KMU 396 MATERIAL SCIENCE AND TECHNOLOGY- I PRESENTATION

Auger Electron Spectroscopy, AES

Prepared and will be presented by:
Duygu Örgen

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Goal of the Presentation

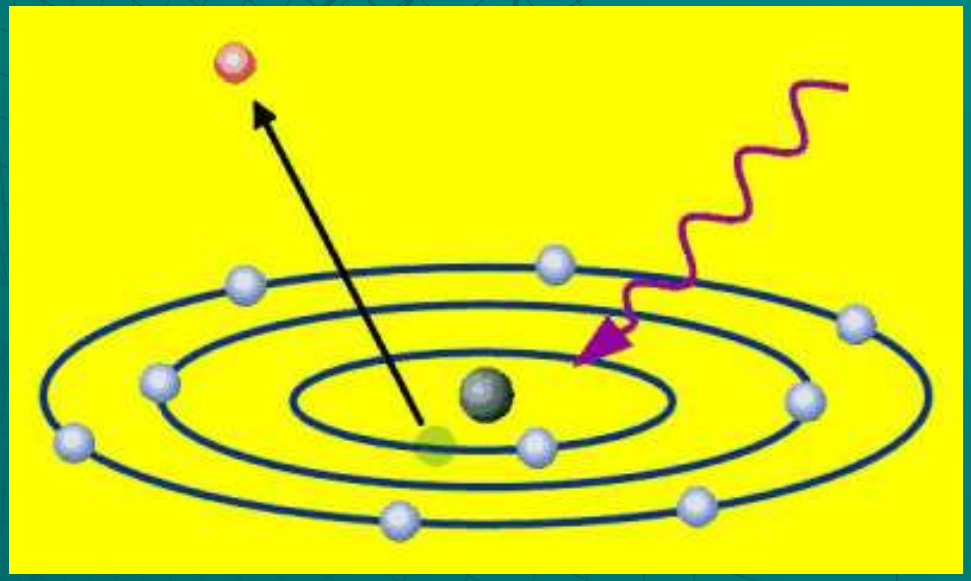
- Our main goal is to give some information to the audience about electron spectroscopy and Auger Electron Spectroscopy (AES), and discussing its applications, history, advantages, disadvantages and how it work.

Outline

- Electron Spectroscopy
- History of AES
- What is AES?
- General Uses
- The Auger Process
- How It Works?
- Instrumentation
- Auger Spectrum
- Common Applications
- The Main Advantages of AES
- The Disadvantages of AES

Electron Spectroscopy

- Electron spectroscopies analyze the electrons that are ejected from a material for qualitative or semi-quantitative analysis.



http://www.almaden.ibm.com/st/scientific_services/materials_analysis/xps/

- Detecting photoelectrons that are ejected by x-rays is call X-ray Photoelectron Spectroscopy (XPS) or electron spectroscopy for chemical analysis (ESCA).

- Detecting electrons that are ejected from higher orbitals to conserve energy during electron transitions is called Auger Electron Spectroscopy (AES).

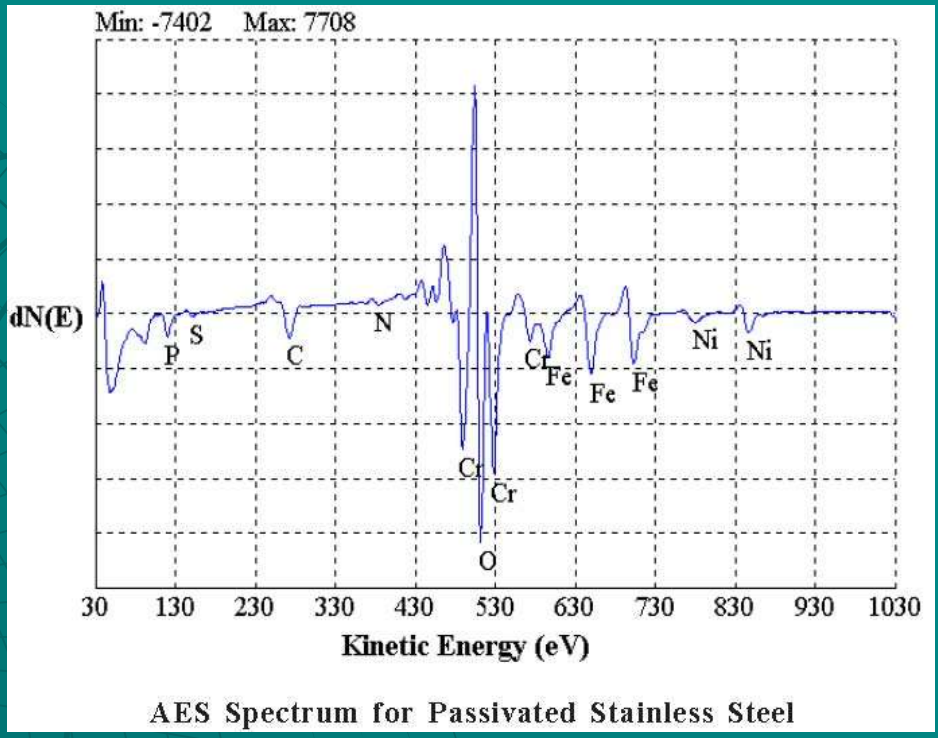
History of AES

- Developed in the late 1960's
- Name was derived from the effect first observed by Pierre Victor Auger, a French Physicist, in the mid-1920's.

http://www.phi.com/surface-analysis-techniques/aes.html

What is AES?

- AES is a popular technique for determining the composition of the top few layers of a surface.



AES Spectrum for Passivated Stainless Steel

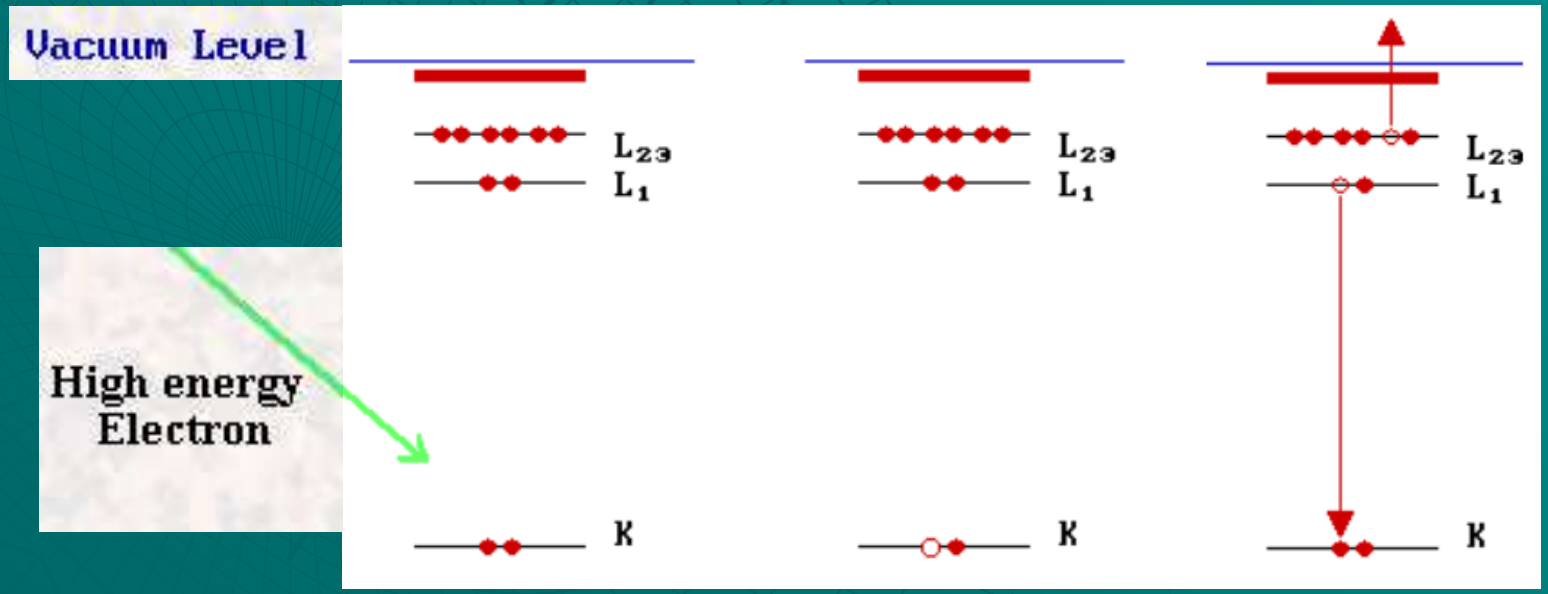
http://mee-inc.com/hamm/HAMM%202006%20300dpi_img_10.jpg

General Uses

- Identification of elements on surfaces of materials
- Quantitative determination of elements on surfaces
- Depth profiling by inert gas sputtering
- Phenomena such as adsorption, desorption, and surface segregation from the bulk
- Determination of chemical states of elements
- In situ analysis to determine the chemical reactivity at a surface
- Auger electron elemental map of the system

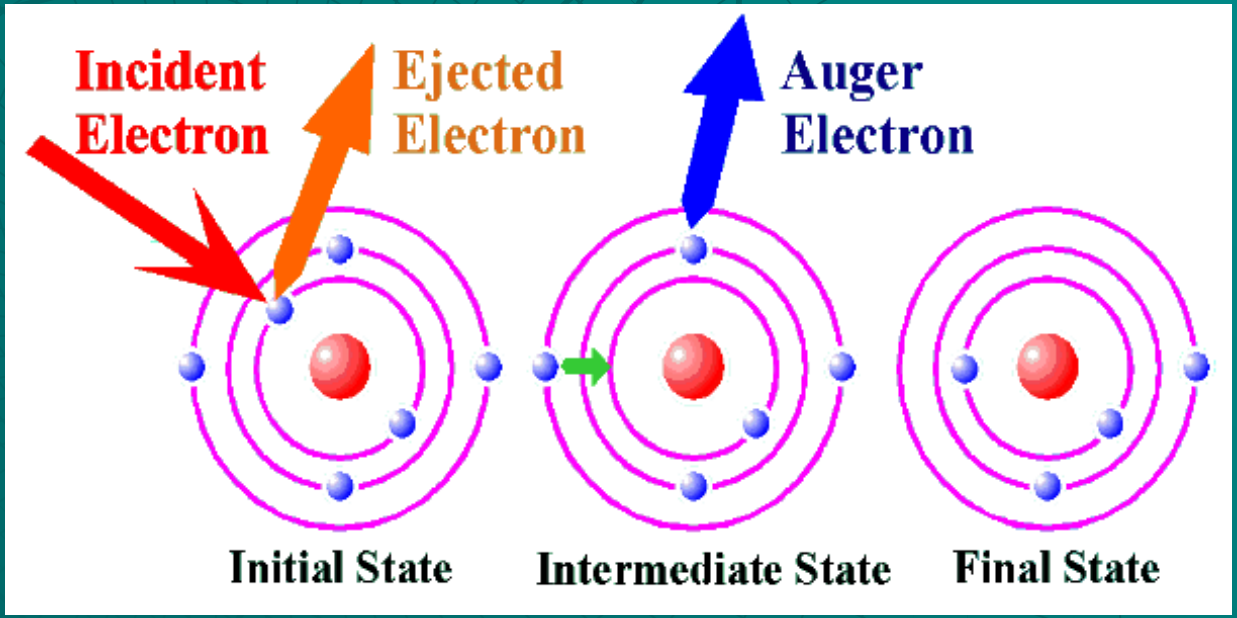
The Auger Process

- The sample is subjected to bombardment by electrons with high energy.
- When a core electron is removed, leaving a vacancy, an electron from a higher energy level may fall into the vacancy, resulting in a release of energy.



http://www.jhu.edu/chem/fairbr/surfacelab/aes.html

- This energy is released in the form of an emitted photon or the energy can also be transferred to another electron, which is ejected from the atom.
- This second ejected electron is called an Auger electron.



www.barnant.com/com/cda/change_country/

- The kinetic energy of these Auger electrons are measured and are elementally characteristic. The low escape depth of Auger electrons means that AES analyses only the top few atomic layers of the sample material.

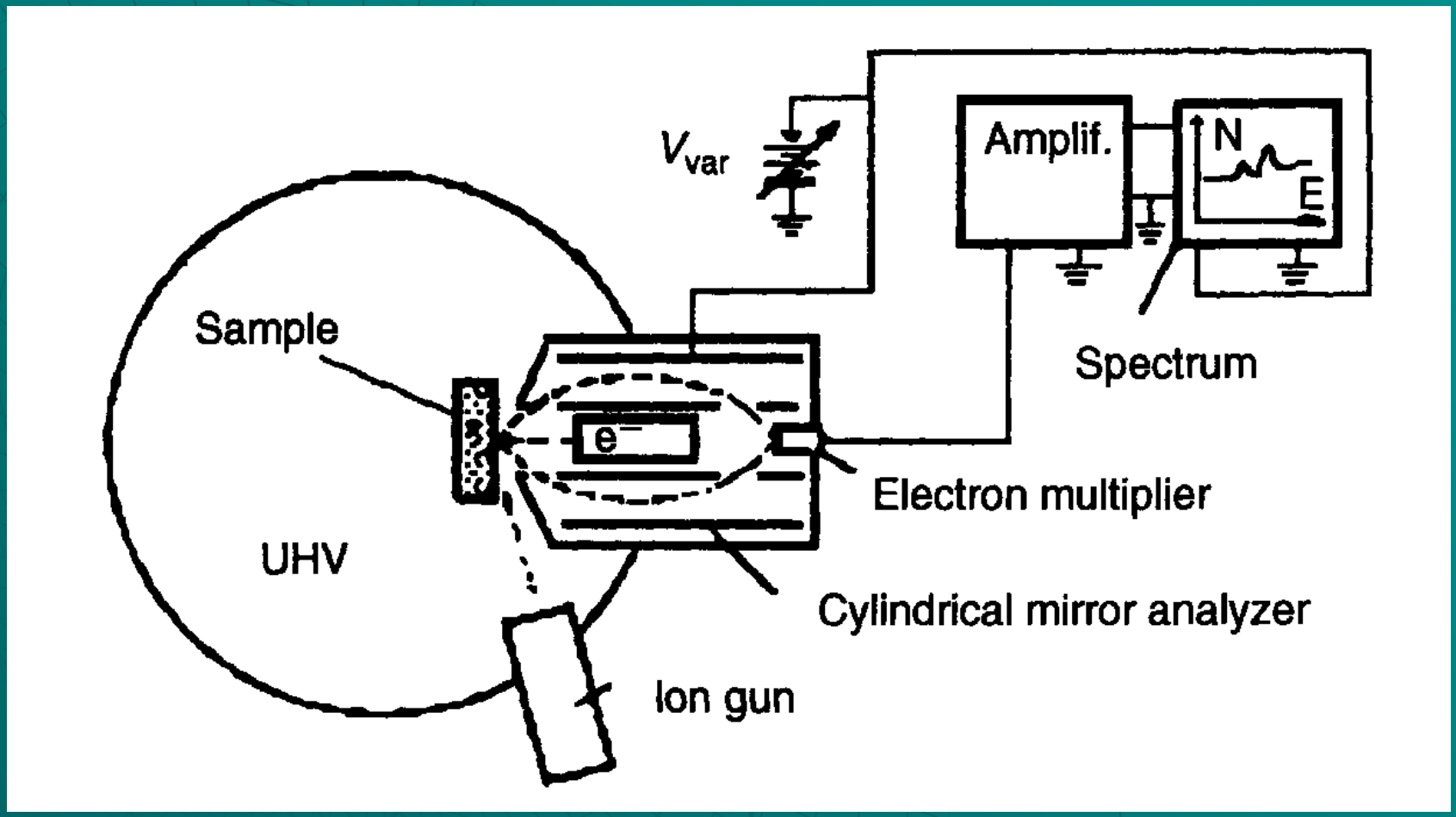
How It Works?

- The sample is irradiated with electrons from an electron gun. The emitted secondary electrons are analyzed for energy by an electron spectrometer.

The essential components of an AES spectrometer are:

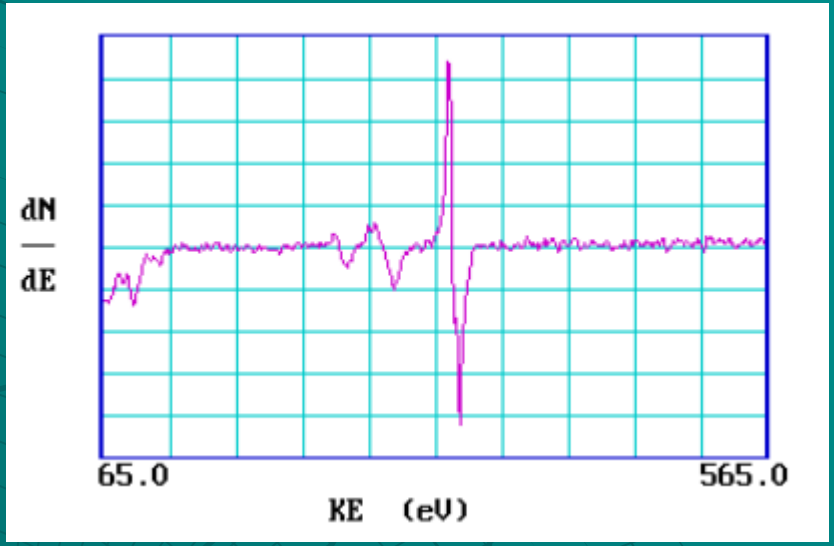
- UHV environment
- Electron gun
- Electron energy analyzer
- Electron detector
- Data recording, processing, and output system

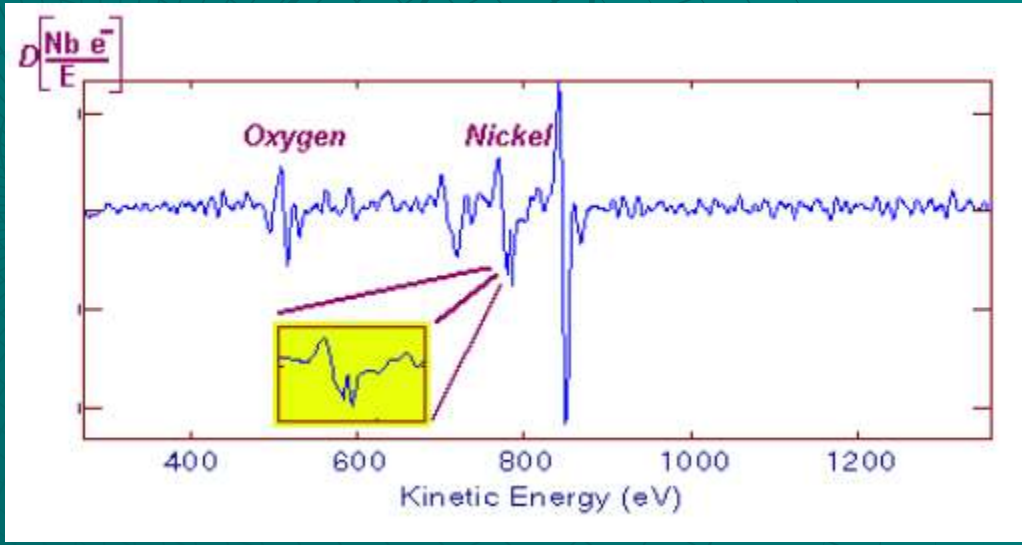
Instrumentation



http://www.cem.msu.edu/~cem924sg/Topic10.pdf

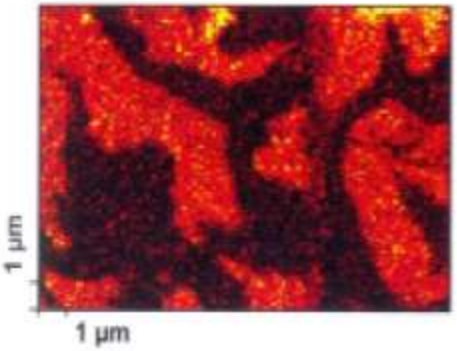
Auger Spectrum



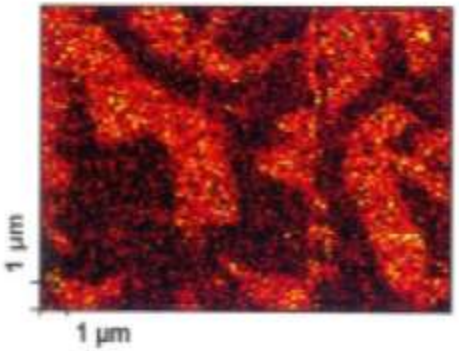


http://www2.aku.edu.tr/~hitit/DERSLER/BAHAR/MALZEME

Carbon

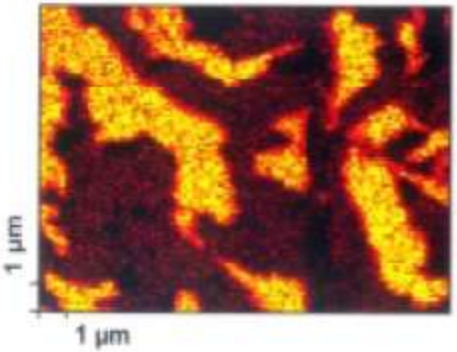


Nitrogen

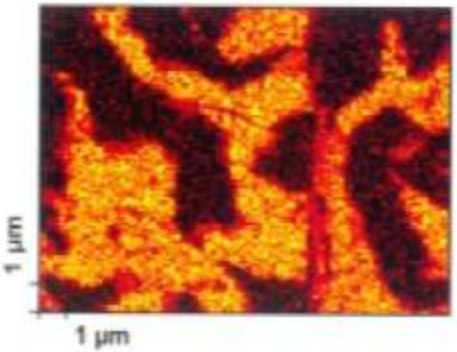


SEM Image

Chromium



Cobalt



http://www.files.chem.vt.edu/chem-ed/spec/material/auger.html

Common Applications

- Qualitative analysis through fingerprinting spectral analysis
- Identification of different chemical states of elements
- Determination of atomic concentration of elements
- Depth profiling
- Adsorption and chemisorption of gases on metal surfaces
- Interface analysis of materials deposited in situ on surfaces

The Main Advantages of AES

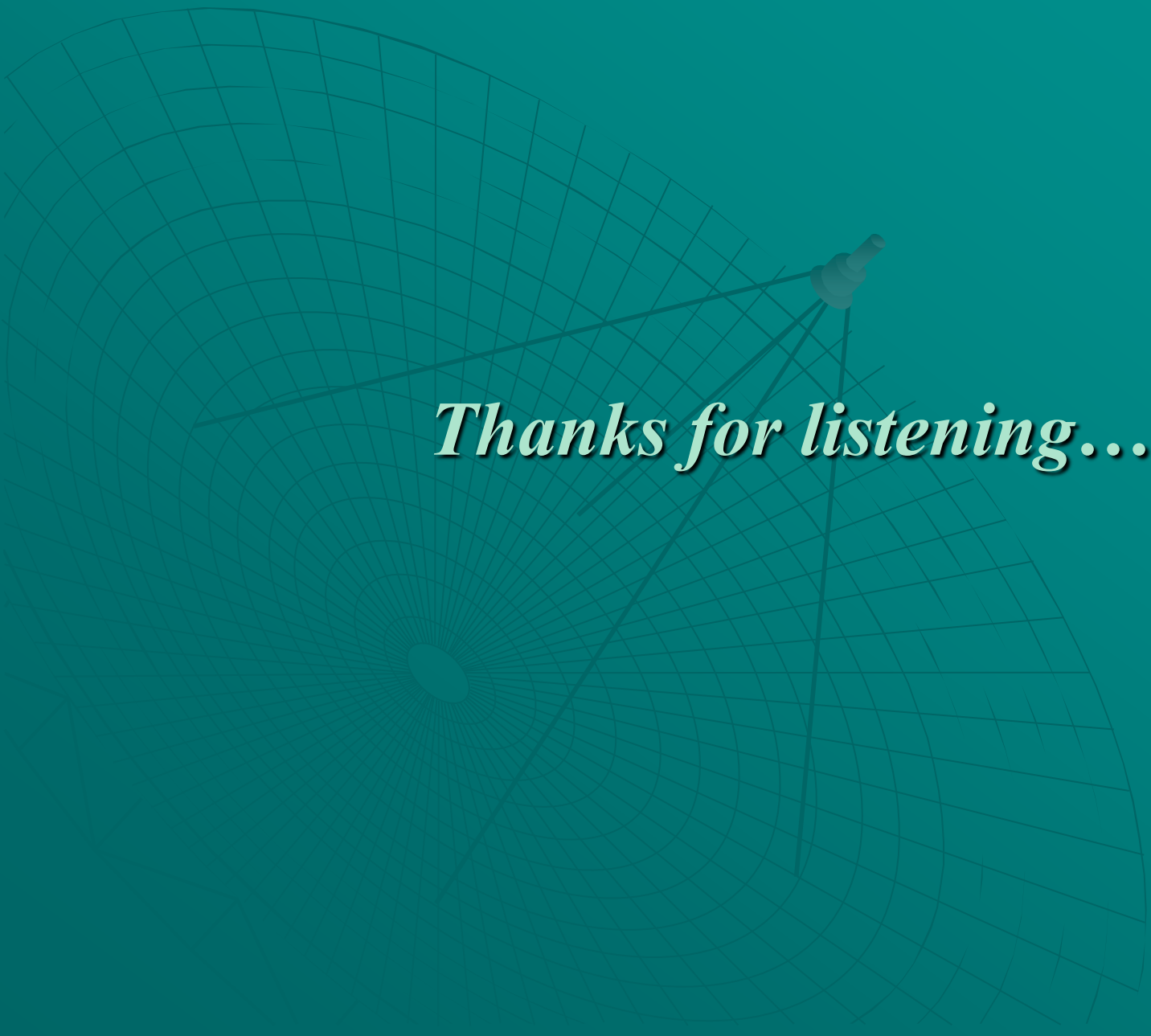
- Spatial resolution is high.
- Analysis is relatively rapid.
- Surface or subsurface analysis can be performed.
- It is sensitive to light elements (except H and He).
- It provides reliable semiquantitative analysis.
- Chemical information is available in some cases.

The Disadvantages of AES

- Insulators are difficult to study due to surface charging.
- Surface may be damaged by the incident electron beam.
- Precise quantitative analysis may require extensive work.
- Sensitivity is modest (0.1 to 1 atom%).
- Depth profiling by ion sputtering or sectioning is destructive.

References

- http://www.eaglabs.com/techniques/analytical_techniques/aes.php#appnotes
- http://www.chem.qmul.ac.uk/surfaces/scc/scat5_2.htm
- http://www.prenhall.com/settle/chapters/ch42.pdf
- http://www.chemistry.adelaide.edu.au/external/soc-rel/content/e-spec.htm
- http://www.polymersolutions.com/auger.html
- http://www2.aku.edu.tr/~hitit/DERSLER/BAHAR/MALZEME%20KARAKTERIZASYON%20TEKNIKLERI/AUGER%20SPEKTROSKOBISI%20%5B8%5D.pdf



Thanks for listening…