Welcome to NACK's Webinar

Introduction to Nano-Characterization

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supporting faculty in Nanotechnology education

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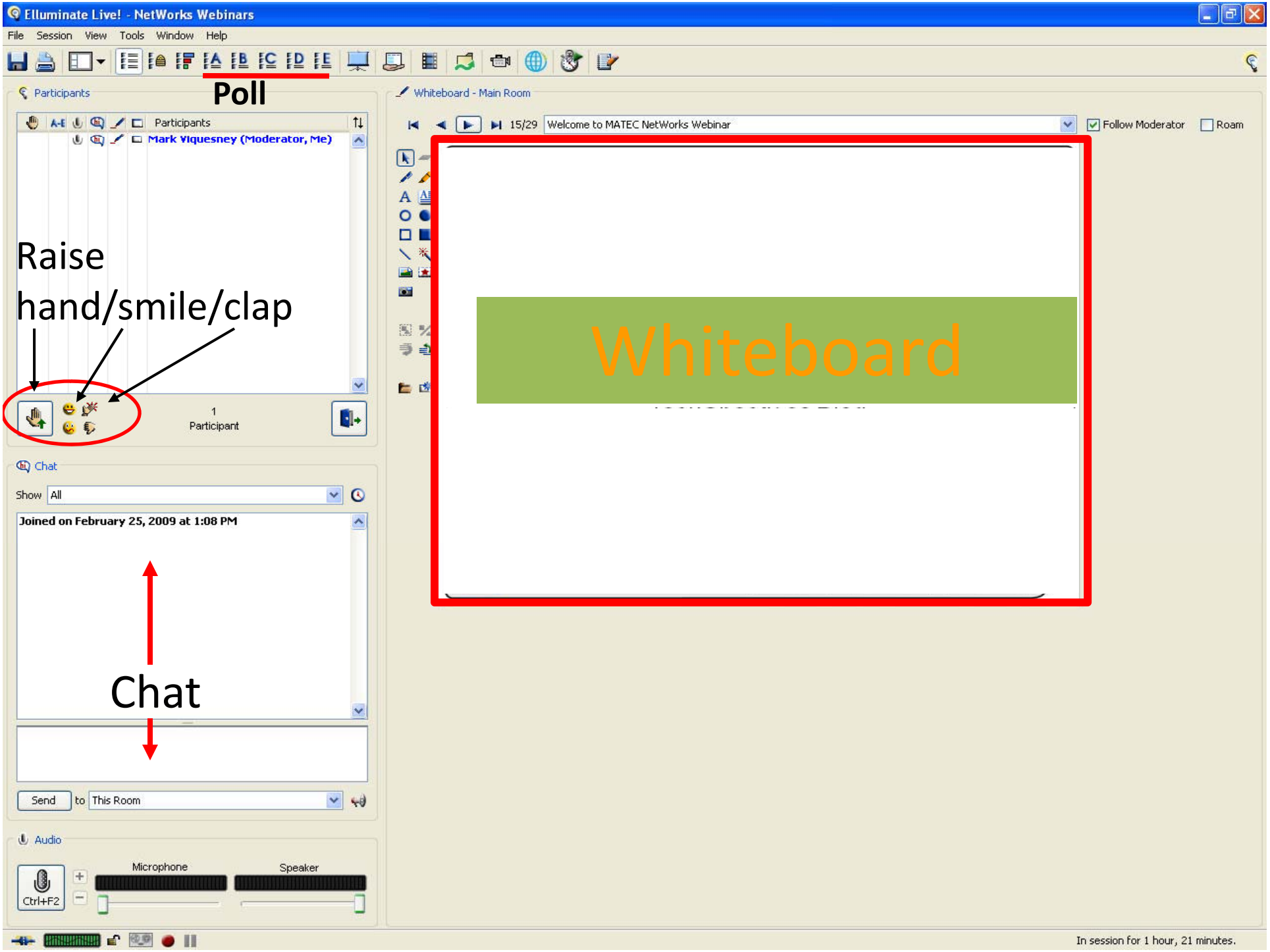
NACK is the NSF ATE National Center for Nanotechnology Applications and Career Knowledge

The NACK National Center is located at Penn State University

Funded, in part, by a grant from the National Science Foundation.
DUE-08020498

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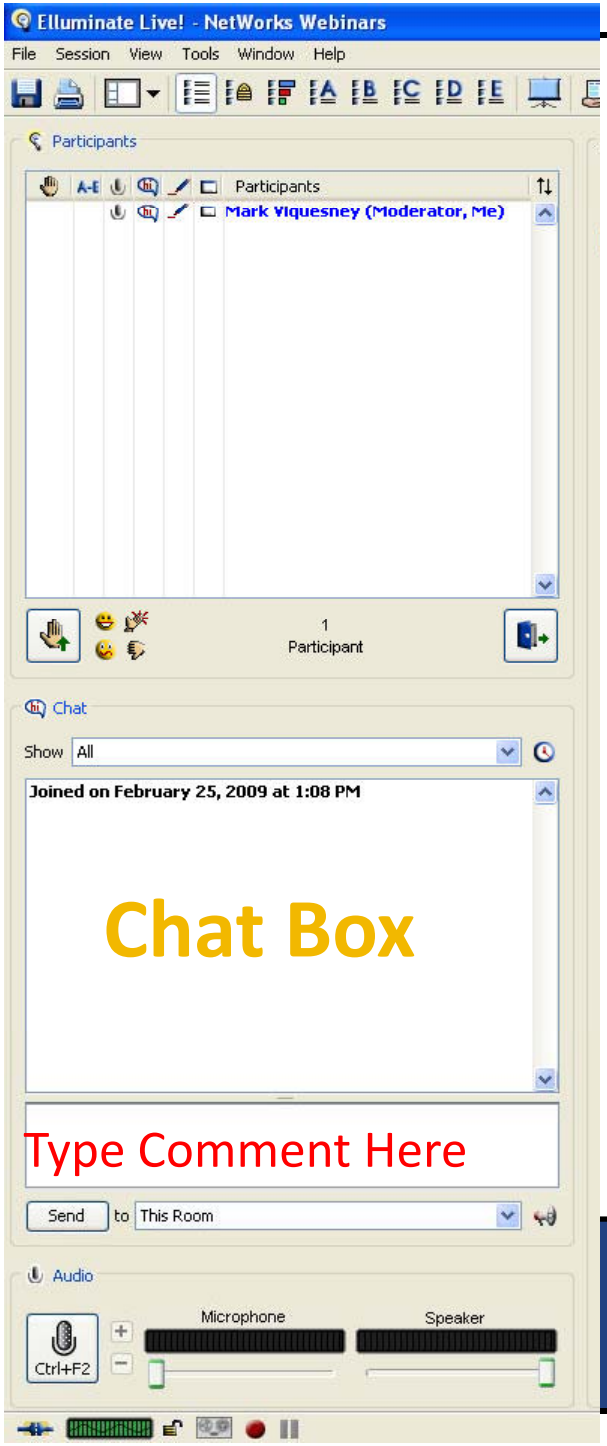
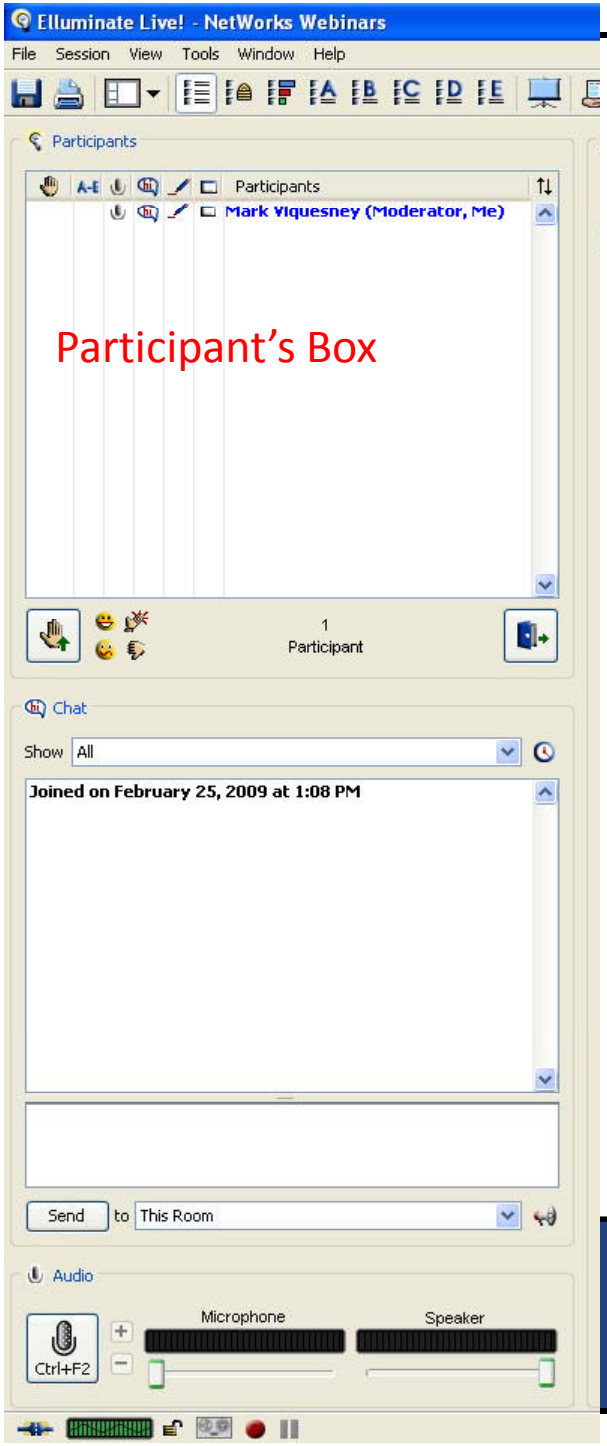


Chat Box

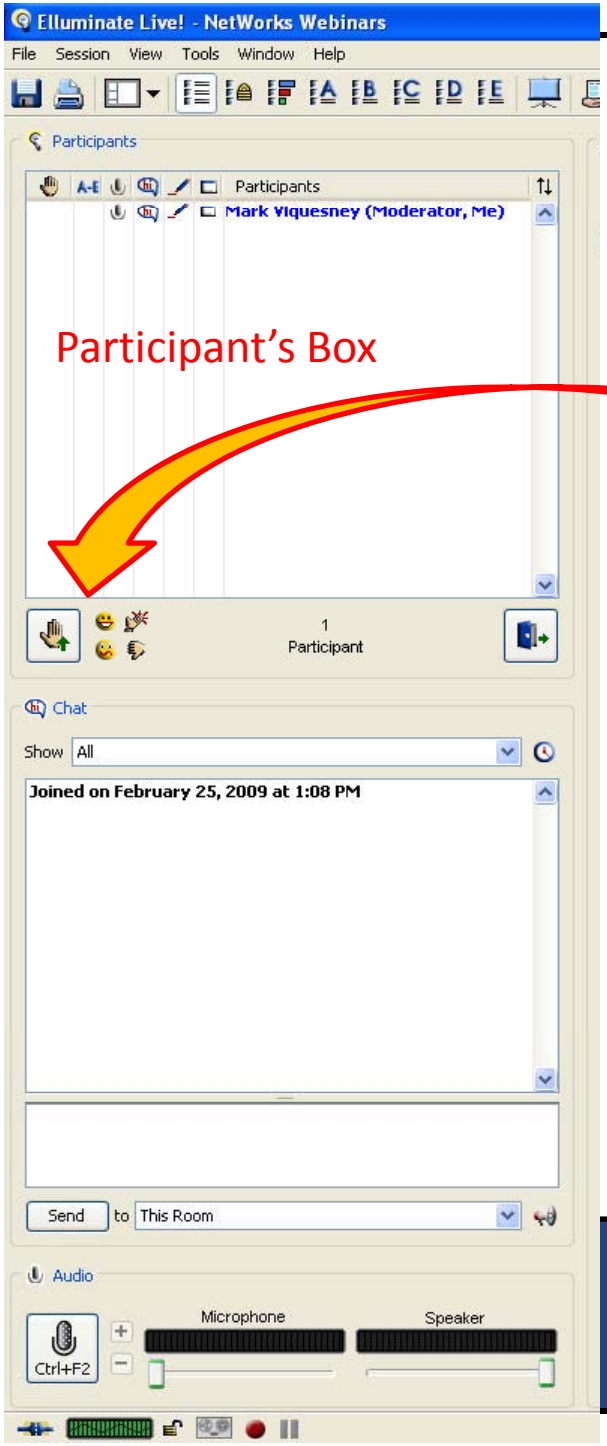
In the **Chat Box**,
please type the name of your school or organization, your location,
and how many people are attending with you today.



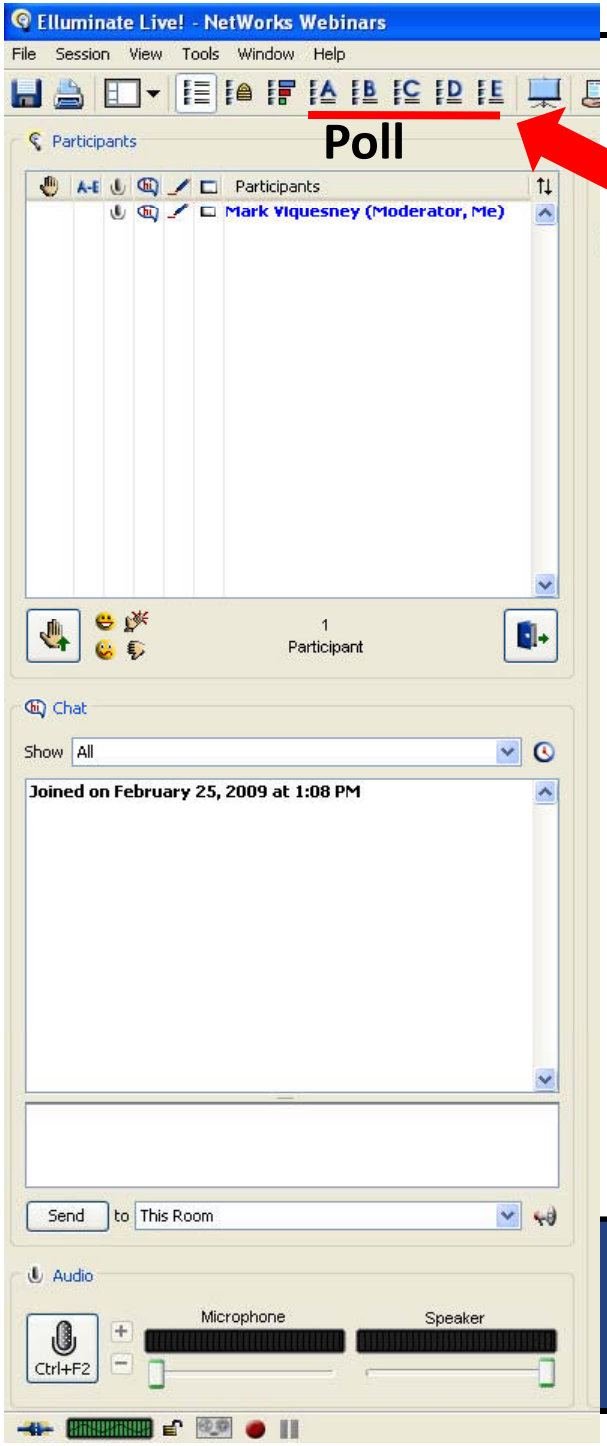
Participant's Box

Allows you to non-verbally respond to the presenter's comments.

Participant's Box



Let the presenter know if you like what they say with a smile or clap. Raise a hand if you have a question – and then type it into the chat box.



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Click A-E to take the Poll

This webinar will have a Poll. Please answer:
I heard about this webinar through:

A. @matec
B. Email from ETD list serv
C. Email from NACK
D. Friend or colleague
E. Other (please type where in chat box)

NetWorks Webinar Presenter

Jamie G. Houseknecht

- Research Associate & NMT College Recruitment Coordinator
- Center for Nanotechnology Education and Utilization (CNEU) Regional Center
- Nanotechnology Applications and Career Knowledge (NACK) National Center
- The Pennsylvania State University

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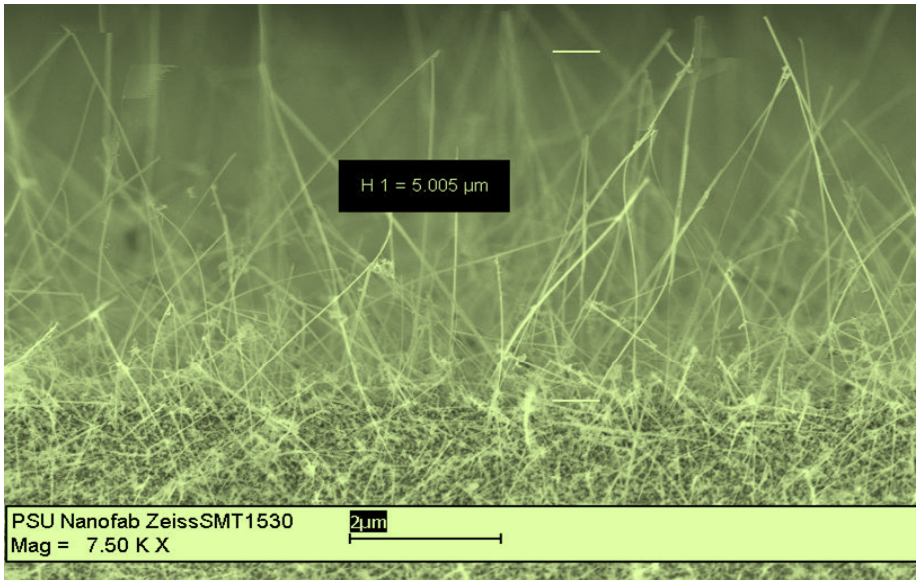
Introduction to Nano-Characterization



- What is it?
  A. Astroturf
  B. Hair Follicles
  C. Wires
  D. Grassblades

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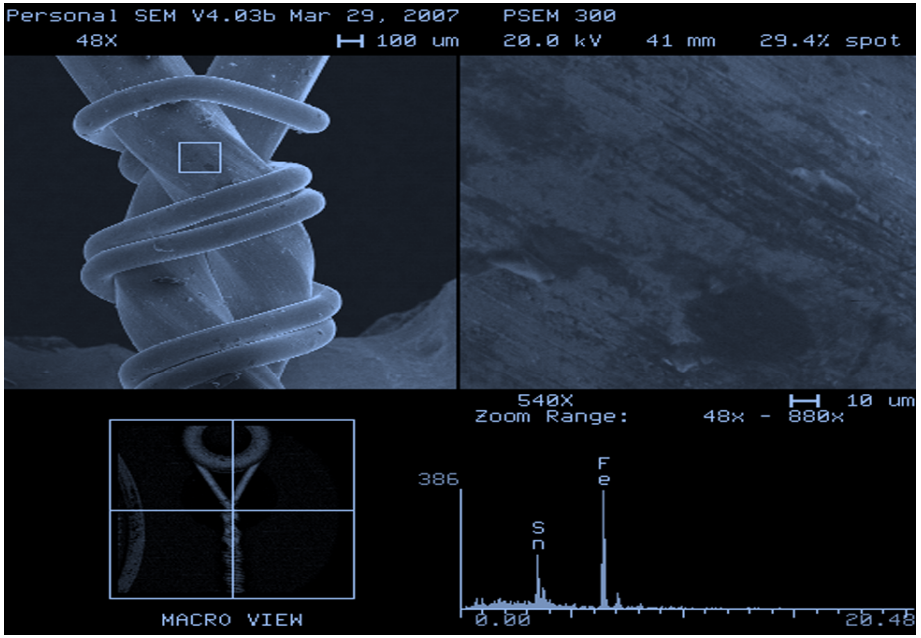
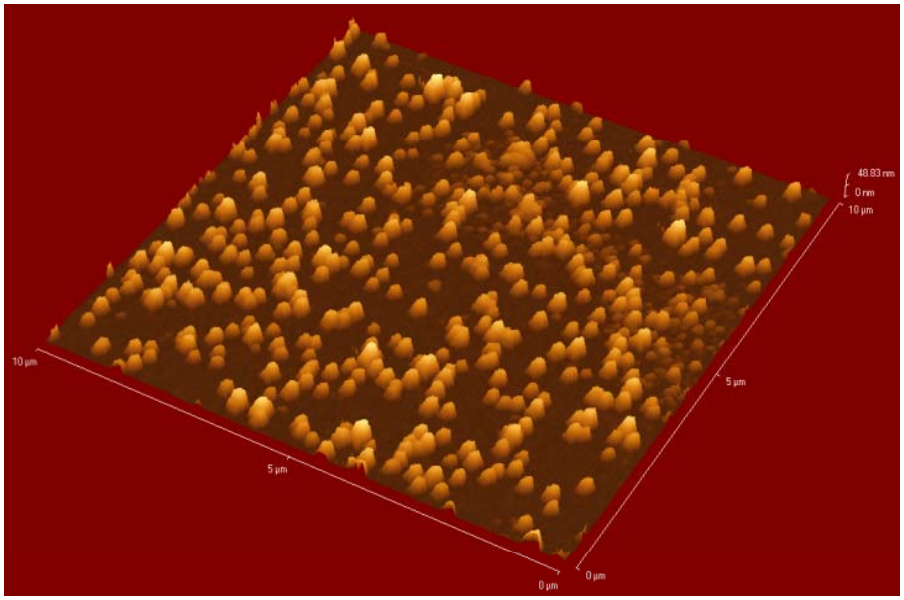
Introduction to Nano-Characterization



- What is it?
  A. Necklace
  B. String
  C. Barbwire
  D. Dental Floss



Introduction to Nano-Characterization



- What is it?
  A. Rash
  B. Mountains
  C. Cells
  D. Gold



Outline

- What is NACK?
- Nanotechnology…A “Small” Discussion
- What is Nano-Characterization?
  - How and What do we truly “see” at the nano-scale?
- What Instrumentation is Utilized?
  - SPM, SEM, TEM, STM, Profilometer.
  - How does the instrumentation “work”?
- Image Library
- What Resources are Available?
- Conclusion

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What is NACK?

- The Nanotechnology Applications and Career Knowledge (NACK) Center, a National Science Foundation Advanced Technology Education (ATE) national center.
- Located at The Pennsylvania State University in University Park, Pennsylvania.

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What is NACK? (Cont.)

- With goals of…
  - Developing a workforce for existing and emerging micro- and nanotechnology-based US industries.
  - Bringing the high-paying jobs of micro- and nanotechnology to Americans.
  - Encouraging the use of nanotechnology by industry.
  - Creating a nanotechnology-knowledgeable citizenry.
  - Continuing the very successful, resource-sharing Nanofabrication Manufacturing Technology model within Pennsylvania.

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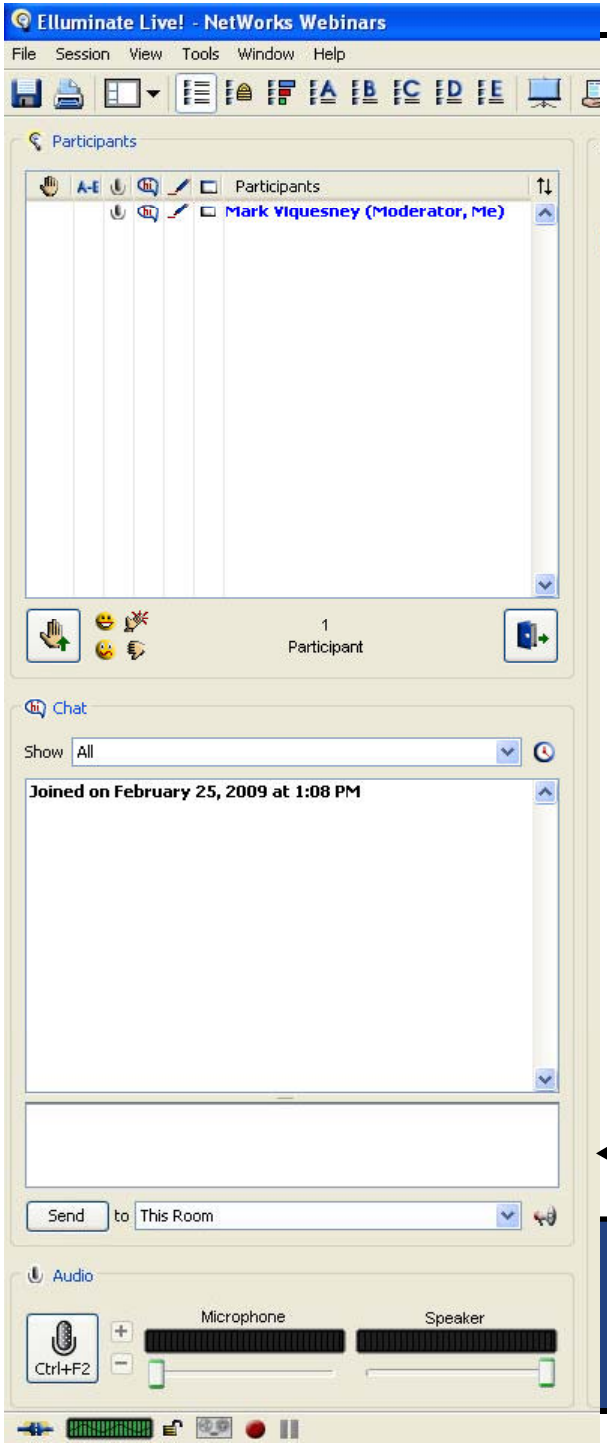

Questions?

Type them in your chat window

Nanotechnology…A “Small” Discussion

- How much do you know about nanotechnology?
  A. Almost no knowledge
  B. Very little knowledge
  C. Some knowledge
  D. A lot of knowledge

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Nanotechnology…A “Small” Discussion

- The manipulation of matter at the atomic level.
- A very broad term, impacting many scientific disciplines.
- Recall, ‘nano’ is a prefix, referring to 1×10^{-9}.
  - Or, one billionth, of a measurable quantity.

1 meter	~ 3.28 feet
1 /100th meter	1 centimeter
1/1,000th meter	1 millimeter
1/1,000,000th meter	1 micrometer
1/1,000,000,000th meter	1 nanometer

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What is Nano-Characterization?

How and What do we truly "see" at the nano-scale?

- In order to "see" at the nano-scale…
  - We need instrumentation.
  - We also need knowledge.

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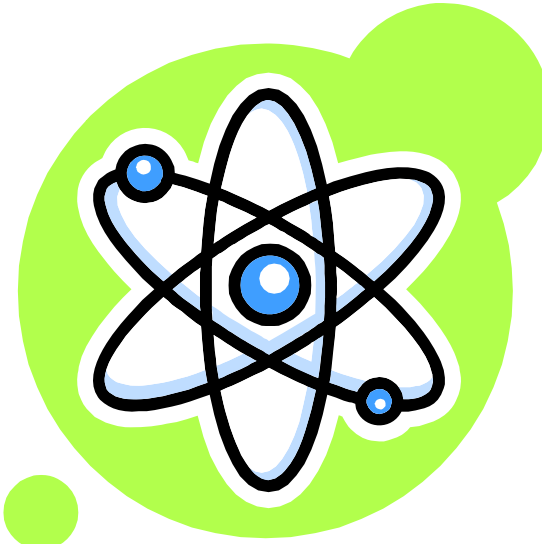
What is Nano-Characterization?

How and What do we truly "see" at the nano-scale?

- At the nano-scale, we can "see" the following:
  - Size, Shape, Structure, etc.
  - Composition of the material in question (elements).



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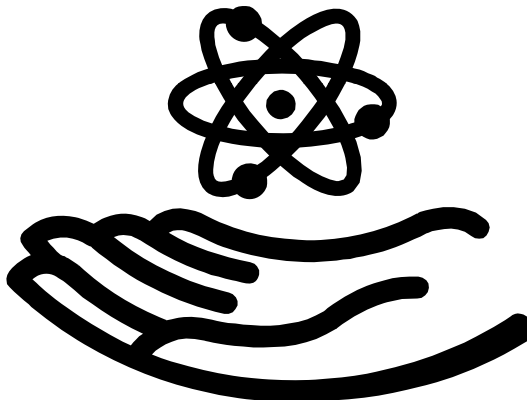
What is Nano-Characterization?

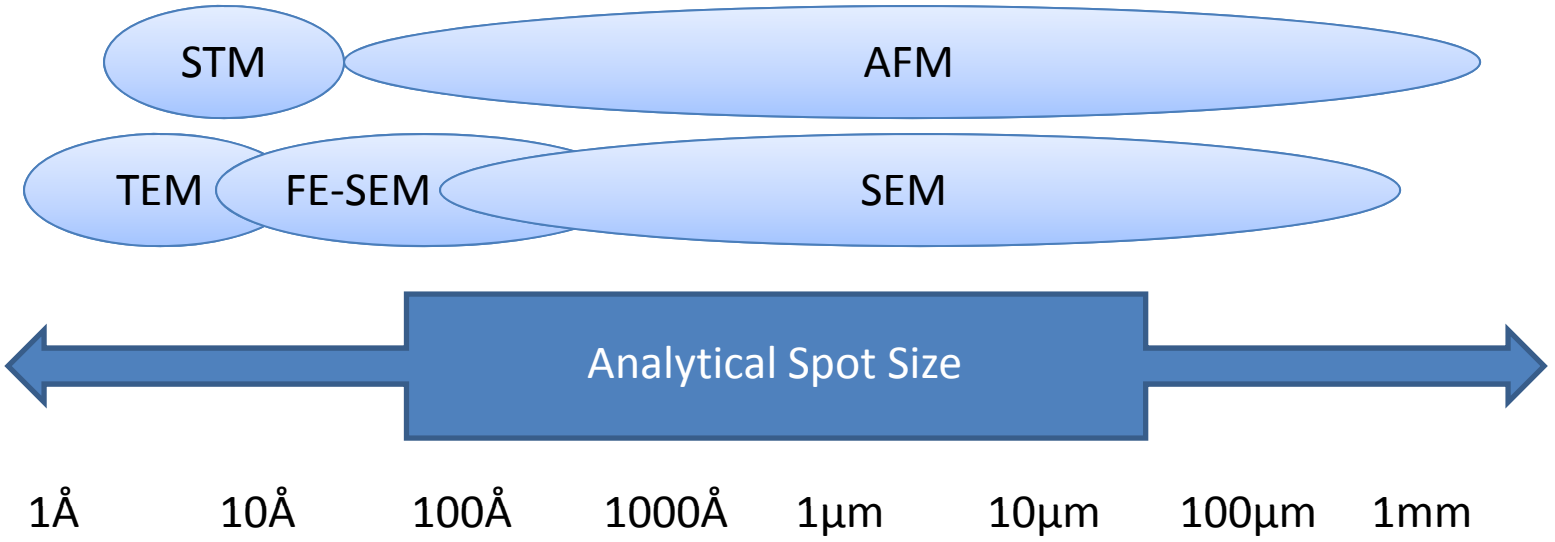
How and What do we truly "see" at the nano-scale?

- From this, we can determine the following:
  - Chemical and Physical properties.
  - How the material in question "behaves" at the nano-scale!

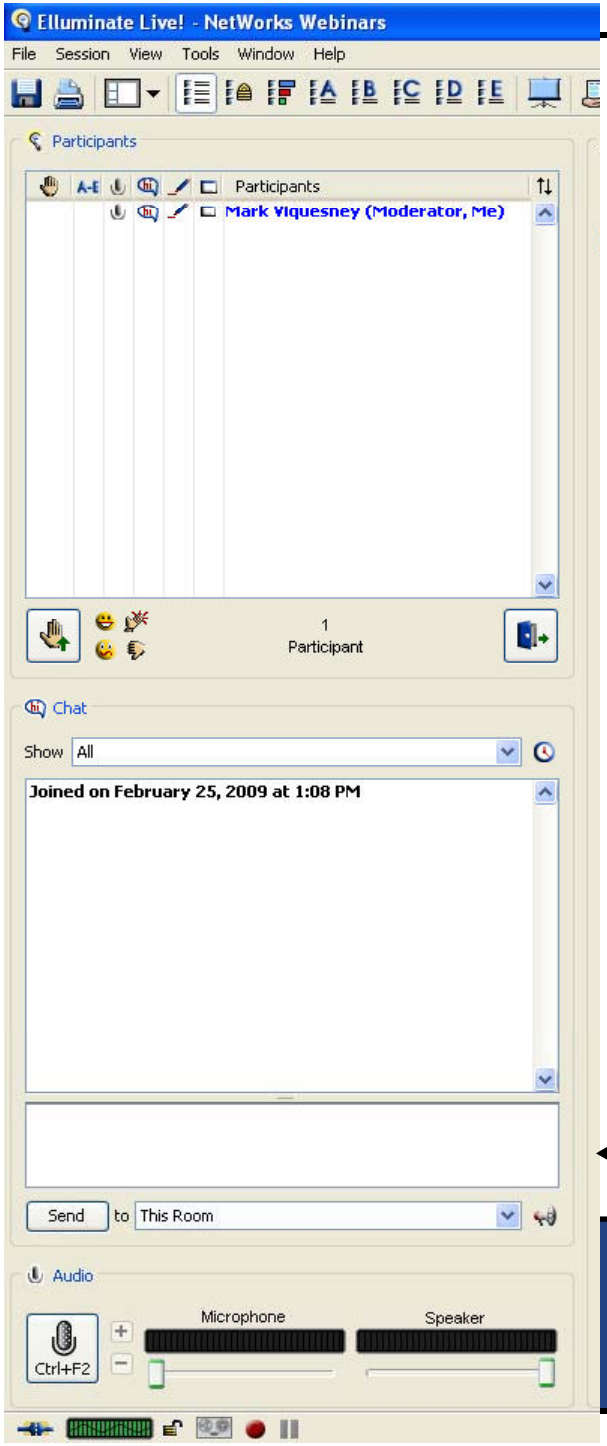


What is Nano-Characterization? (Cont.)

How and What do we truly "see" at the nano-scale?







Questions?

Type them in your chat window

What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

- Numerous techniques, which include the following:
  - Atomic Force
  - Scanning Tunneling
  - Magnetic Force
  - Lateral Force



What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

- Numerous techniques, which include the following:
  - Atomic Force
    - Numerous modes utilized:
      - Contact, Non-Contact, Intermittent
    - Uses forces between atoms of the probe and those of the surface being scanned to create an image. Can be used on any surface.
  - Scanning Tunneling
  - Magnetic Force
  - Lateral Force



What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

- Numerous techniques, which include the following:
  - Atomic Force
  - Scanning Tunneling
    - Uses quantum mechanical tunneling current between atoms of the probe and those of the surface being scanned to create an image. Can only be used on surfaces able to conduct an electric current.
  - Magnetic Force
  - Lateral Force



What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

- Numerous techniques, which include the following:
  - Atomic Force
  - Scanning Tunneling
  - Magnetic Force
    - Very tip sensitive/dependent. Sample does not need to be electrically conductive.
    - One can also observe magnetic frequency shifts, dipoles, etc., associated with a sample.
  - Lateral Force

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What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

- Numerous techniques, which include the following:
  - Atomic Force
  - Scanning Tunneling
  - Magnetic Force
  - Lateral Force
    - Deflections of the cantilever are detected, parallel to the plane of a sample's surface.
    - Surface friction, contaminant detection, and transitions between polymer components can be analyzed.

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What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)

- Veeco di CP-II

- Modes
  - Contact/Non-contact Mode
  - Lateral Force Microscopy
  - Magnetic Force Microscopy
  - PhaseImaging™
  - Scanning Tunneling Microscopy
  - Tapping Mode™

What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)

- Veeco di Innova

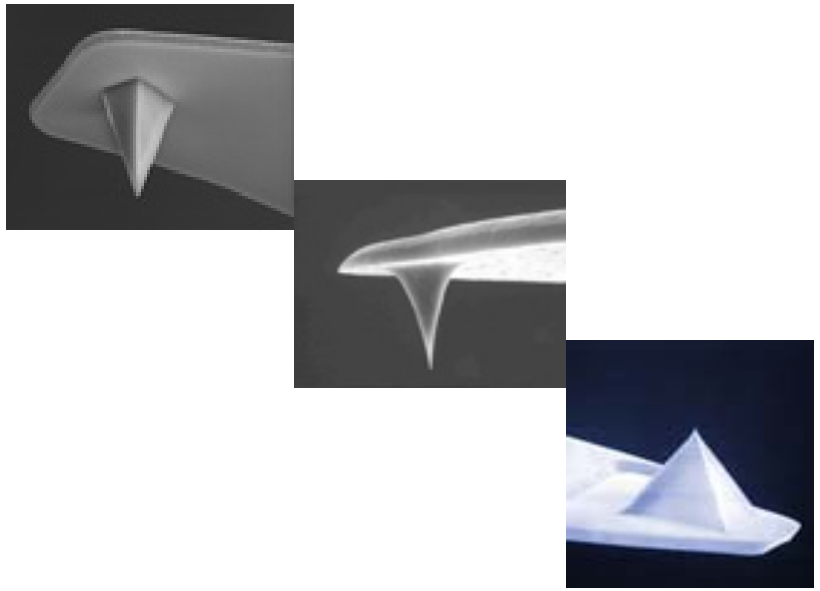
- Modes
  - Contact/Non-contact Mode
  - Electrostatic Force Microscopy
  - Force-Distance Measurements
  - Force Modulation Microscopy
  - PhaseImaging™
  - Magnetic Force Microscopy
  - Scanning Capacitance Microscopy
  - Scanning Tunneling Microscopy
  - Surface Potential
  - TappingMode™
  - *Conductive Atomic Force Microscopy (optional)*

What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)

- Something in common with all SPM techniques…Probes.
- The type of probe dictates the type of measurement and the force applied to the sample.
- Specifications
  - Spring constant
  - Resonance frequency
  - Tip radius
  - Cantilever dimensions



Images Courtesy of:
http://www.VeecoProbes.com

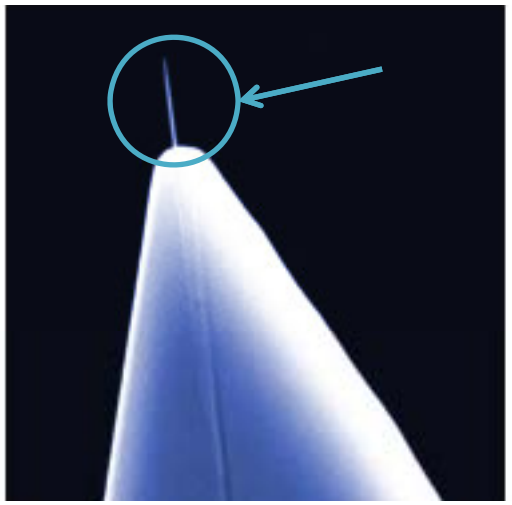


What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)

- Does the following statement make sense?
  - The smaller the probe, the smaller of something we can manipulate, detect, and “see”.
  - Check this out!
    - A carbon nanotube, on the end of an SPM probe tip.
    - Talk about precision!



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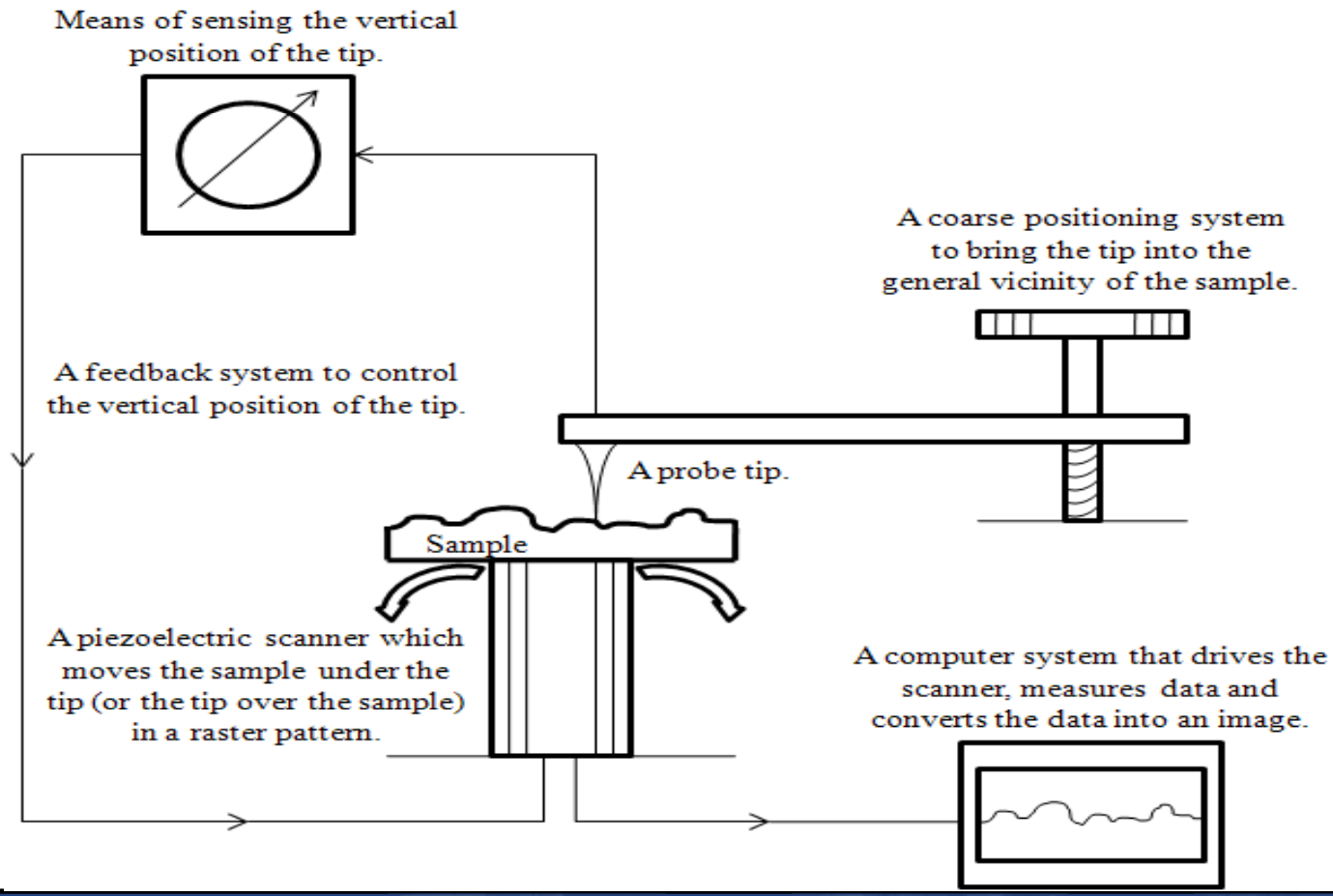
What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

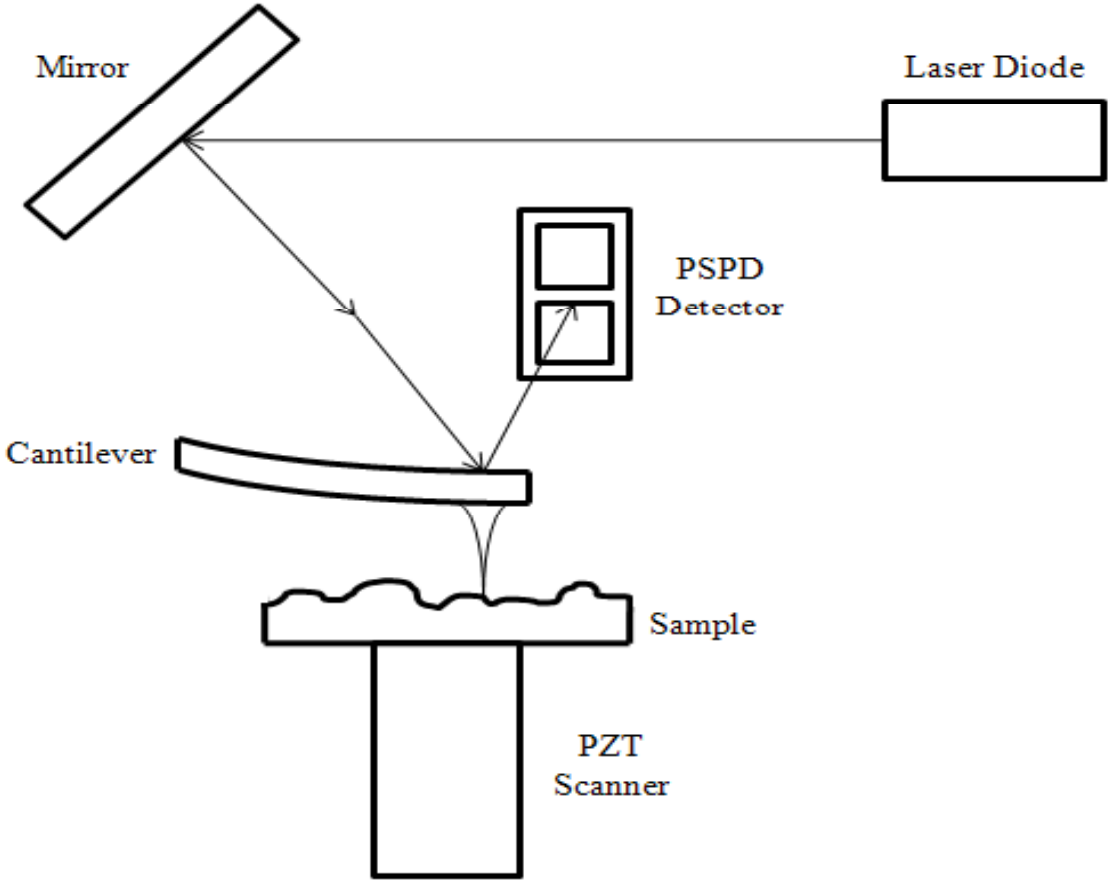
(Cont.)



What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)

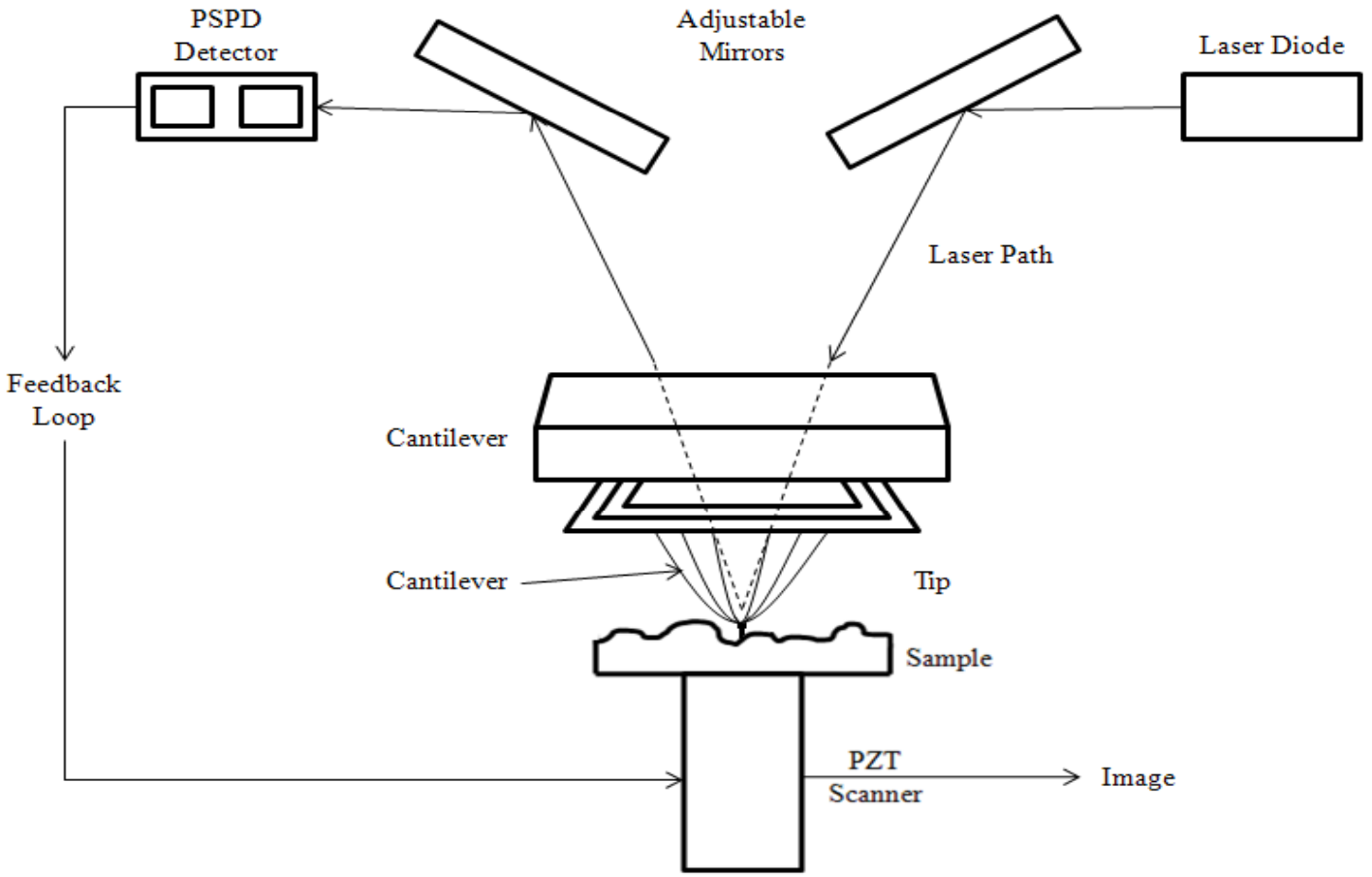




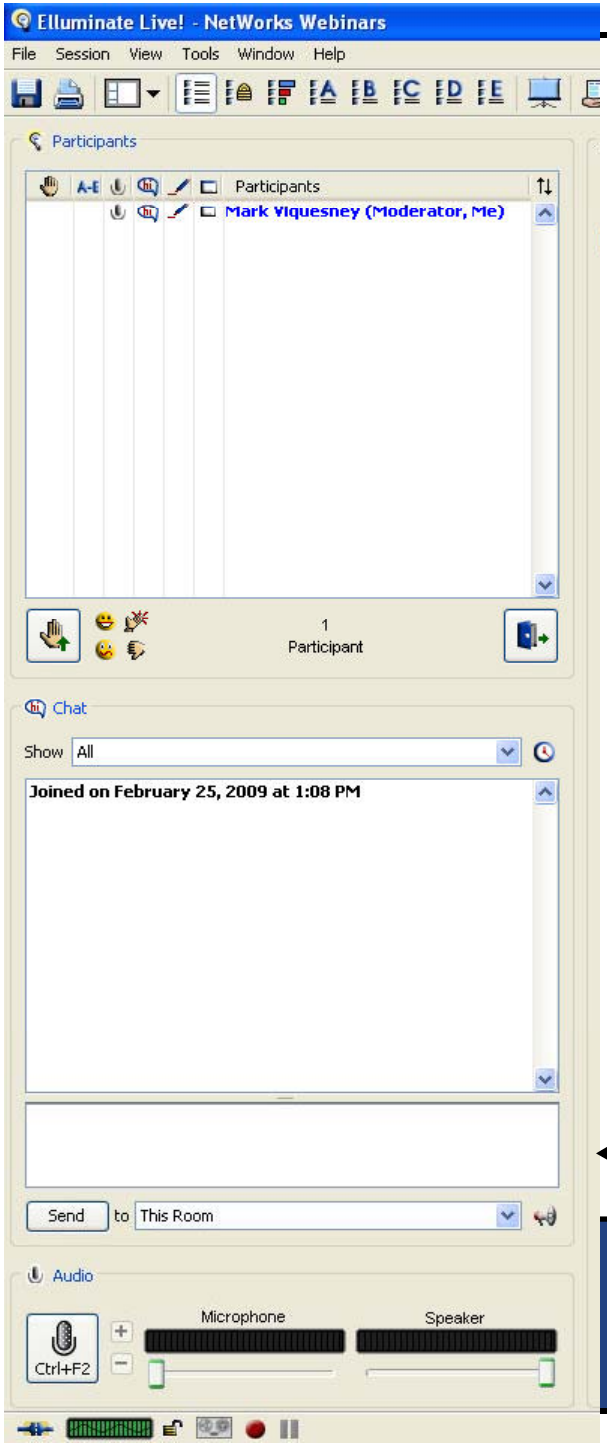
What Instrumentation is Utilized?

Scanning Probe Microscopy (SPM)

(Cont.)







Questions?

Type them in your chat window

What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

- Electrons are used for imaging samples of various compositions.
  - This includes, but not limited to:
    - TEM – “using” transmitted electrons to “see”.
    - SEM – “using” backscattered electrons to “see”.
    - And variations thereof.
  - Numerous other techniques exist, however, not discussed here in great detail.

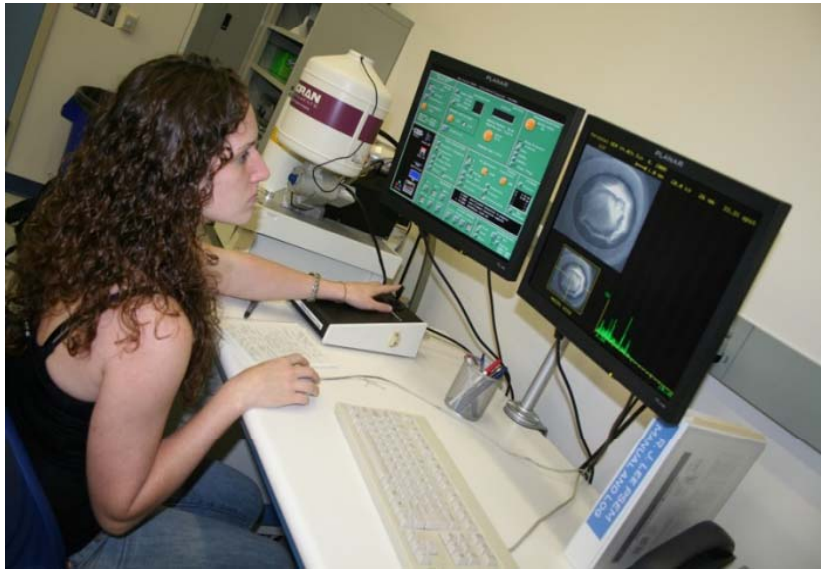


What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

- R.J. Lee Personal SEM



- Specifications
  - Peak Magnification of 200,000X.
  - Operating Pressure up to 10^{-6} Torr.
  - Voltage Range between 2kV and 15kV.

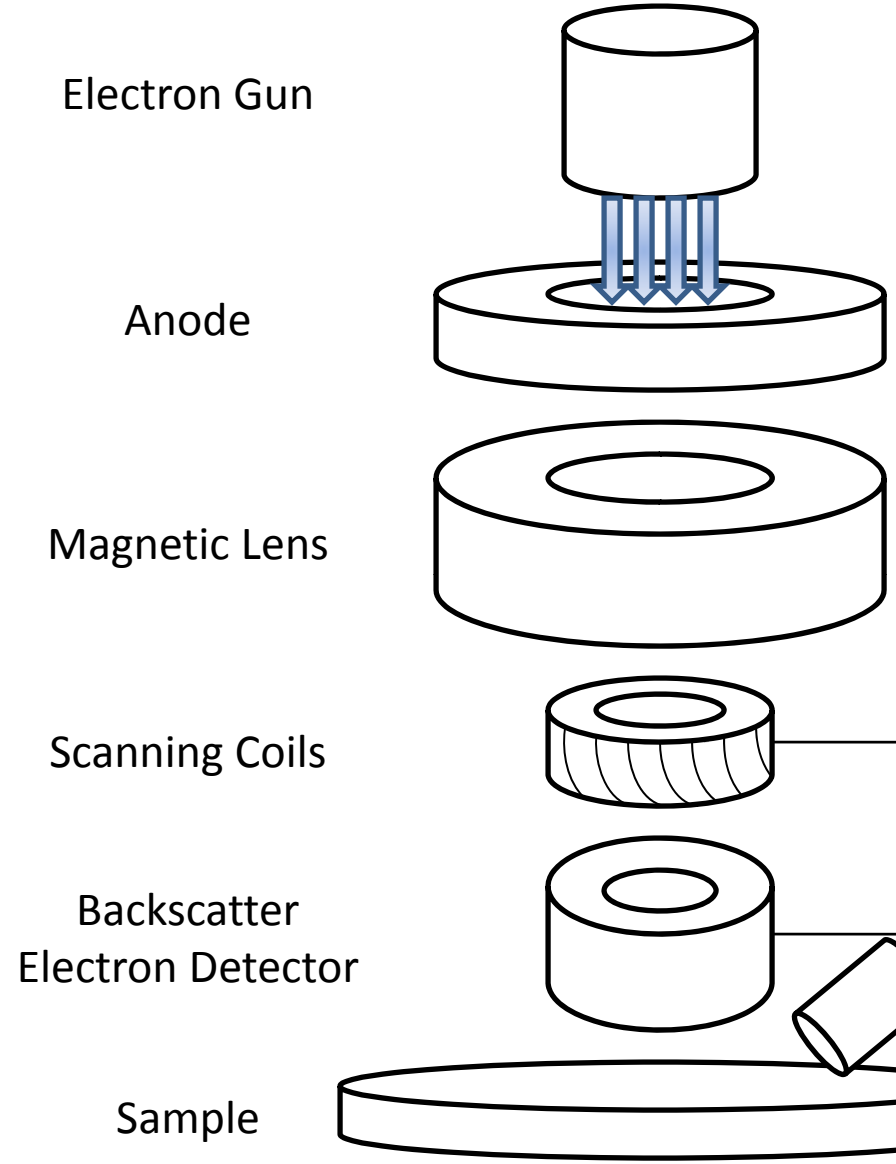
What Instrumentation is Utilized?

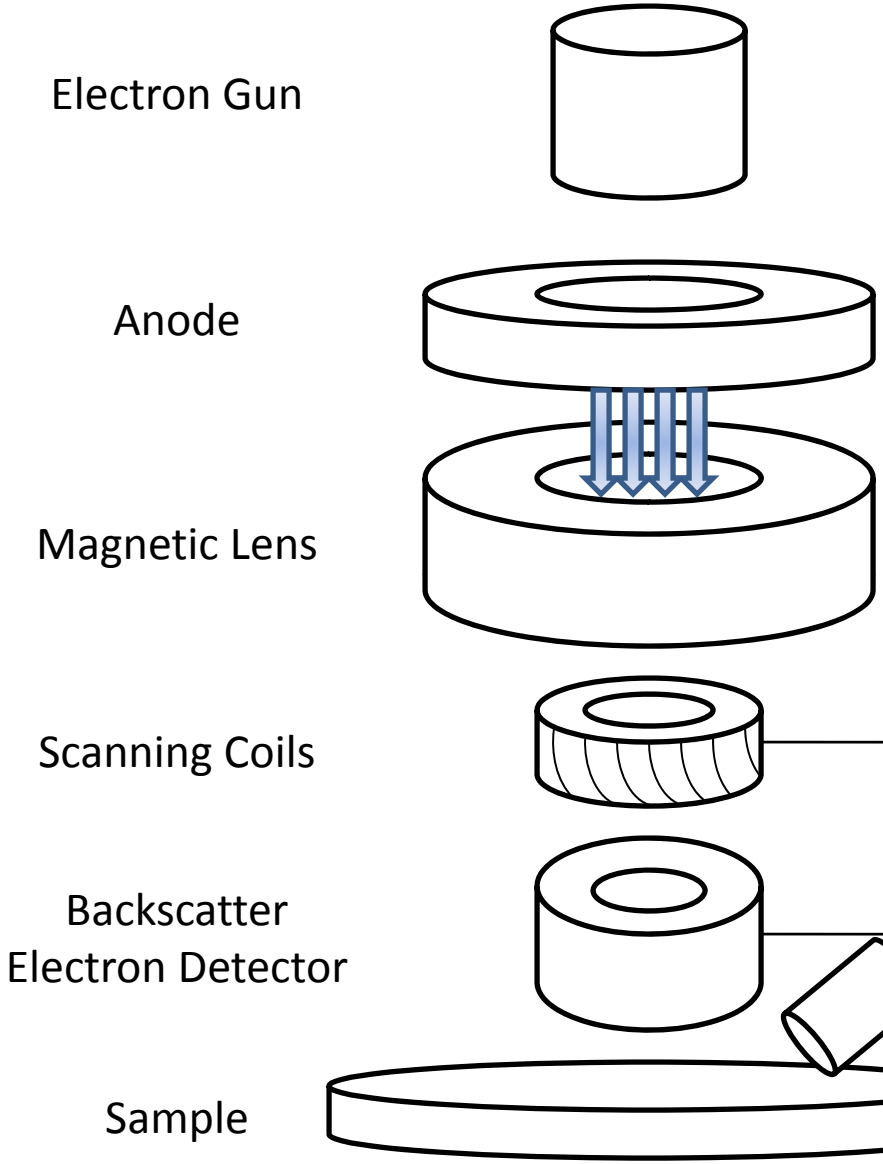
Scanning Electron Microscopy (SEM)

(Cont.)

- Zeiss Ultra55 FE-SEM

- Specifications
  - Peak Magnification of 900,000X.
  - Operating Pressure up to 10^{-10} Torr.
  - Voltage Range between 100V and 30kV.


Electron Gun
Anode
Magnetic Lens
Scanning Coils
To Scanning Circuit and Computer for Image Processing
Backscatter Electron Detector
Secondary Electron Detector
Sample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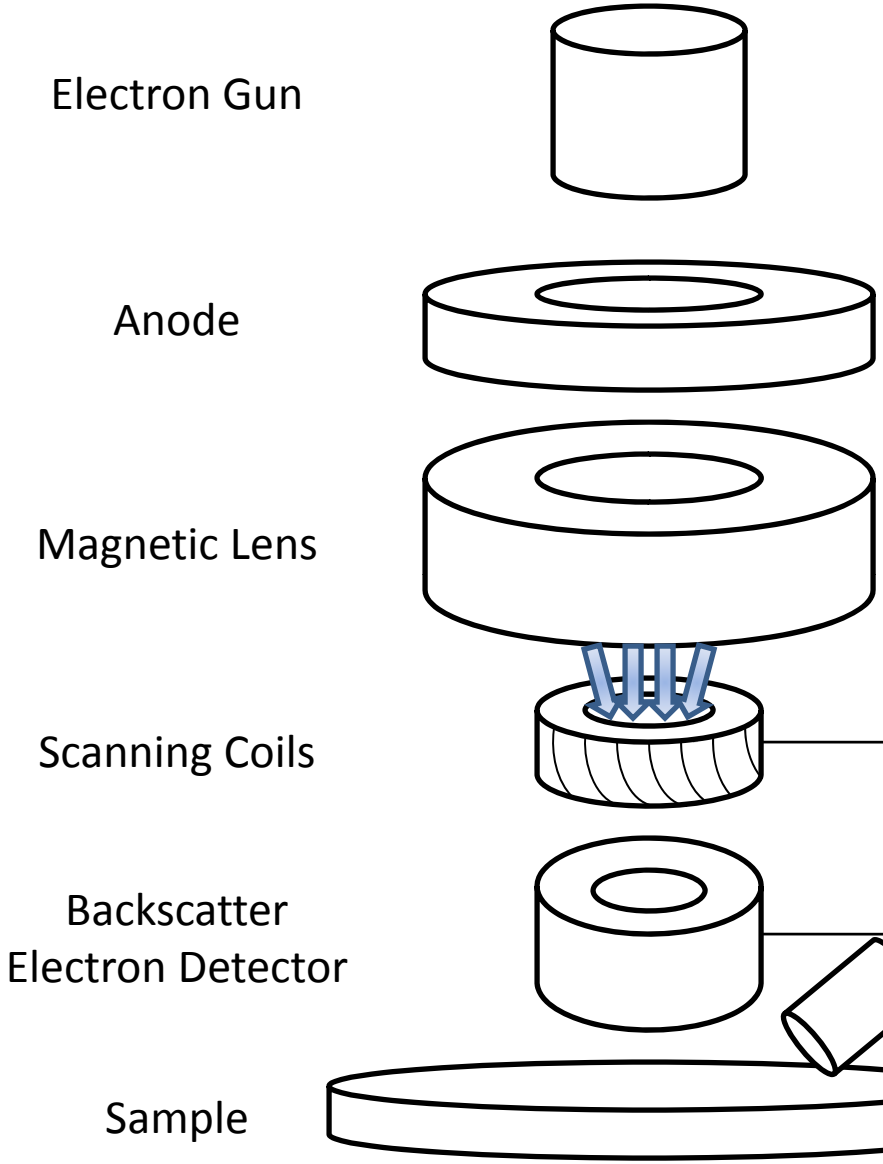
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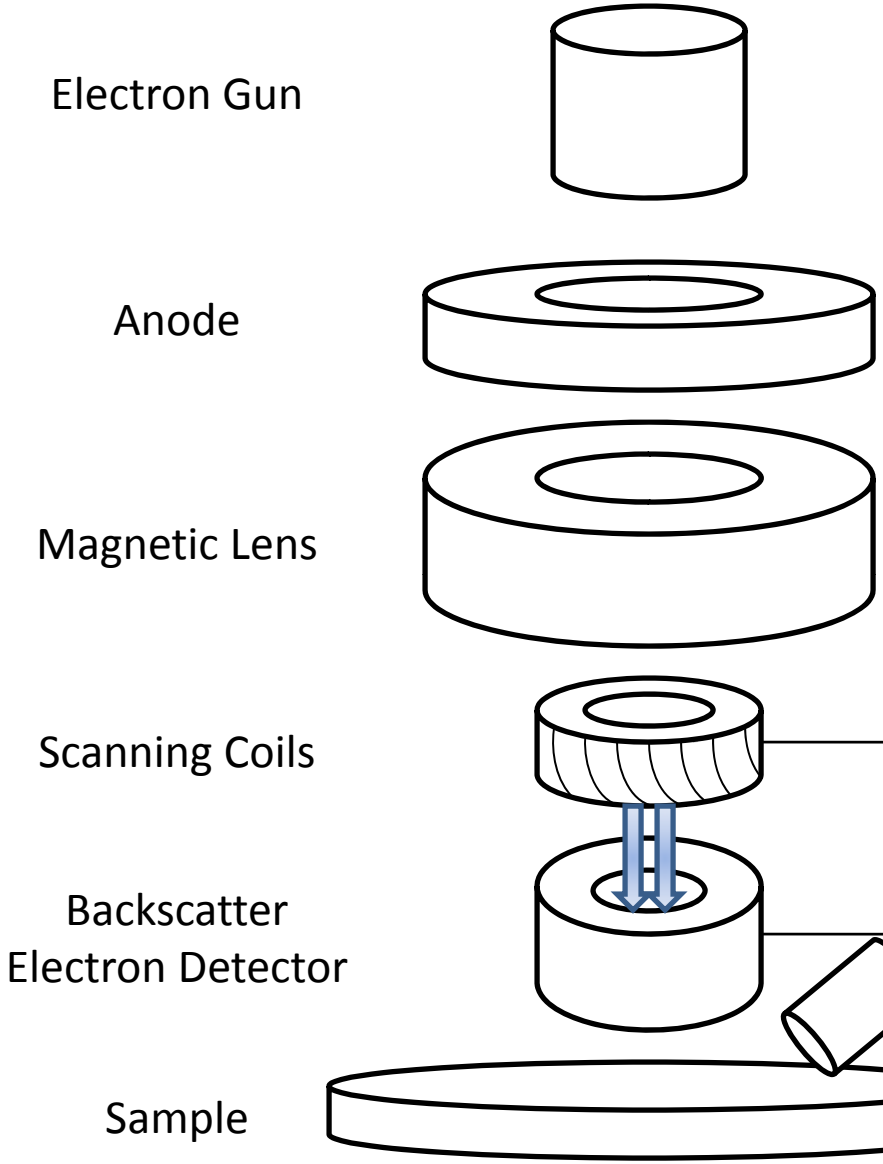
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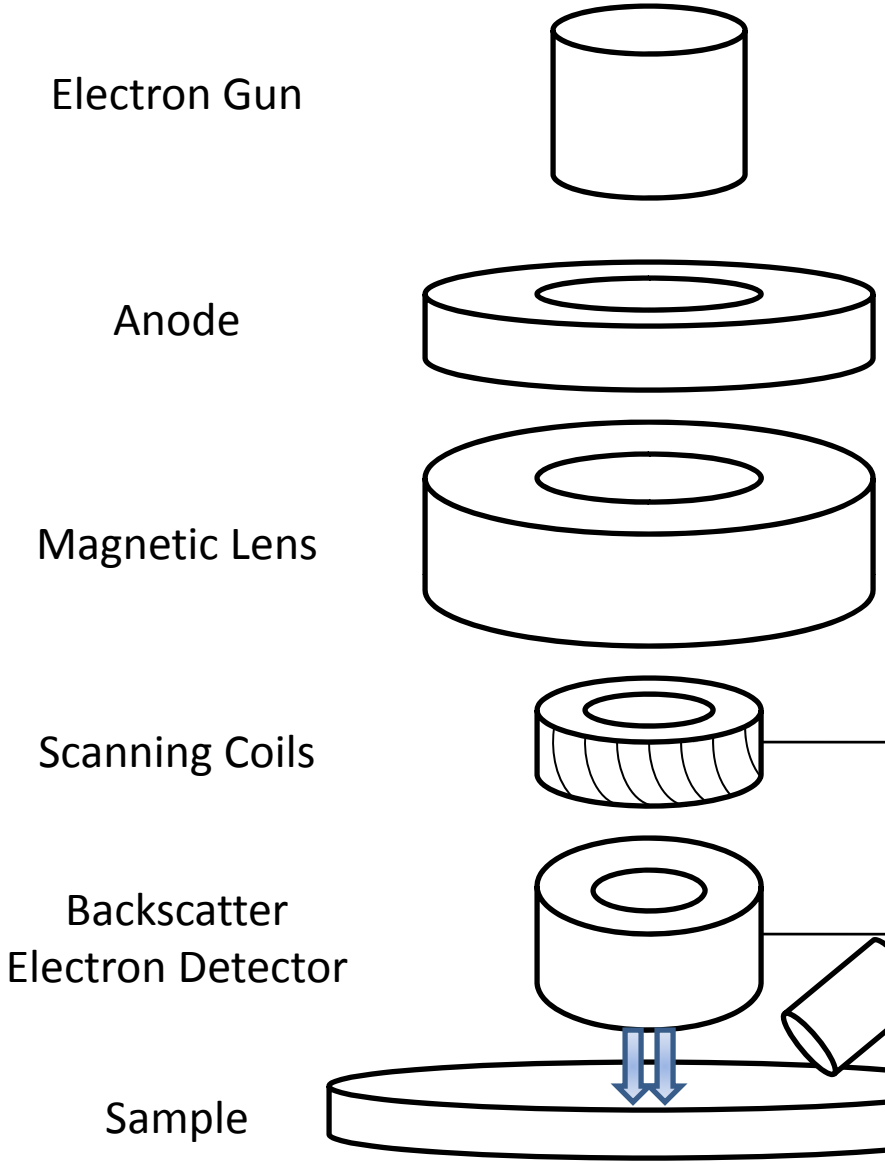
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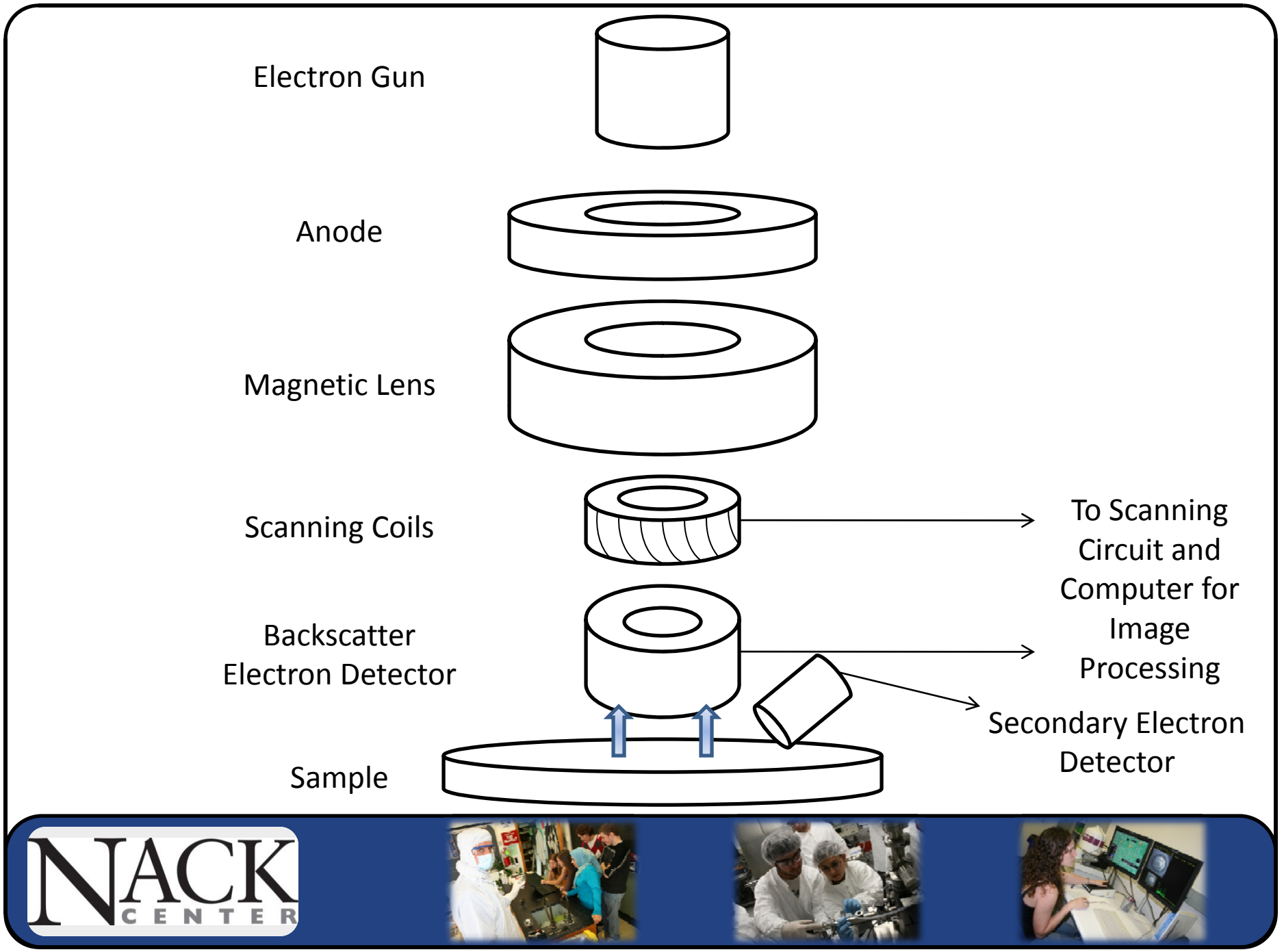
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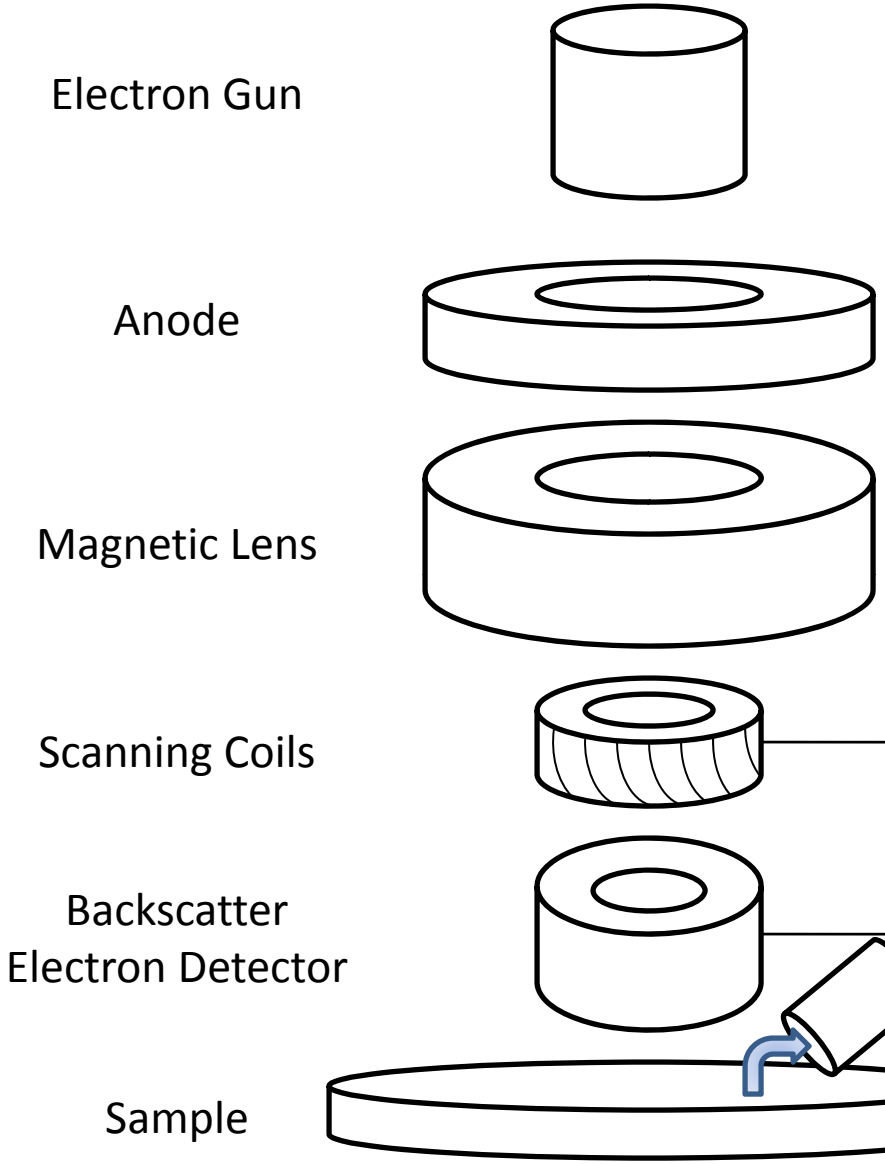
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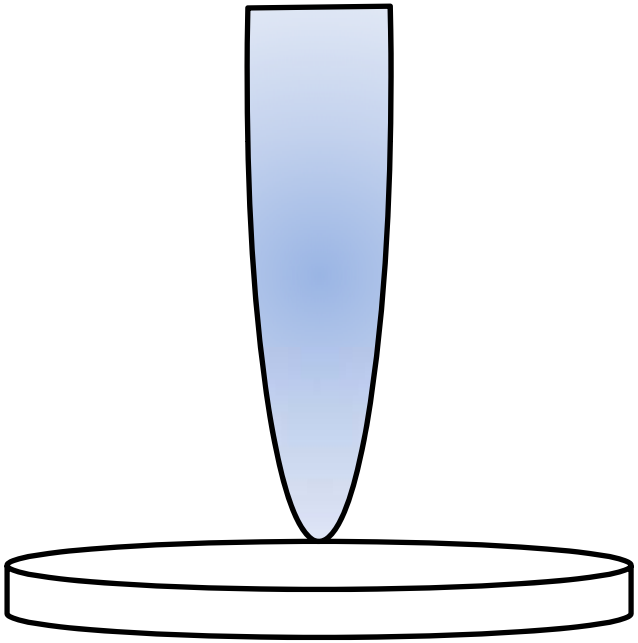
Secondary Electron Detector
Sample

What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

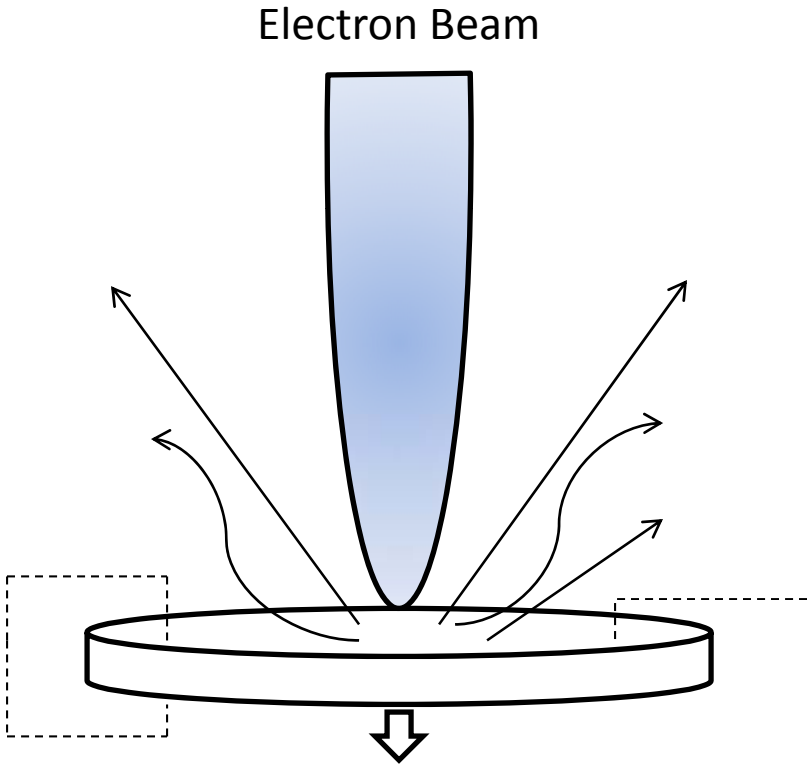
Electron Beam



What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)



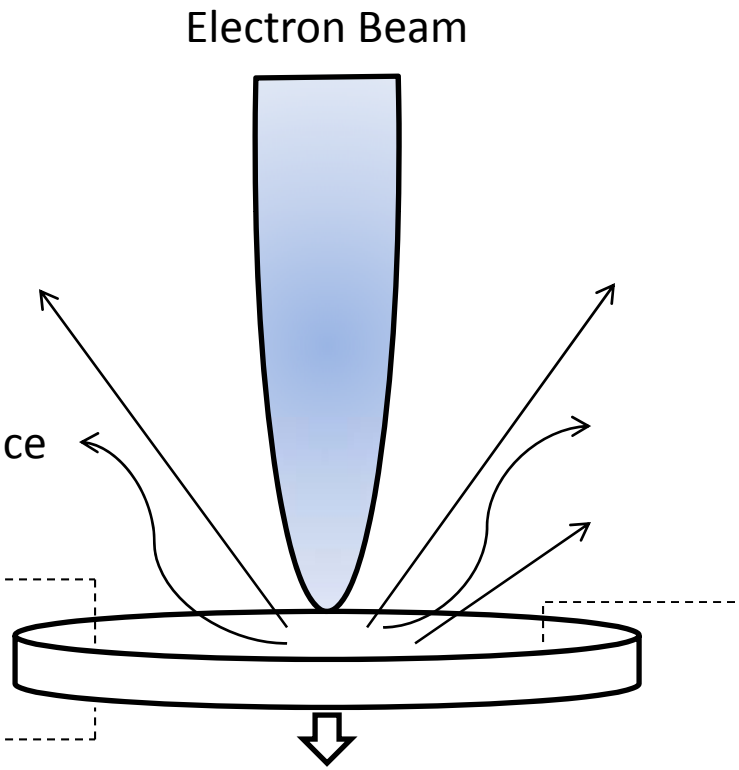
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

What do these "tell" us?

Internal Characteristics, electrical information.





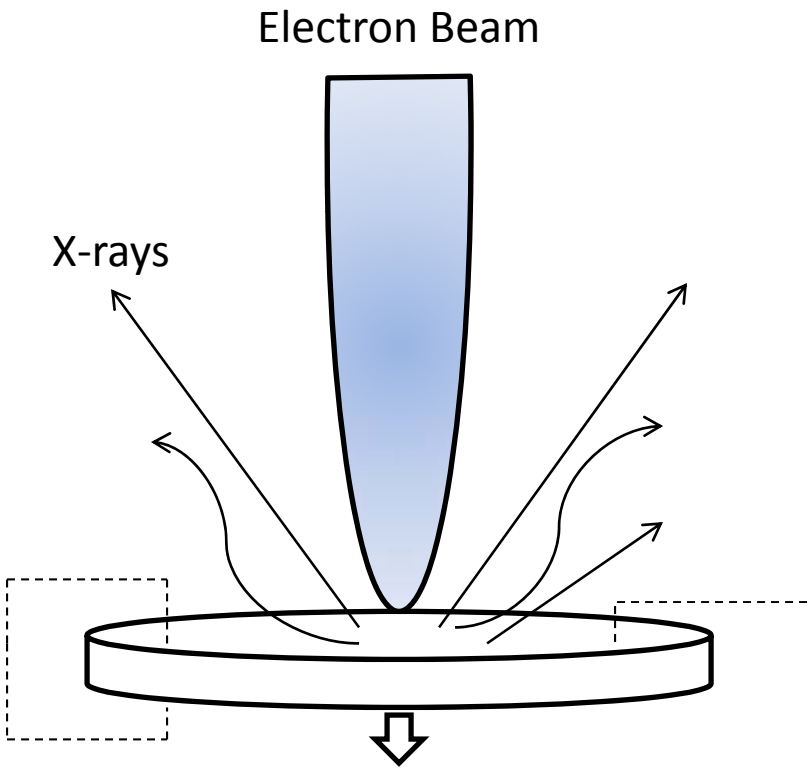
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

<u>What does this "tell" us?</u>

Elemental analysis, through thickness of sample.





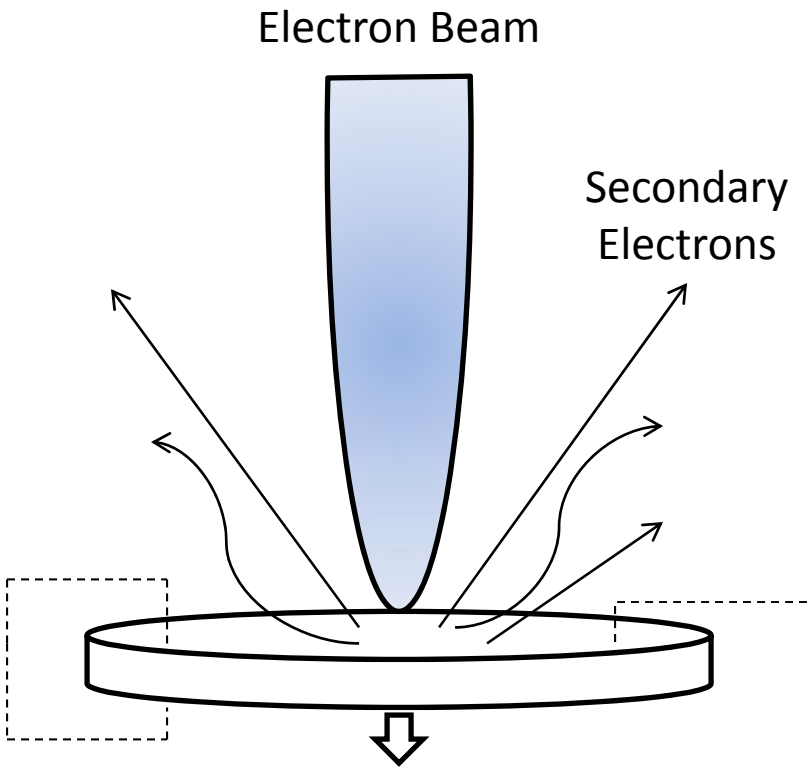
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

What does this "tell" us?

Topographical observation of the surface, lends to crystalline structure.





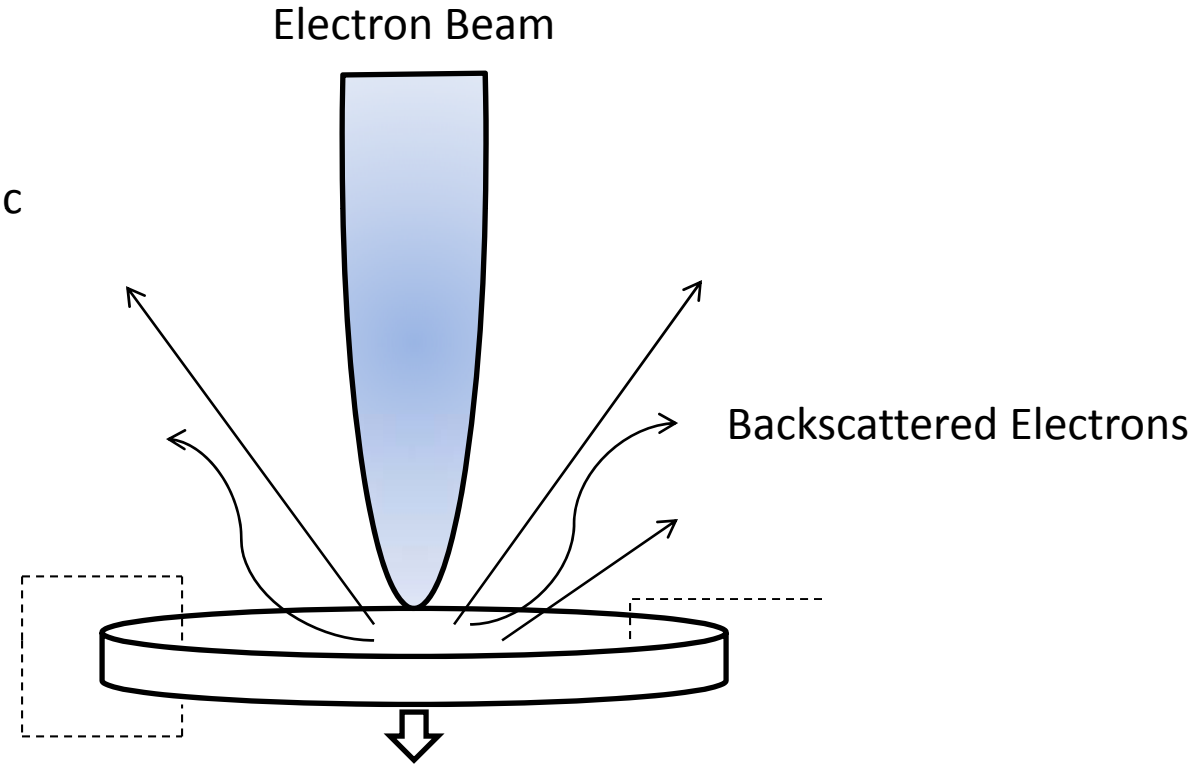
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

What does this "tell" us?

Compositional observation of the surface, lends to atomic number.





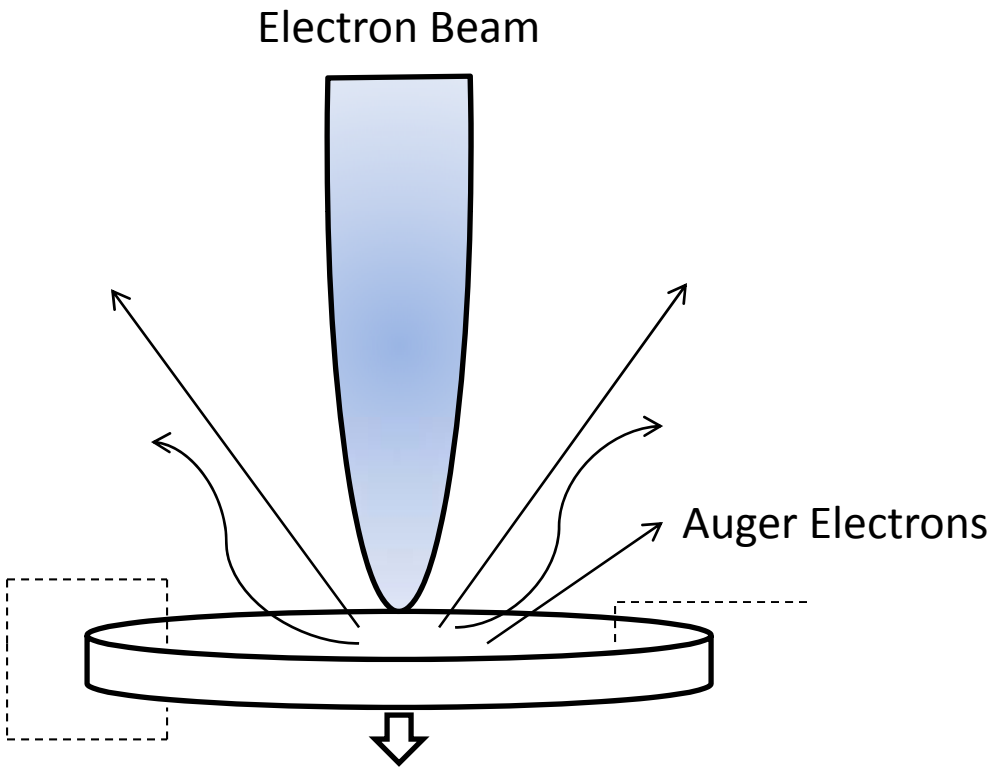
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

What does this "tell" us?

Compositional information, surface sensitive.





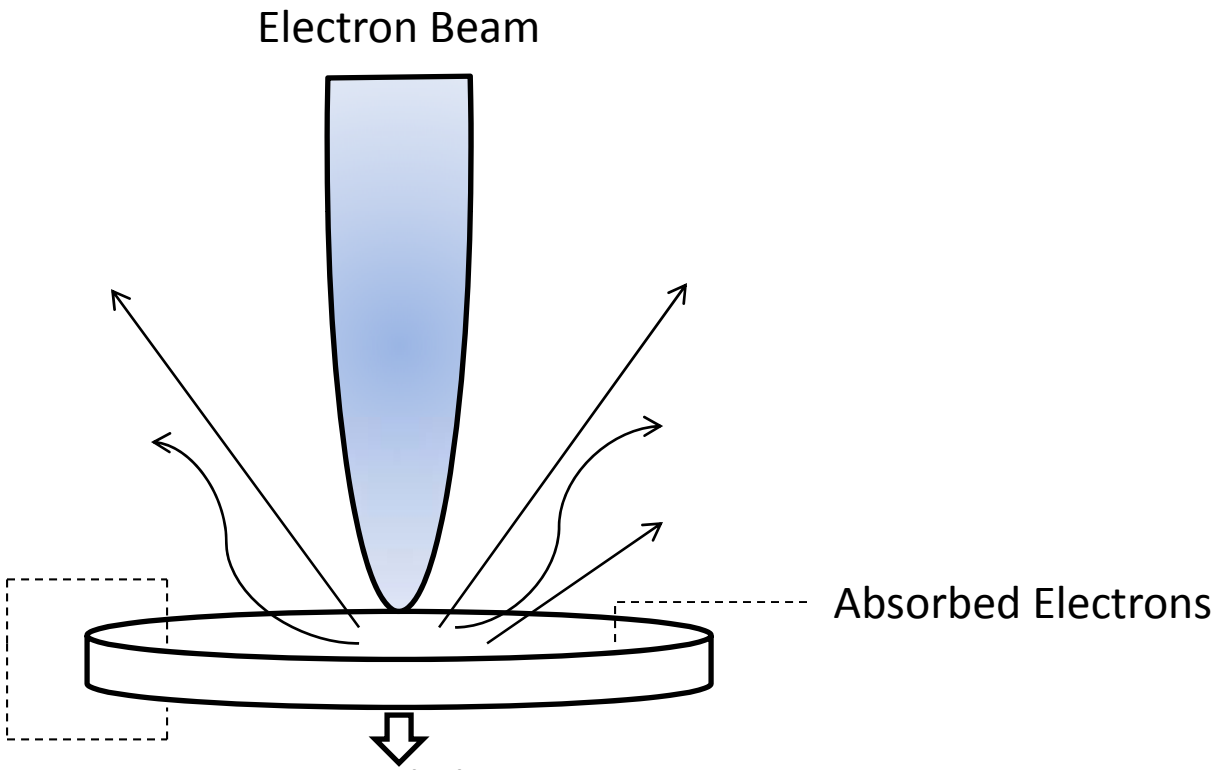
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

What do these "tell" us?

Morphological and crystalline information, some compositional .



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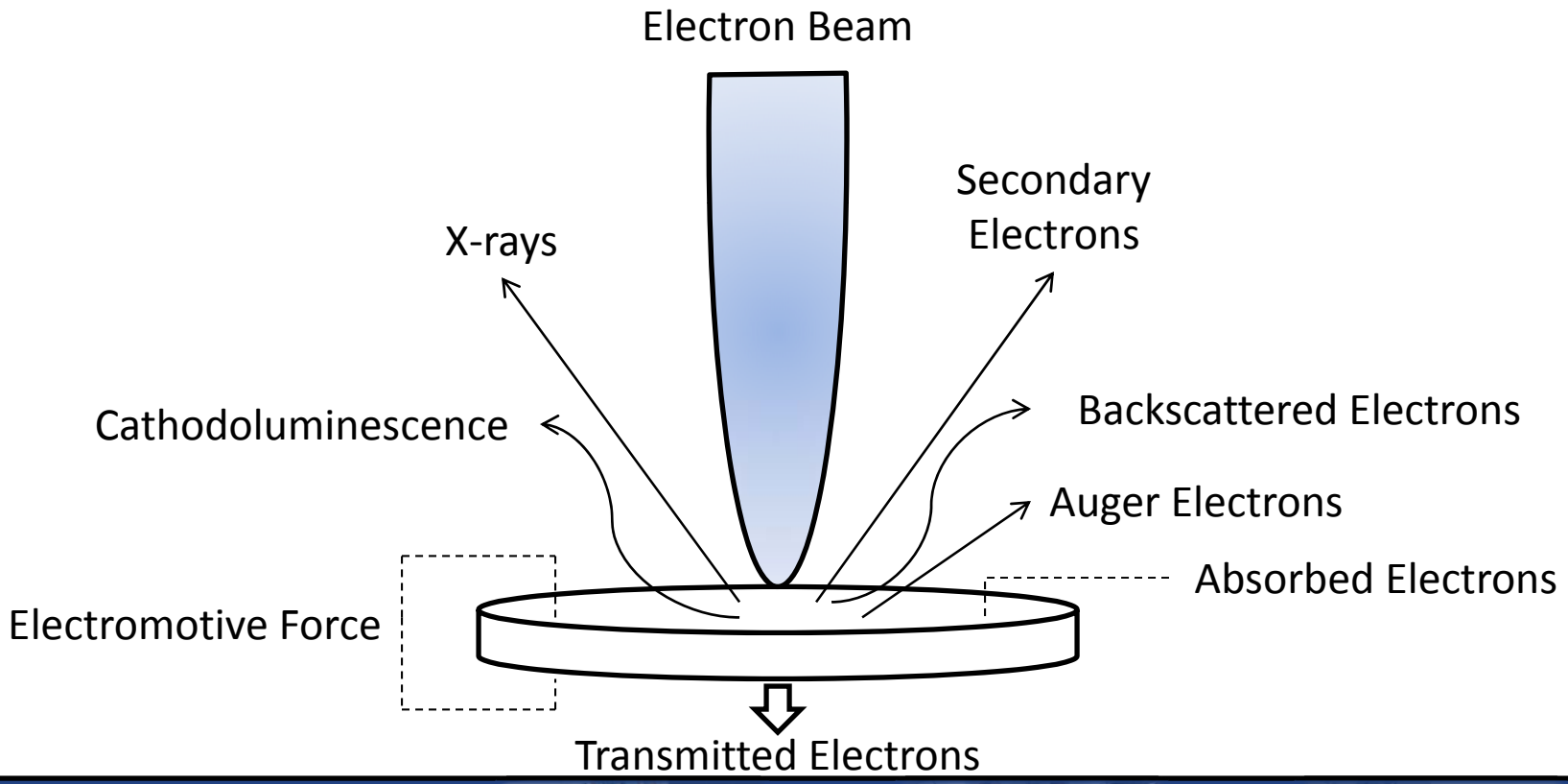
What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)





What Instrumentation is Utilized?

Scanning Electron Microscopy (SEM)

(Cont.)

- Considerations associated with SEM use:

- Smaller working distance
  - Smaller depth of field
  - Higher resolution
  - Smaller spot size

- Larger working distance
  - Large depth of field
  - Lower resolution
  - Larger spot size

- Also, samples must be conductive, therefore, a coating treatment must be utilized.

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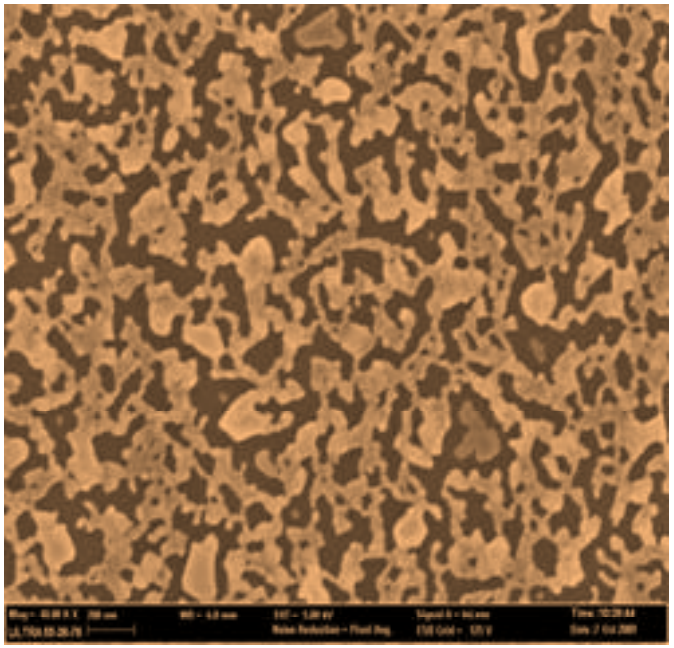
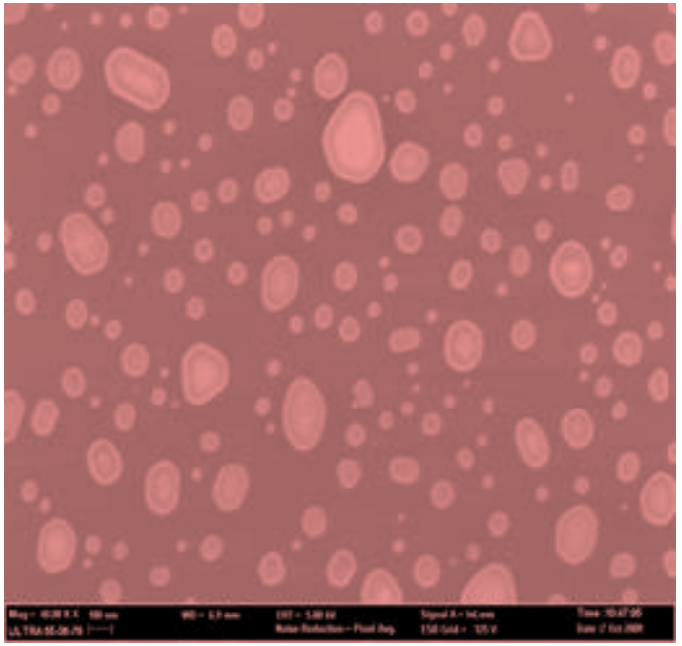
Image Library





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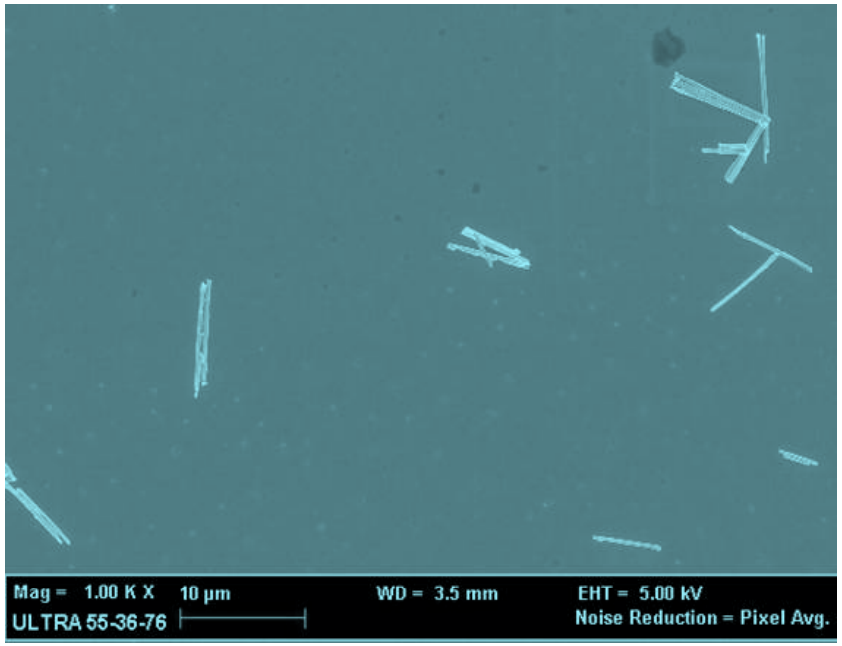

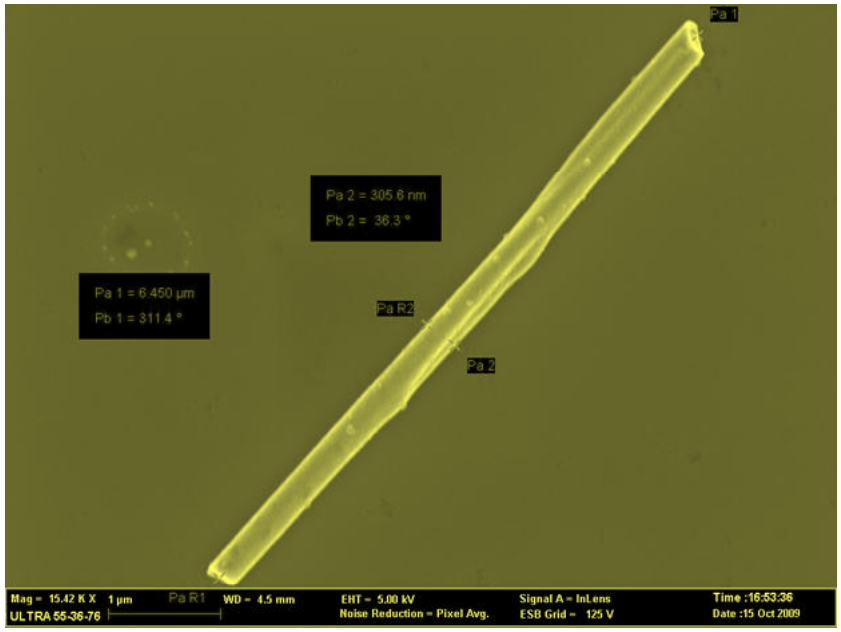

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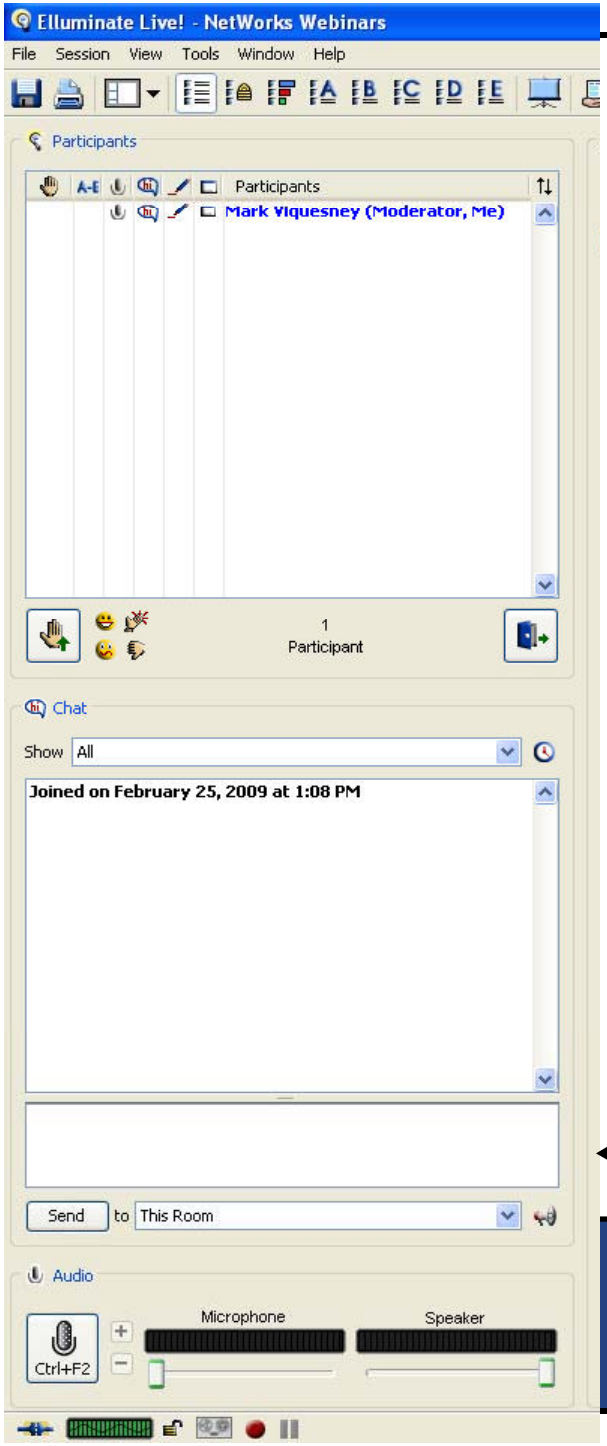


Questions?

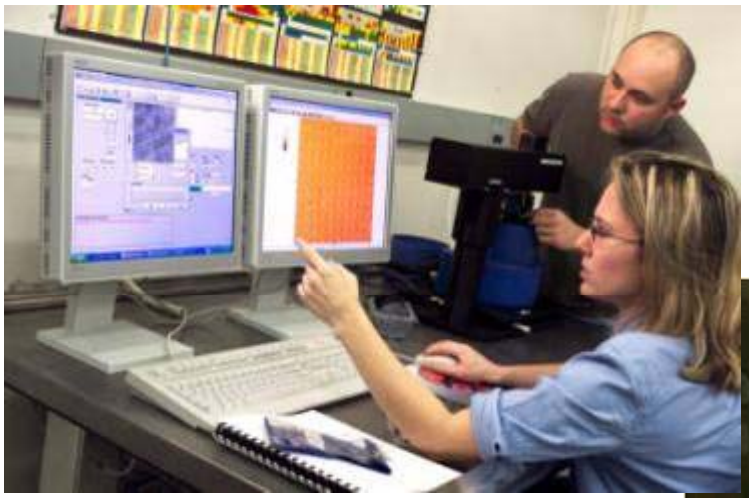
Type them in your chat window

What Resources are Available?

- http://www.nano4me.org
  - Here, you will find course notes, steps for holding a remote access session, laboratory exercises, educational modules used in the creation of this presentation, and much, much more!
- Many other resources available online.



Remote Access



From our lab…

…to your classroom!

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Remote Access

- Remote Access is a way to utilize high-tech equipment at a research institution through an Internet connection at any school.

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Remote Access can be Utilized…

- For an Outreach Experience
- For Workshop Demonstrations
- For Class Demonstrations
- To Supplement the Equipment at an Institution
- For “Hands-On” Access by students in their laboratory experiences

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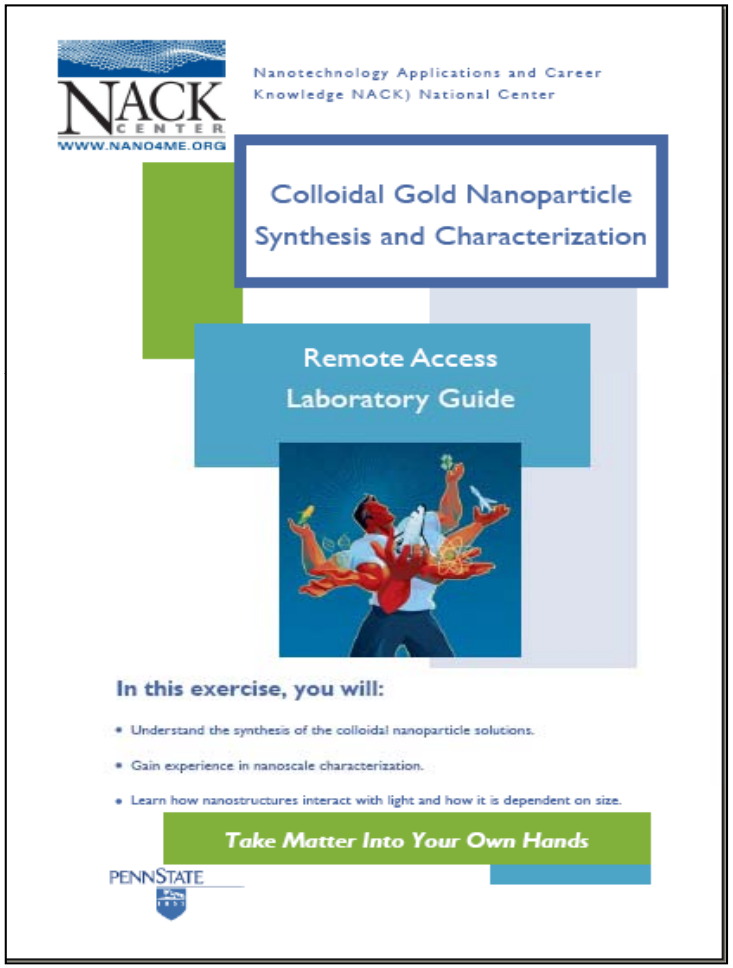
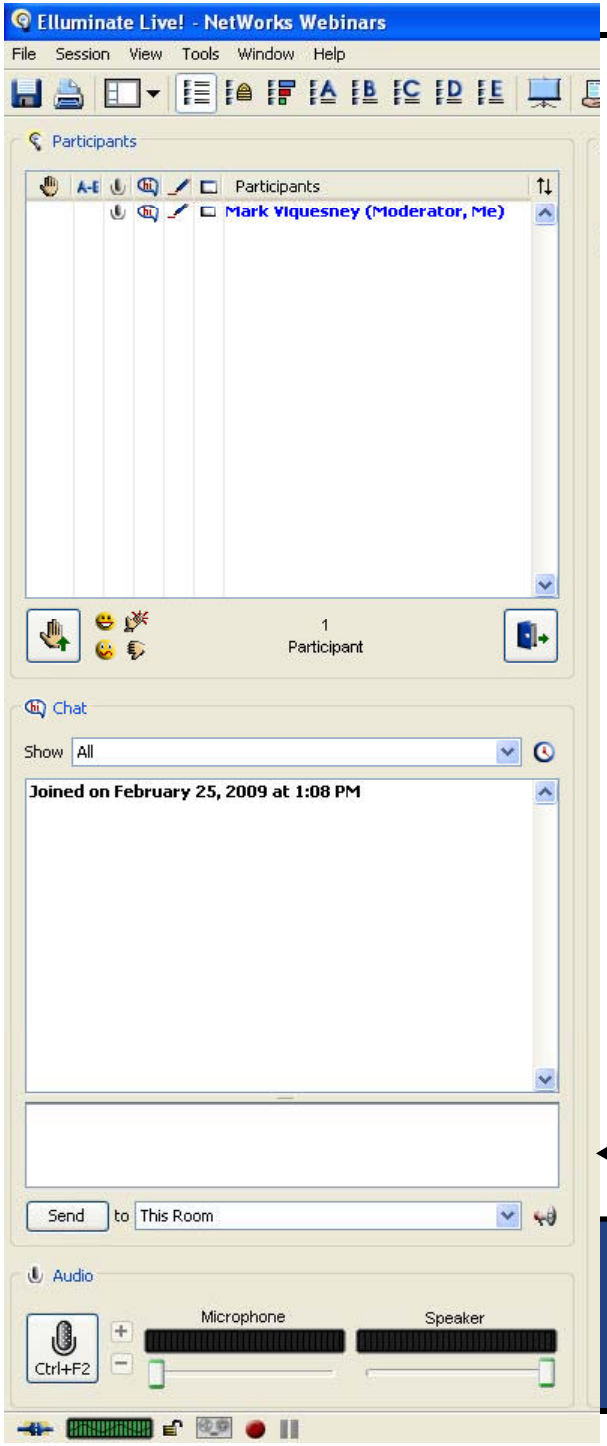
Remote Access



- NACK has integrated remote components into a number of nanotechnology classroom experiments.
- This will allow students to visualize what they create first hand, remotely.





Questions?

Type them in your chat window

What Resources are Available? (Cont.)

- Instrumentation Available for Remote Access within the NACK National Center…

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What Resources are Available? (Cont.)

What Can You Do?

- Contact me, or another NACK representative.
  - Jamie G. Houseknecht
  - Email: juh147@engr.psu.edu
  - Phone: 814-865-5285

  - Amy Brunner
  - Email: abrunner@engr.psu.edu
  - Phone: 814-865-8977

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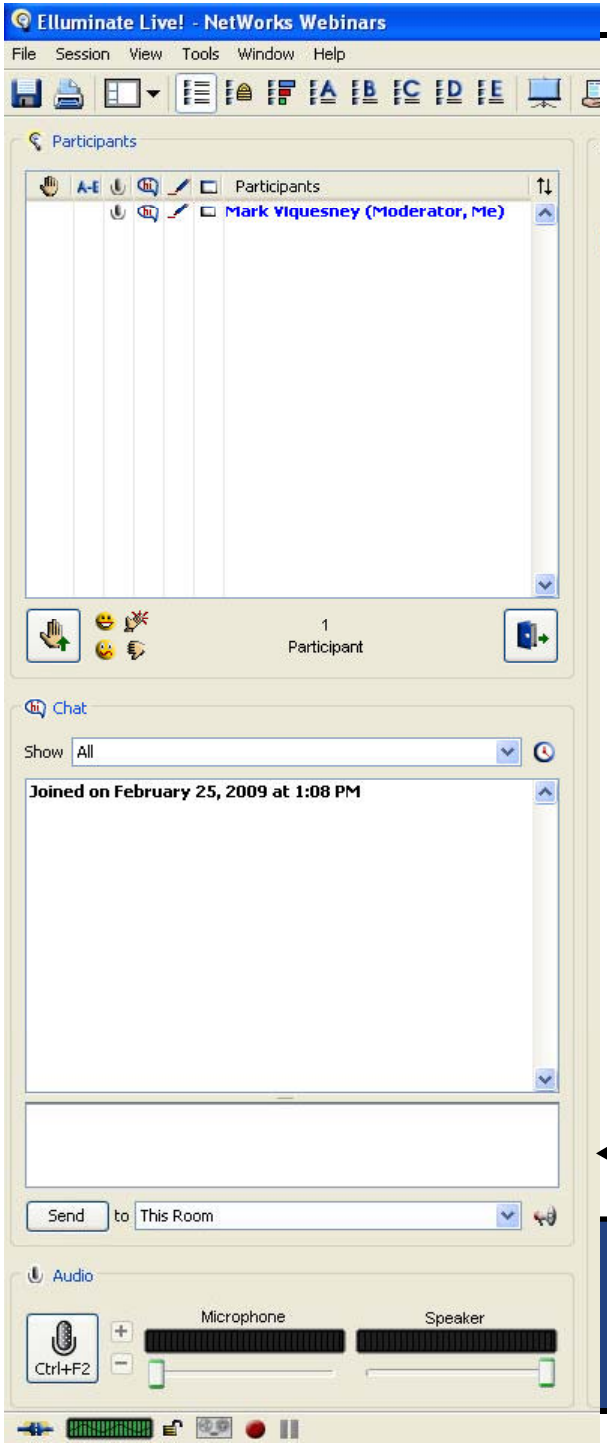
What Resources are Available? (Cont.)

What Can You Do?

- We are actively seeking individuals from academic institutions to utilize remote access in the classroom; the possibilities are endless!
  - You can hold a single session, multiple sessions, or for an entire semester in a laboratory-based format.
  - Sending the NACK National Center your own samples is encouraged also!
- Again, visit http://www.nano4me.org for more details!





Questions?

Type them in your chat window

Thank you for attending

NACK's Webinar

Introduction to Nano-Characterization

You may find additional resources and free curriculum for nanotechnology at www.nano4me.org and click Educators.



Webinar Recordings

To access this recording or slides, visit www.Nano4me.org - educators

You may also find over 100 resources in the NetWorks Digital Library

www.matecnetworks.org

keyword: nanotechnology

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NACK Upcoming Webinars

February 26: **Remote Access to Nano-Characterization Tools**

March 26: **Recruitment for Nanotechnology Enrollment**

Visit ***www.nano4me.org*** and click Educators and then the Webinar tab for more details about these and other upcoming webinars.

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Kristen Robinson at kjrobinson@engr.psu.edu

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How Can We Better Serve You?

Whether you are joining us live or watching the recorded version of this webinar, please take 1 minute to provide your feedback and suggestions.

http://questionpro.com/t/ABkVkZGxde



Thank you for attending

NACK's Webinar

Introduction to Nano-Characterization

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Webinars

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