboratory Hoods / Glove Boxes

- Positive Pressure Hood
 - e.g., “Clean Bench”
 - Typically protects samples only
- Negative Pressure Hoods
 - a.k.a. “Fume Hood”
 - Typically protects worker
 - Exhaust may or may not be filtered
- Laminar Flow Filtered Hood
 - Protects Worker and Sample



Laboratory Equipment Modification

Filtration on
Vacuum Pump
Systems



Sample Disposal Considerations

- Containerize in Leak Tight Containers
- Wet material prior disposing
- Consider asbestos as a model for disposal for insoluble particles
- For large amounts of waste – return to customer for disposal

Sample Collection

- Direct Read Instruments
- Air
 - Size Selective Samplers and Filters
 - Passive Samplers
- Bulk Samples
- Surfaces
 - Wipes
 - Adhesive Samplers



Sampling – Direct Read Instruments

- Size Selective Particle Counts or Surface Area Concentrations
- Instantaneous Feedback
- Good Application in Clean Environments
- Limitations
 - “Portability” sometimes difficult
 - Counts particles “not of interest”
 - High “Background” Levels interfere
 - Nanoparticulate can be associated with larger particles



Analytical Techniques

- Trace Analysis (gravimetry, ICP-MS, etc.)
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)
- Atomic Force Microscopy (AFM)
- BET Gas Desorption (surface area – bulk samples)

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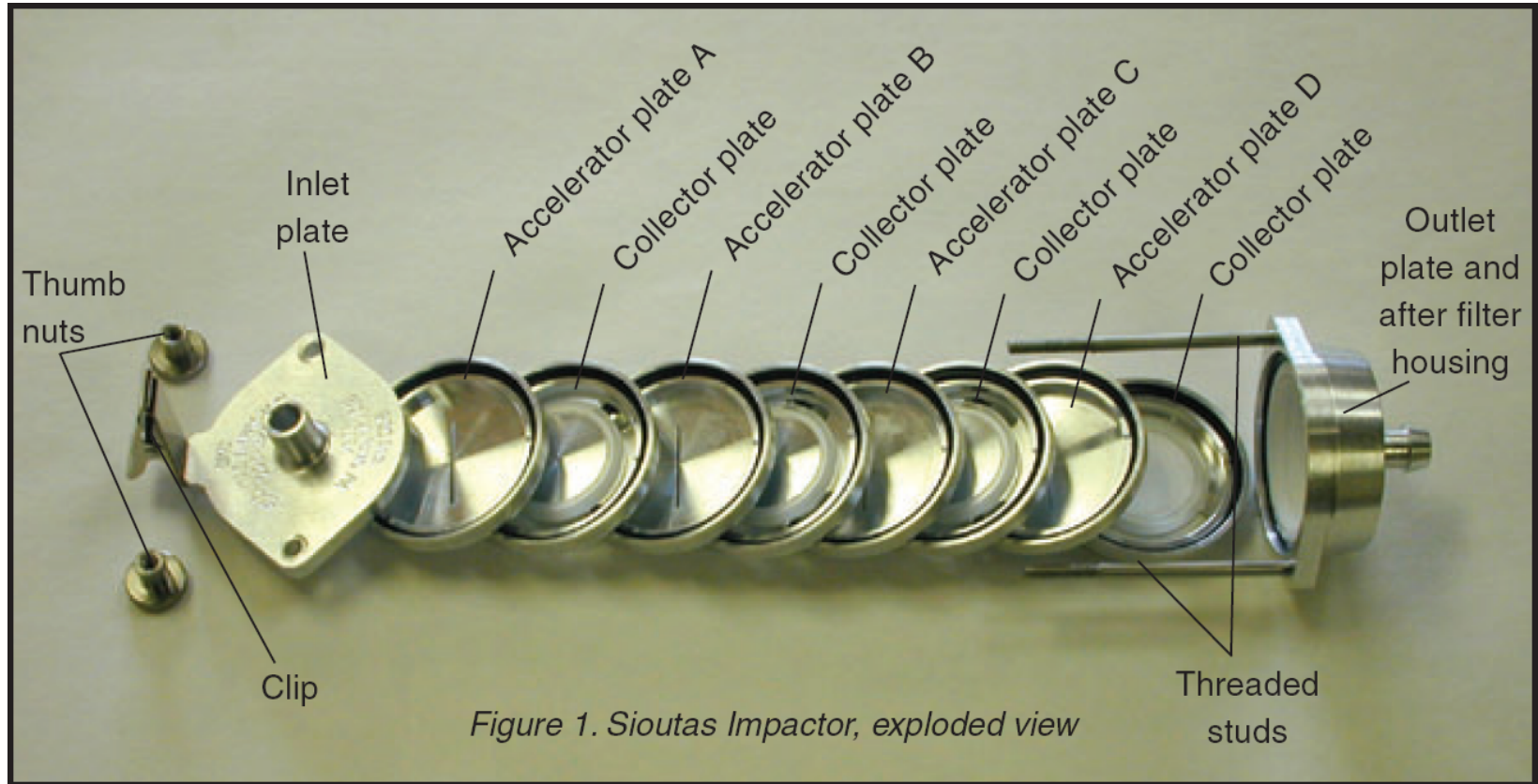
Seeing IS
Believing...
Nanotechnology



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Cascade Impactors



Cascade Impactors



MICRO-ORIFICE UNIFORM DEPOSIT IMPACTORS (MOUDI™)



Non-Rotating MOUDI™



MOUDI™ with Rotator

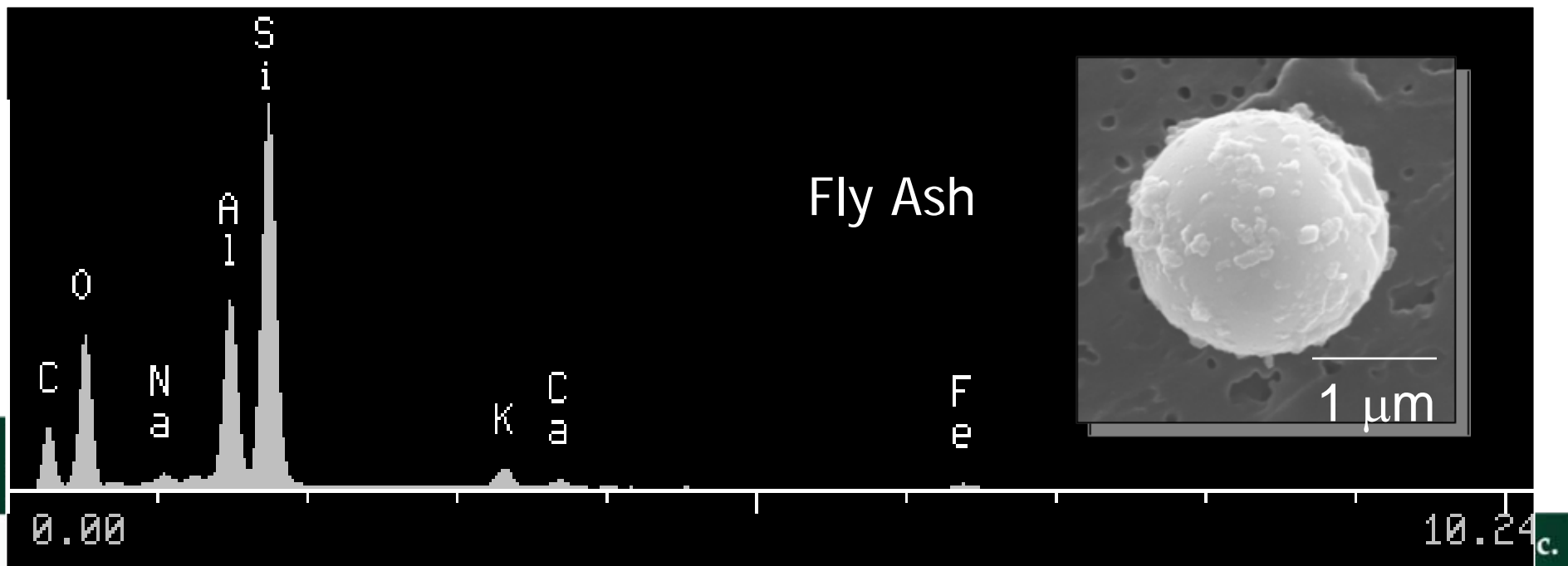
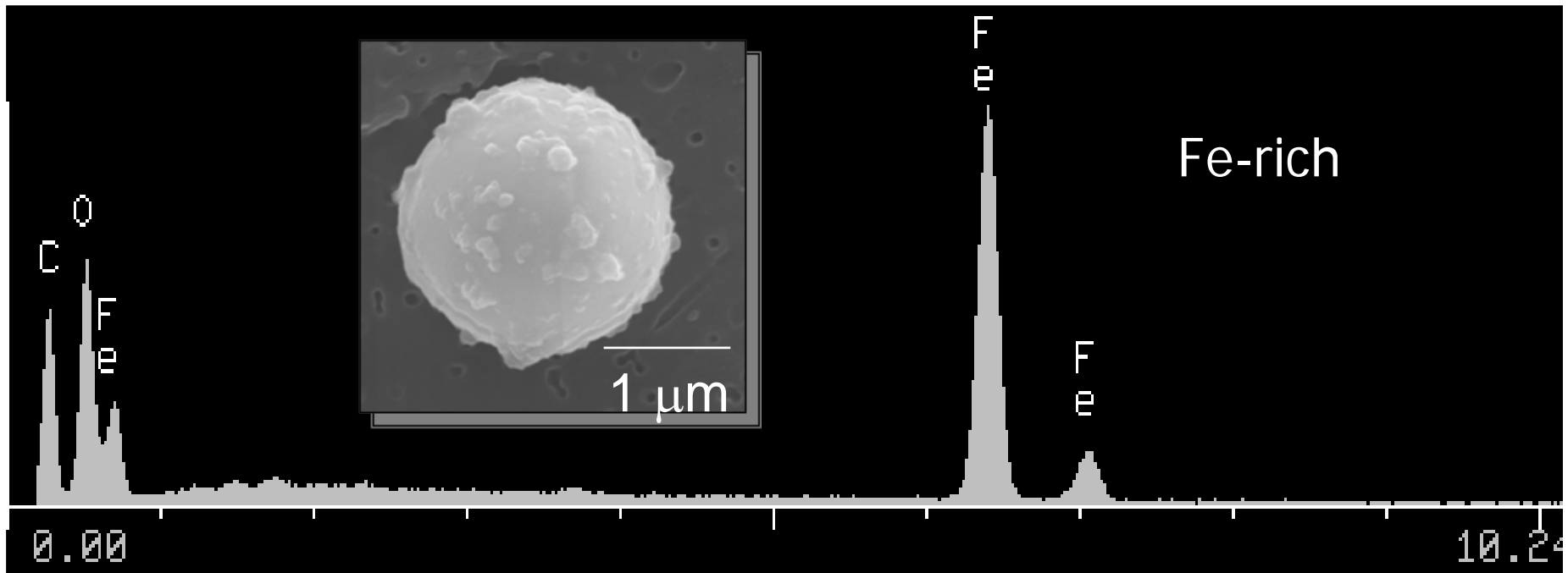


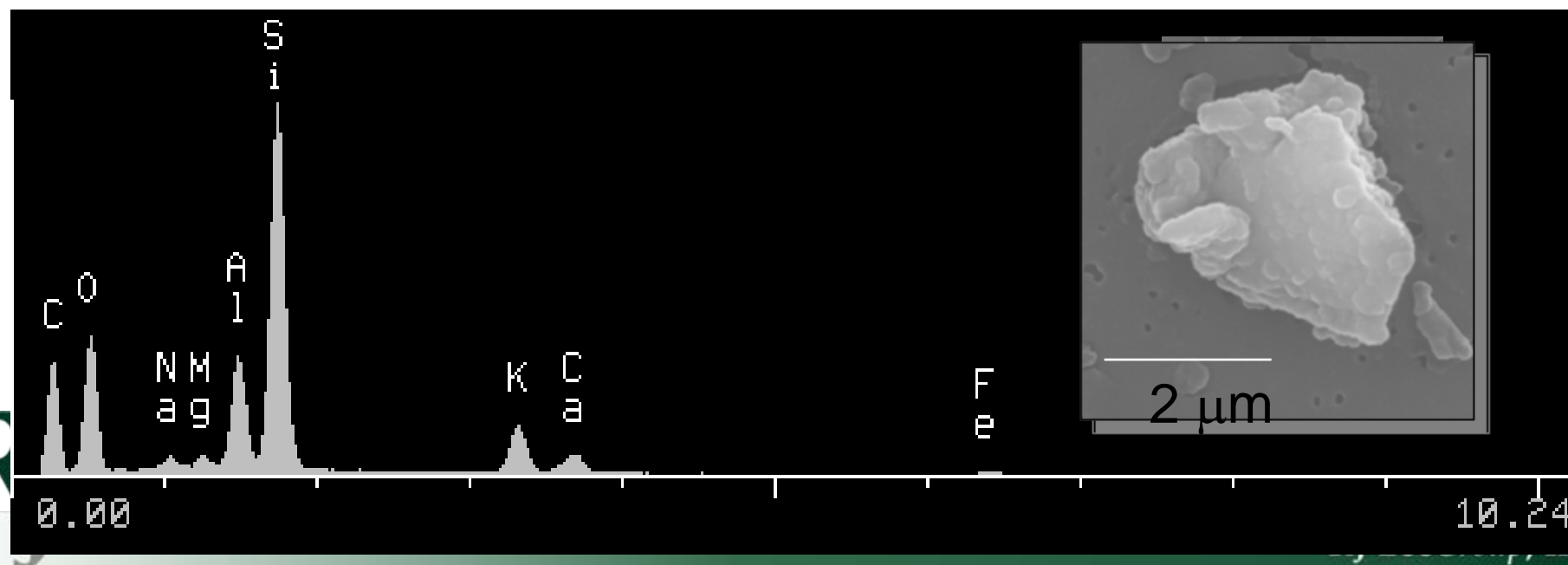
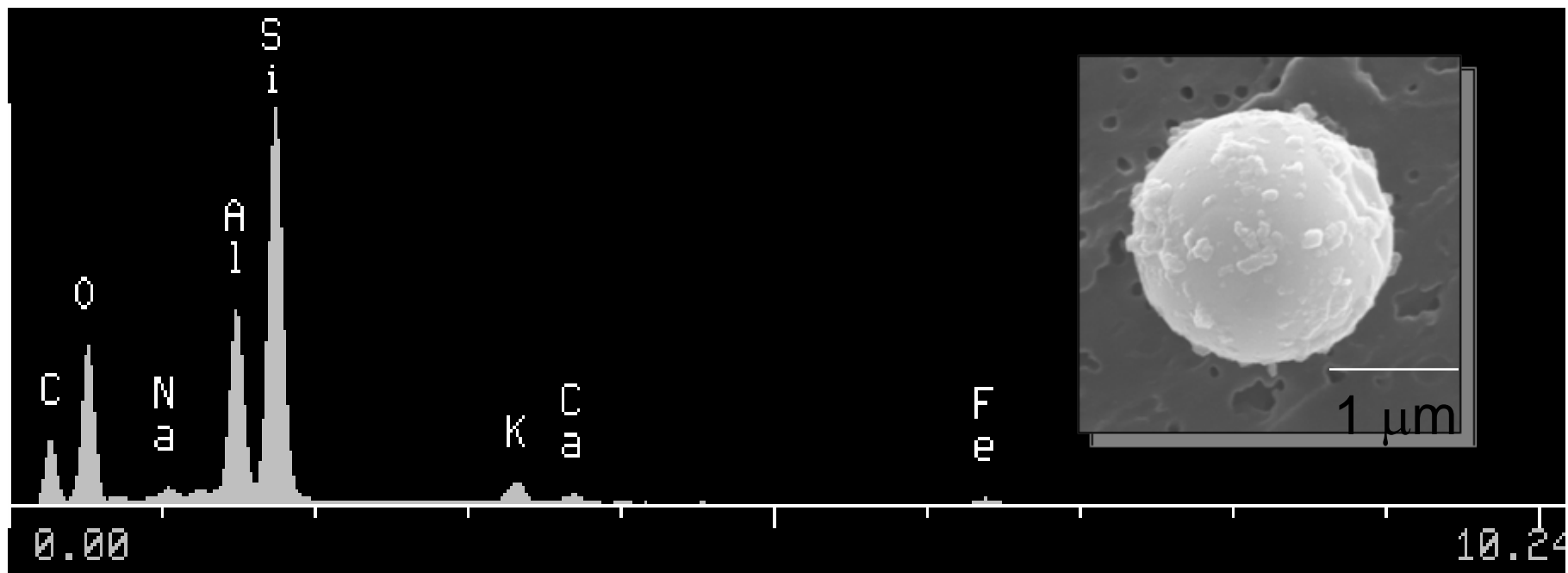
Nano-MOUDI™

Integrated Air Filter Considerations

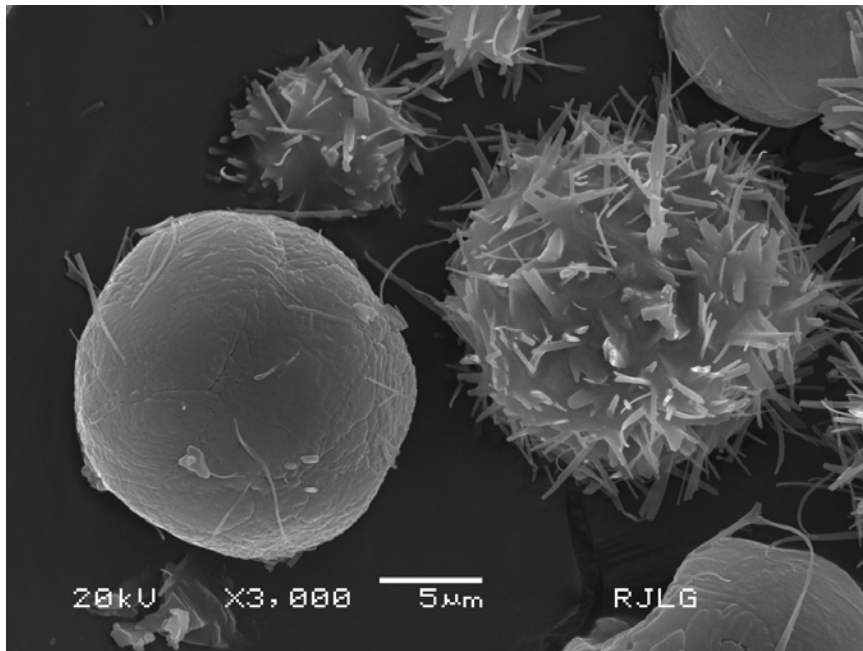
Sample Analysis – TEM or SEM

- Simplified Approach
- Evaluate Material for Unique Characteristics
 - Particle Size
 - Morphology
 - Nano-chemistry
 - Crystalline Properties
- Determine analysis protocol based on bulk analysis results

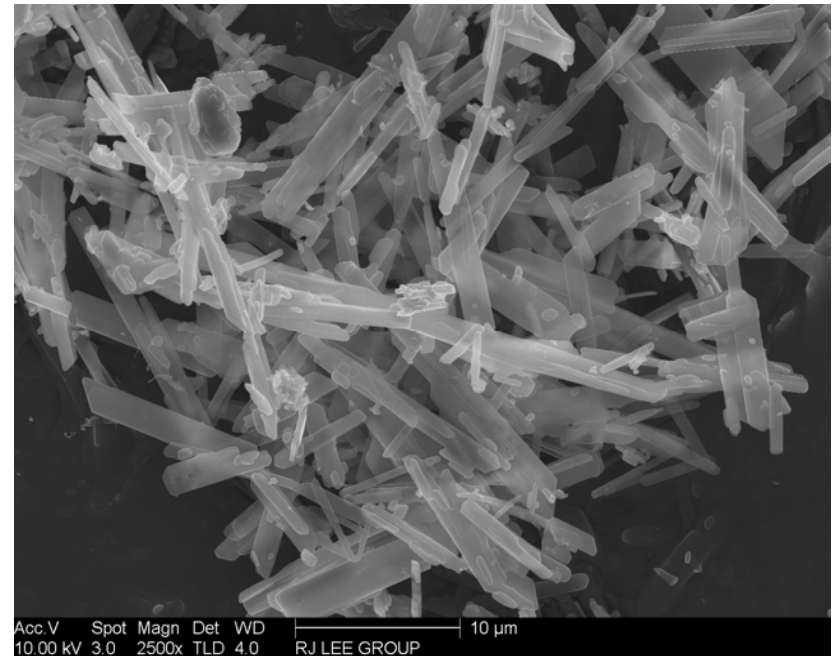




Material Identification - Morphology



▲ SEM Micrograph Displaying Different Morphologies of Two Similar Sized Particles



▲ Crystalline Morphology Obtained by SEM

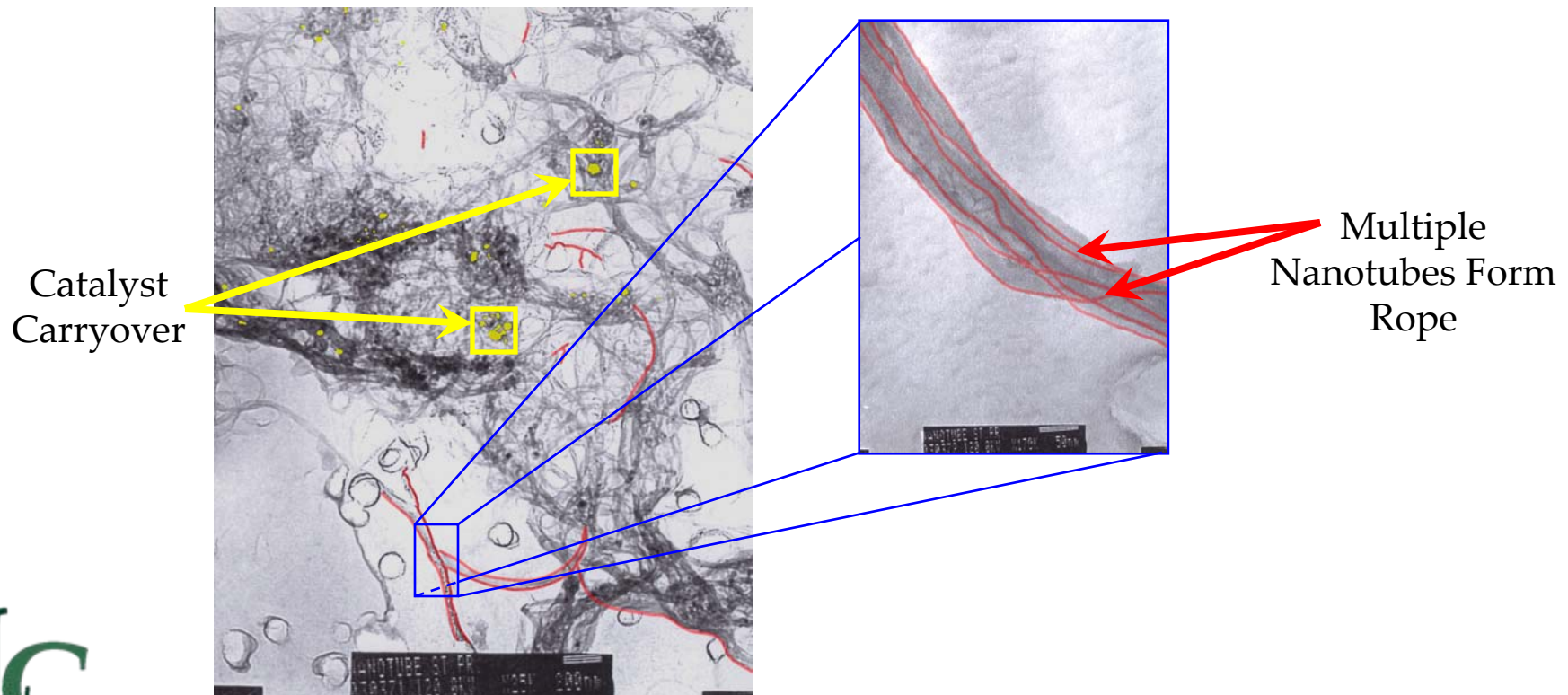
Air Samples by TEM or SEM

- Complements Direct Read Data
- Determine “Background” Levels
- Collect Samples on Polycarbonate Filters
- Speciate and Count Particles
- Establish Reference Values
 - Background
 - Control Banding
 - Surface Area Adjusted PELs



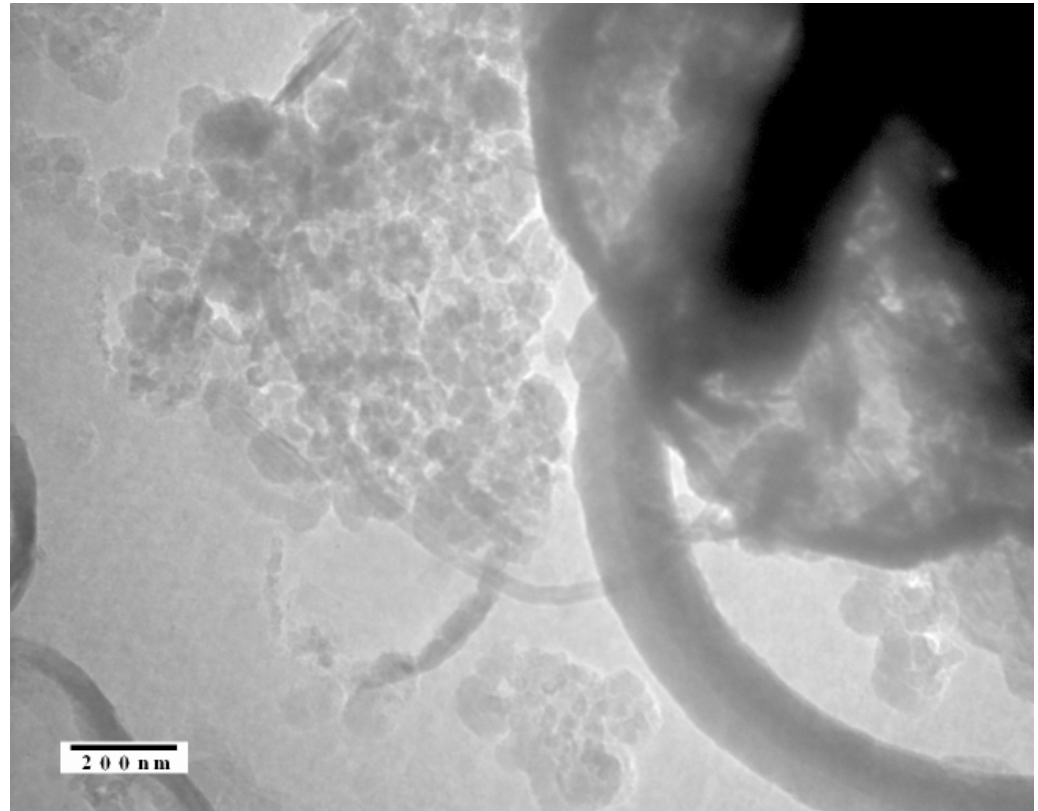
Nanoparticle Characterization

- Fullerene Nanotube Technology



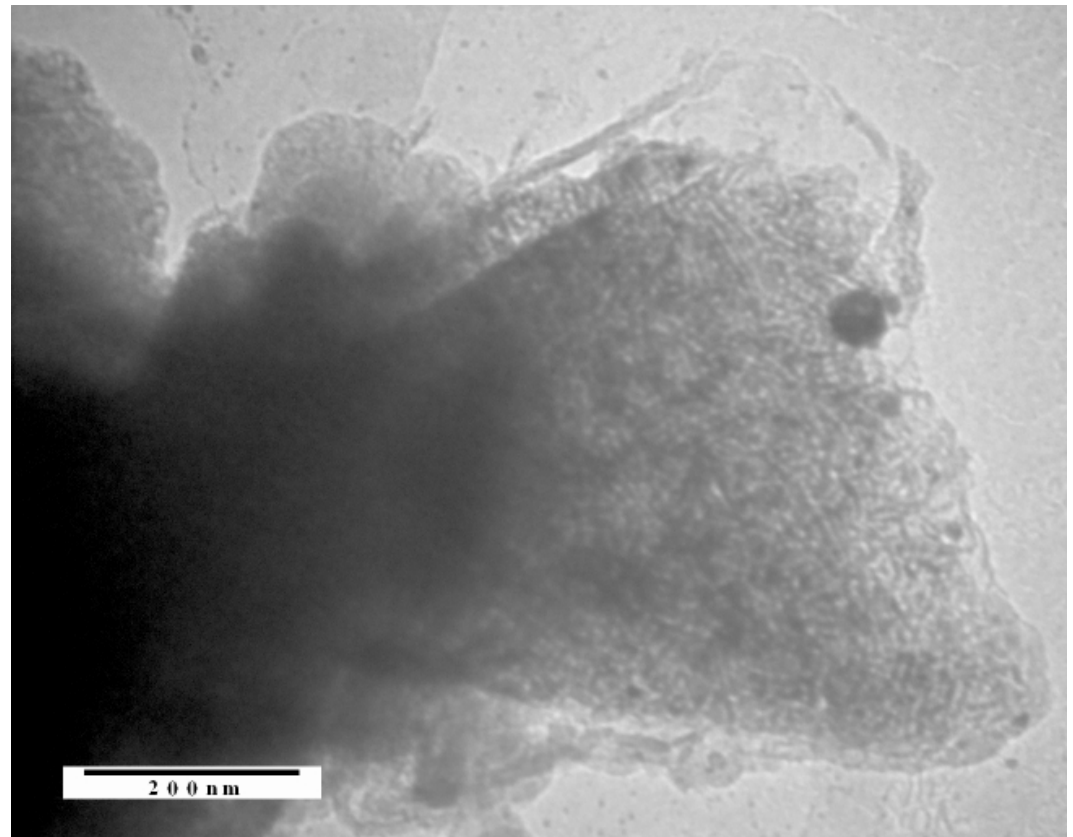
Nanoparticle Characterization

- MWCNT Agglomerate

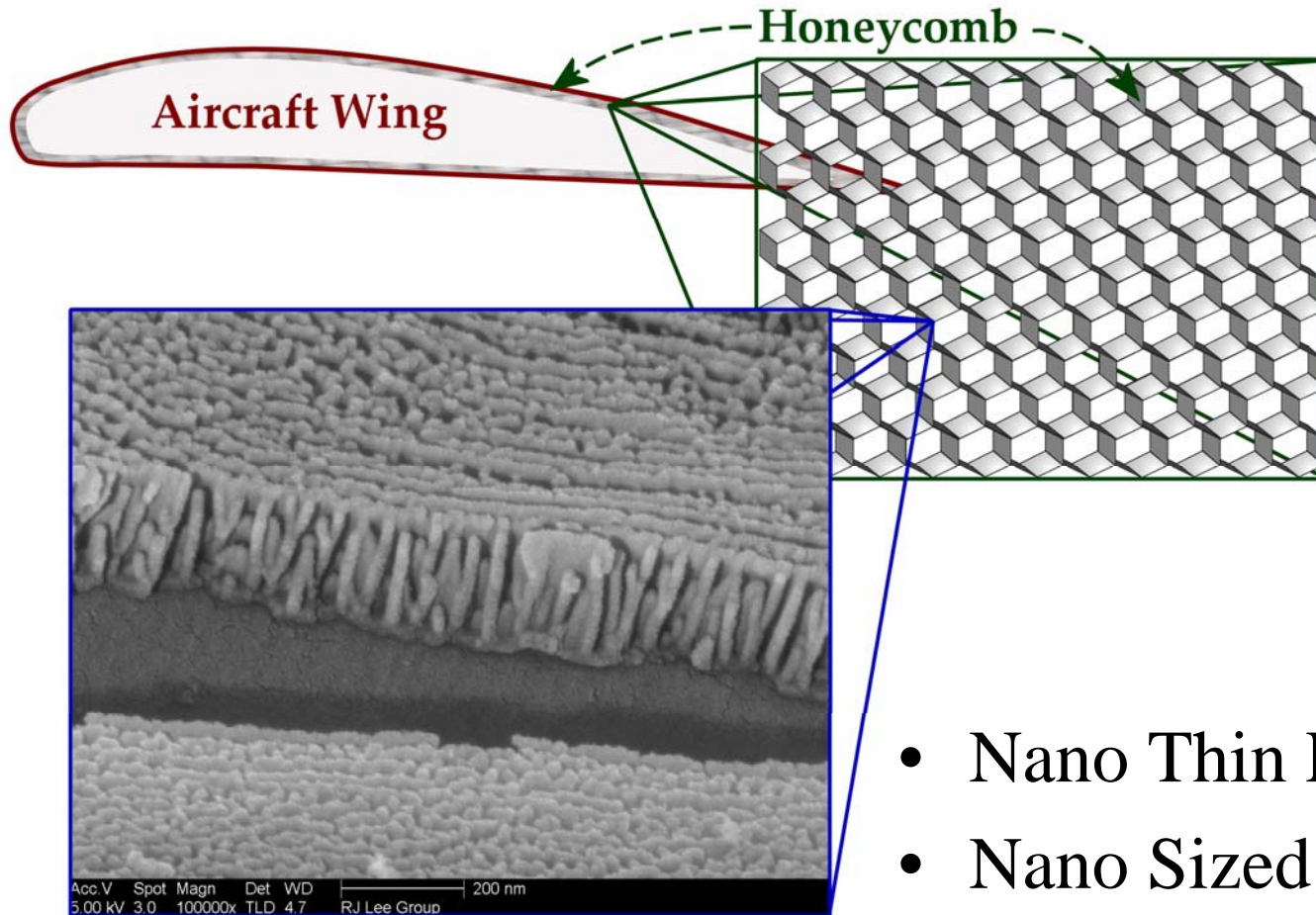


Nanoparticle Characterization

- MWCNT Aggregate



Anodized Aluminum Film



- Nano Thin Layers
- Nano Sized Features

▲ Raw Material Used in
Honeycomb for Aircraft Wings