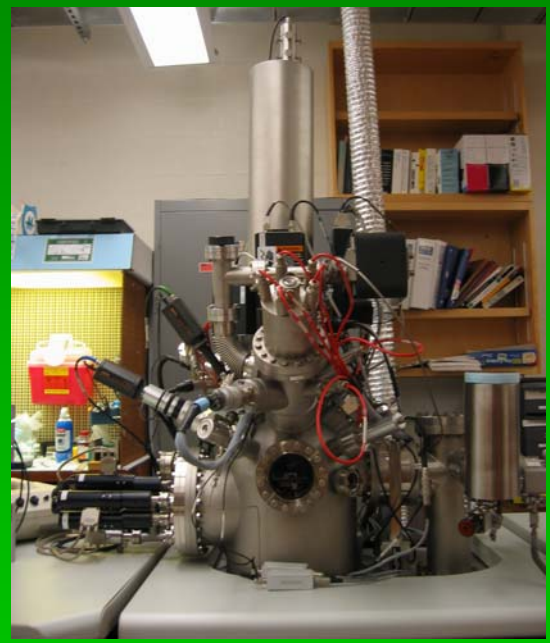
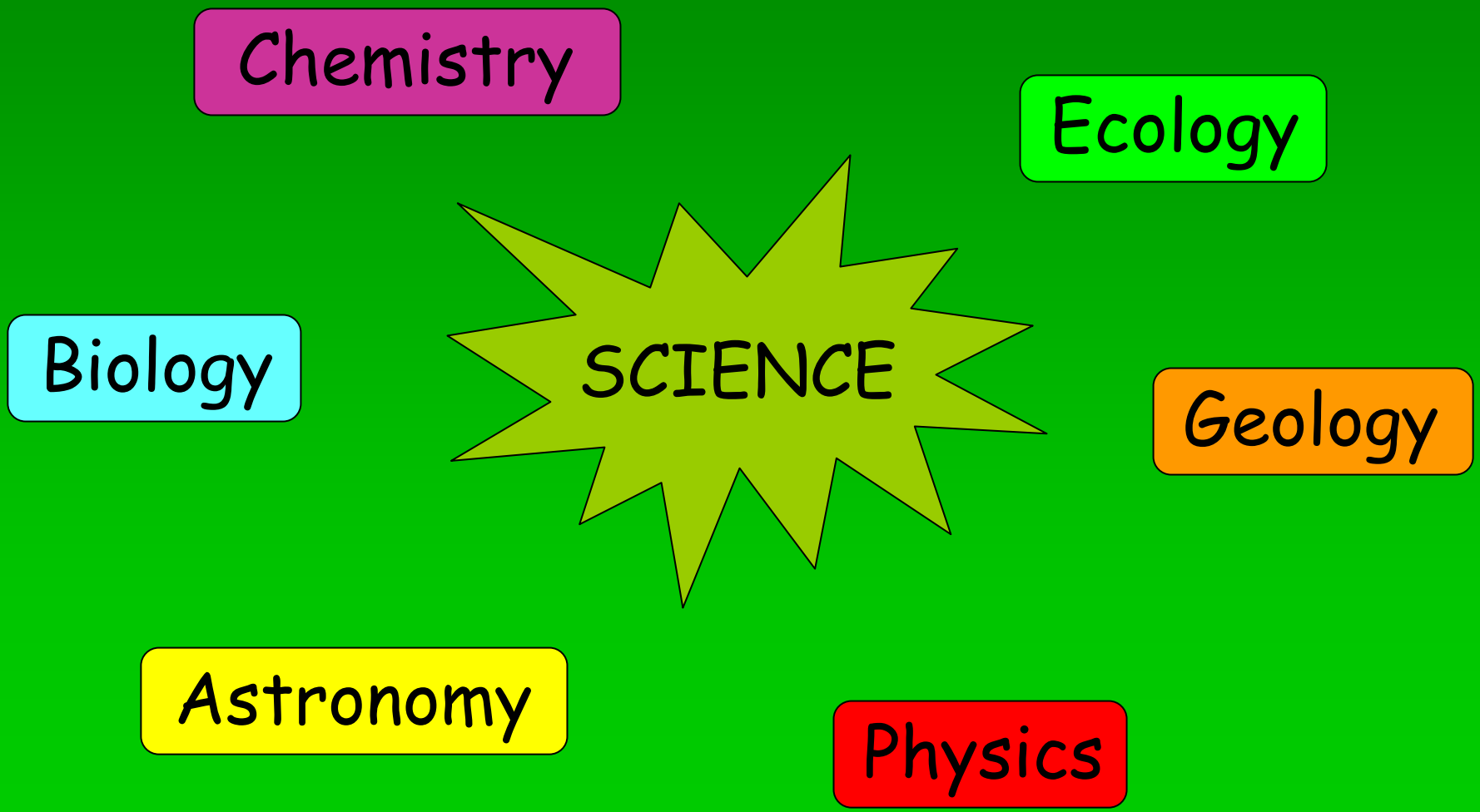
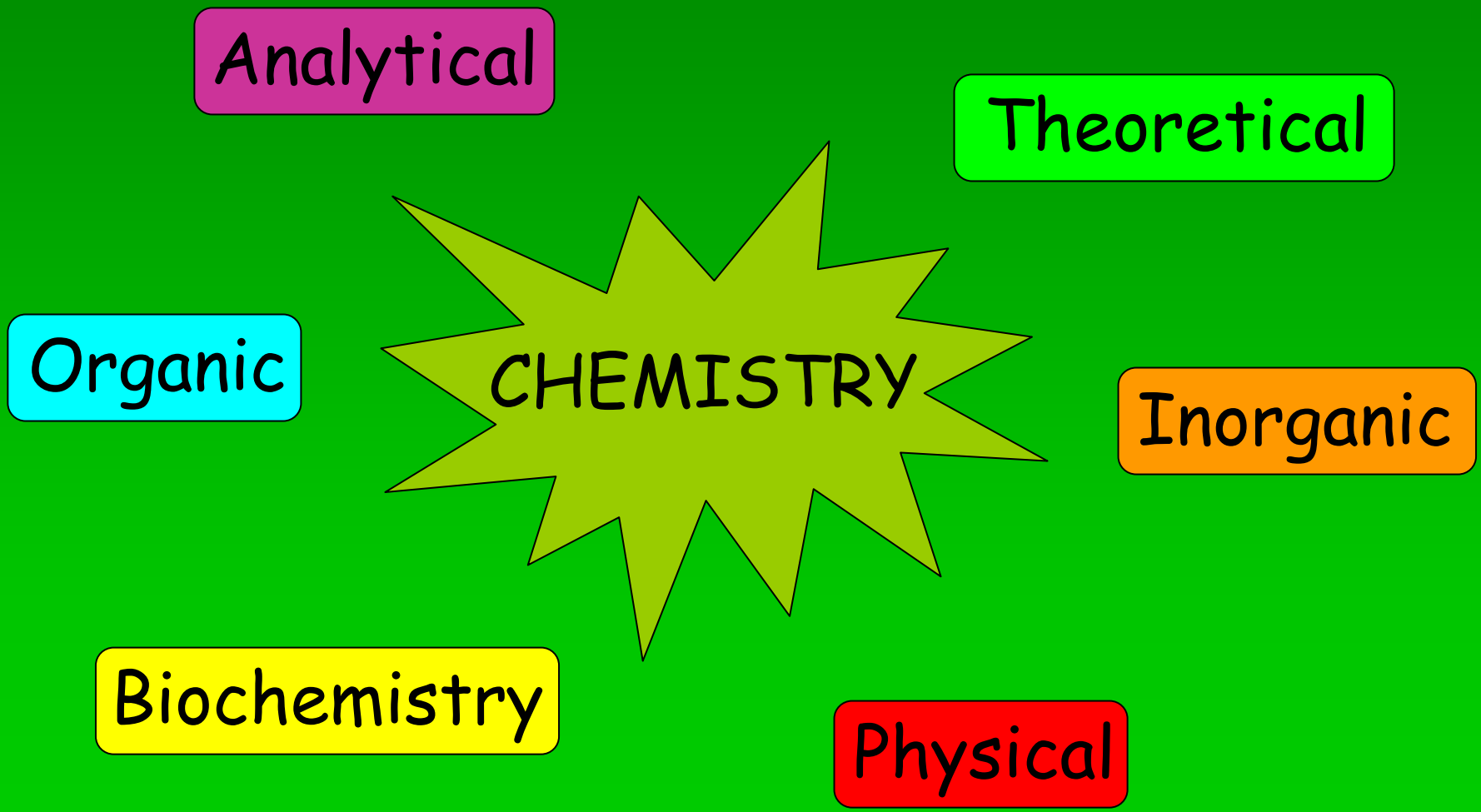
Ms. Longsdorf's Research



Science is Everywhere!!!



Different Types of Chemistry



What is *Analytical* Chemistry?

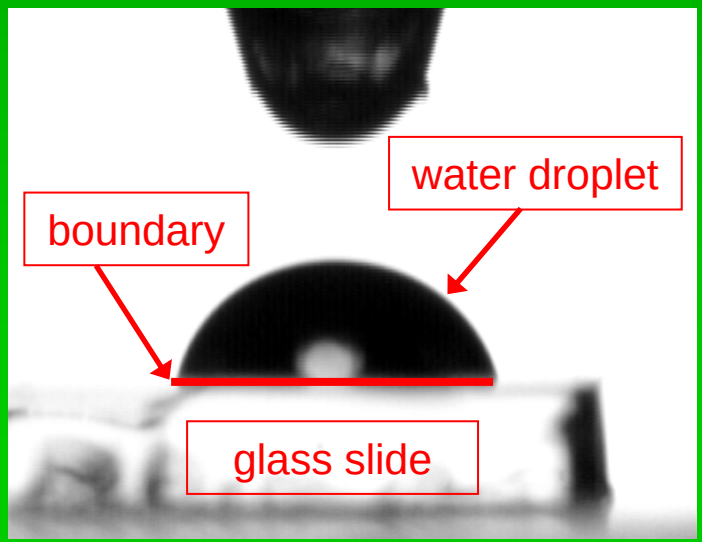
- *Analytical chemistry* is used to determine what elements or compounds are in some piece of matter.

- Questions analytical chemists try to answer:
  - What *type* of elements or chemicals are present?
  - What is the *amount* of these elements or chemicals?
  - What are the *physical* and *chemical properties* of the elements or chemicals in the sample?

- An example of analytical chemistry would be when a scientist examines a pill to find that it has three compounds: acetaminophen (aspirin), calcium carbonate and maltodextrin (fillers).

Surface Chemistry

- Surface chemistry is the study of chemical interactions and reactions at the boundary of two substances.
- The boundary is the place where two substances come in contact with one another.
- In surface chemistry this boundary is usually between substances that have two different states of matter.



- Here the substances are ones with two different states of matter; a liquid is in contact with a solid.
- The boundary is where the water droplet and the piece of glass are touching.

My Research Is...

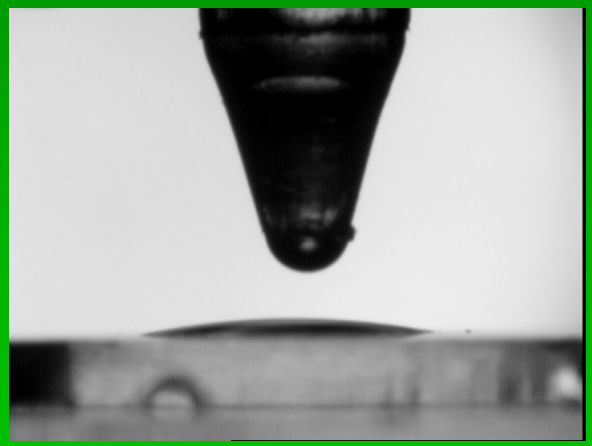
Novel Strategies to Control Molecular Presentation at Biologically Relevant Surfaces

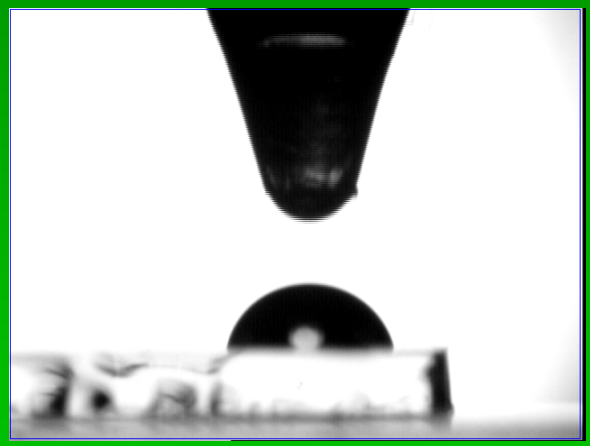
Which really means...

New Ways to Get Molecules to Attach to Surfaces Used in Biology and Biochemistry

Main Goals of My Research

- Reacting chemicals on glass surfaces
  - Some chemicals “like” glass and some don’t.





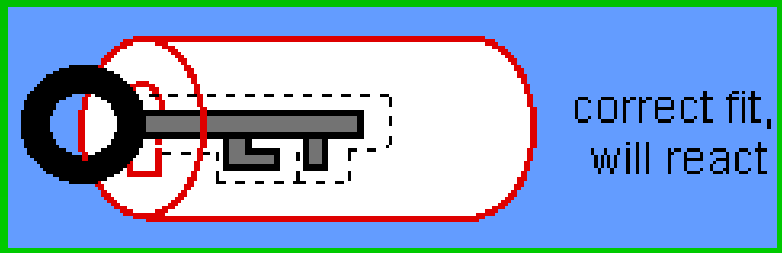
  - Some chemicals just stick to glass loosely (you can wash them off).
  - Some chemicals chemically bond (you can’t just wash them off).

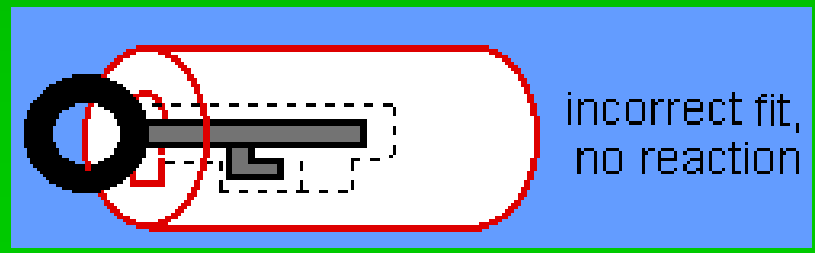
Main Goals of My Research

- Creating controlled patterns of compounds
  - Instead of just covering the whole surface, patterns can be made to limit where the compounds react on the glass.
- Using several instruments and methods to identify the compounds on the surface
  - After all of the chemical steps are done, there needs to be proof that the compound is actually there!

Why is this important?

- Controlled spacing of compounds
  - Many biological compounds need specific spacing to bind and function properly.
  - The way a key fits into a lock is specific. Only a specific key will allow the lock to work properly.





Why is this important?

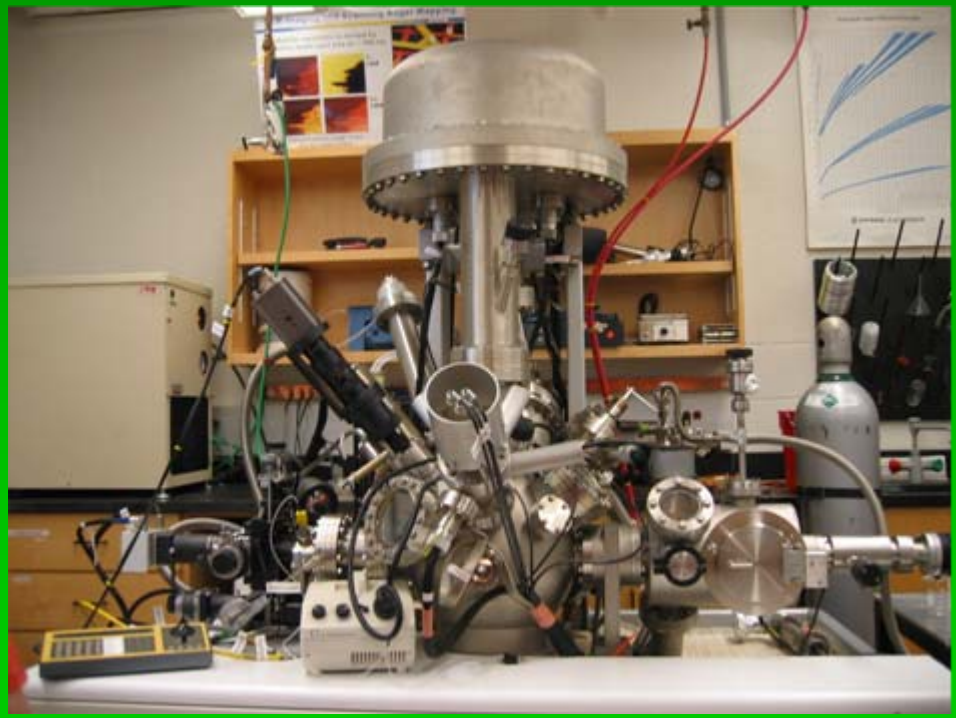
- Determining how strong these compounds bind to a surface or another compound
  - How strong an adhesive is depends on what it can be used for.

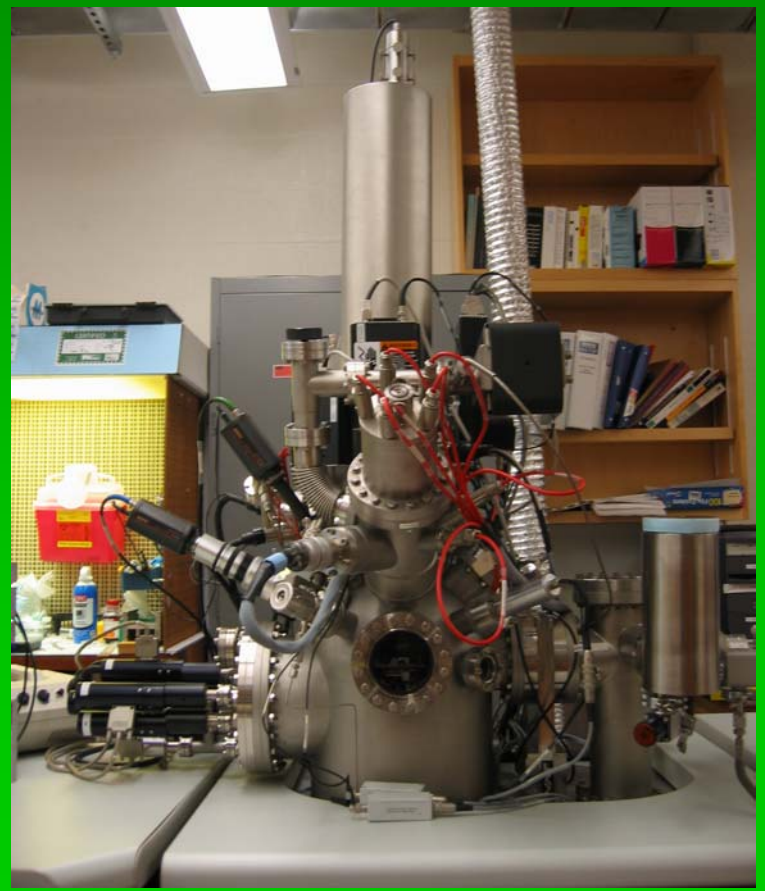
  - In the same way scientists use the knowledge of how compounds bind to one another to understand what they can be used for.

Instruments Are Important

- Data from analytical instruments give chemical information about samples.
- There are different analytical instruments for different purposes:
  - Some identify the *type* of elements or chemicals are present.
  - Some determine of the *amount* of these elements or chemicals.
  - Some determine the *physical* and *chemical properties* of the elements or chemicals.
  - Some do a combination of or all of these things!

Surface Analysis Instruments

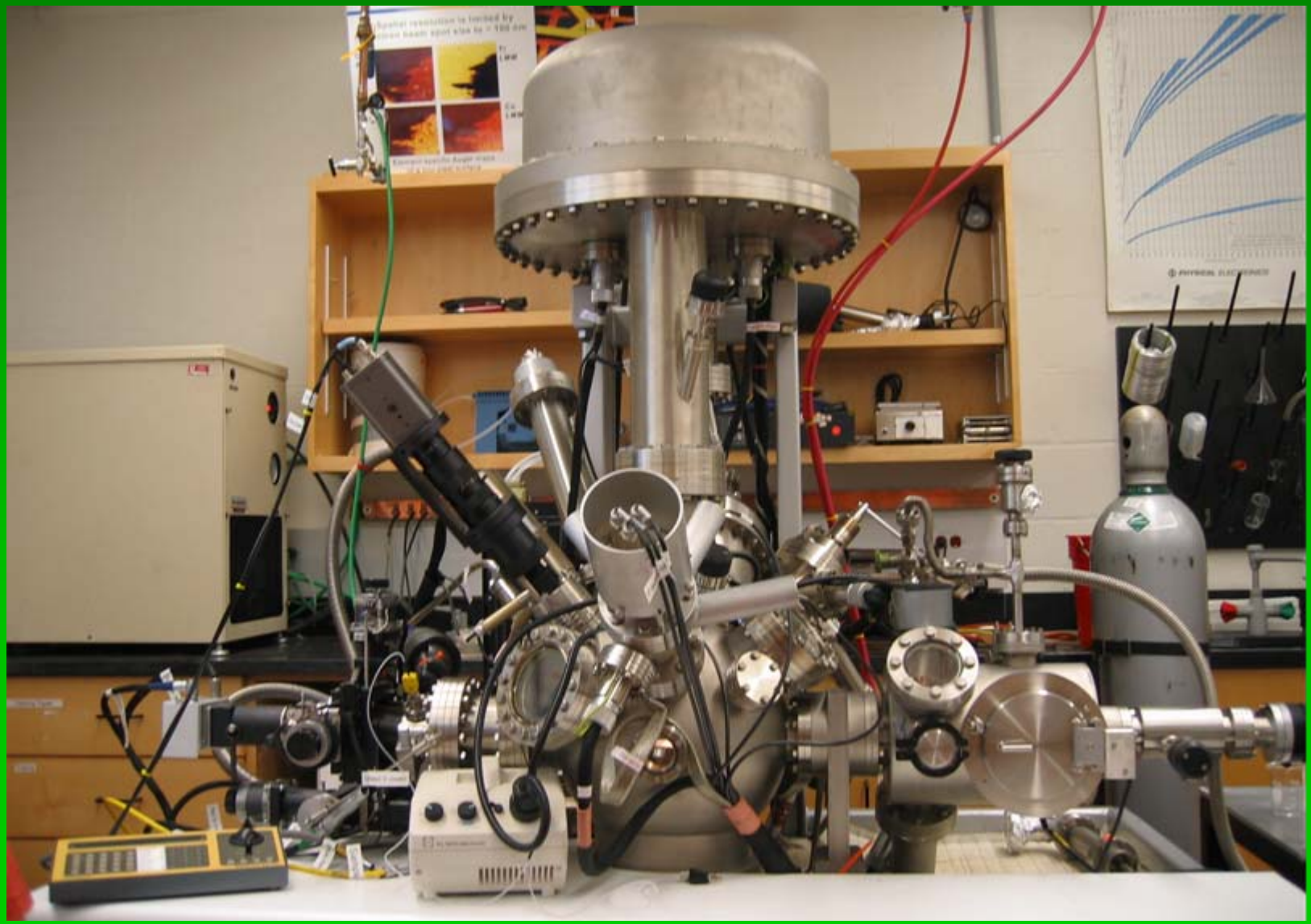




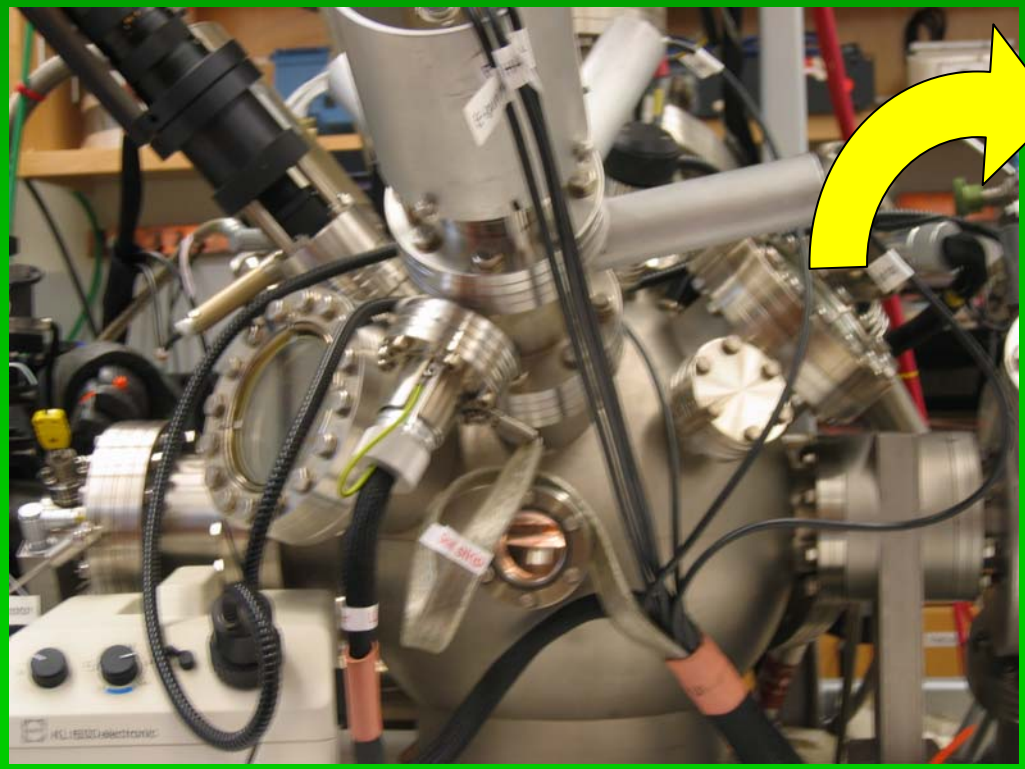
X-ray Photoelectron Spectroscopy (XPS)

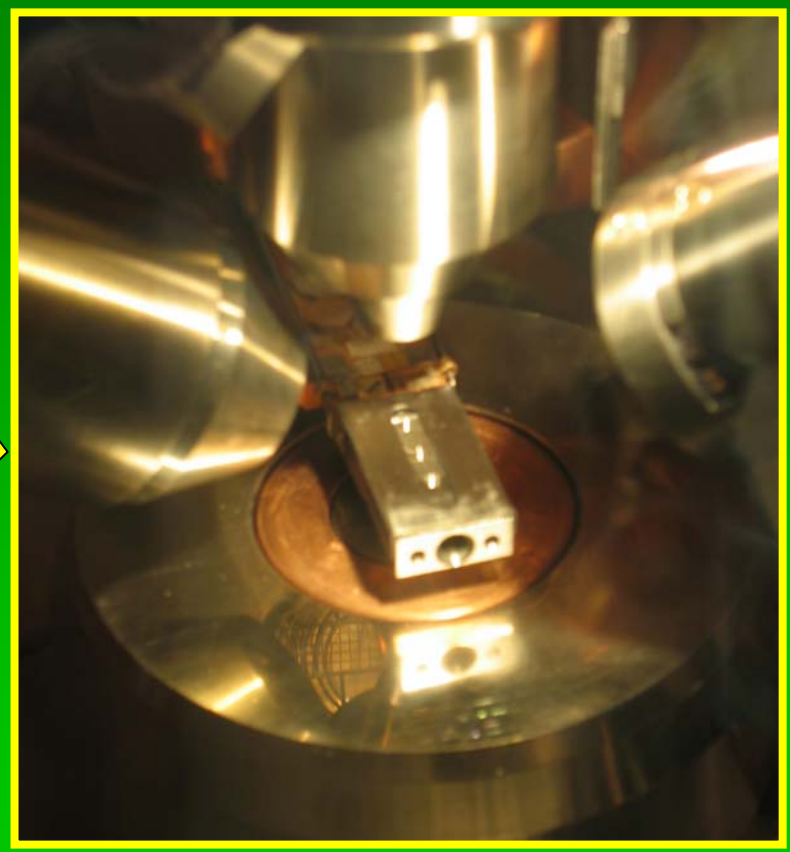
- XPS is used to determine what type of elements are on a surface.
- When XPS detects the elements on a surface, it can also tell the amount of each element is in a percentage.
- XPS can tell how many different elements an element is bonded to
  - For example, if XPS detects carbon on the surface, the data shows if the carbon is bonded to oxygen, nitrogen, carbon or all three.

XPS

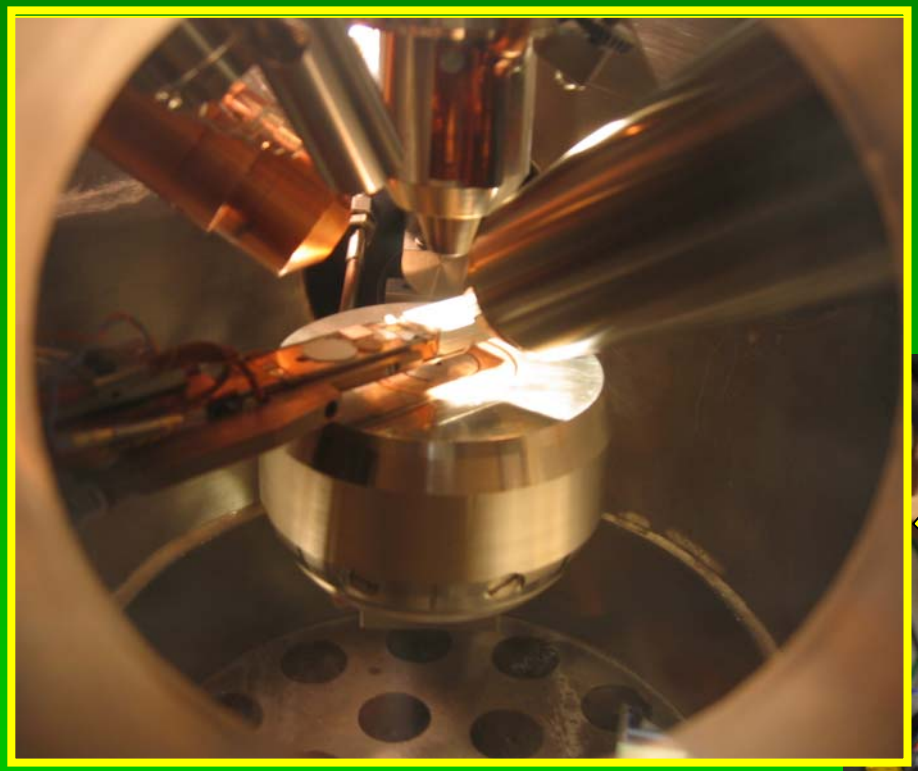


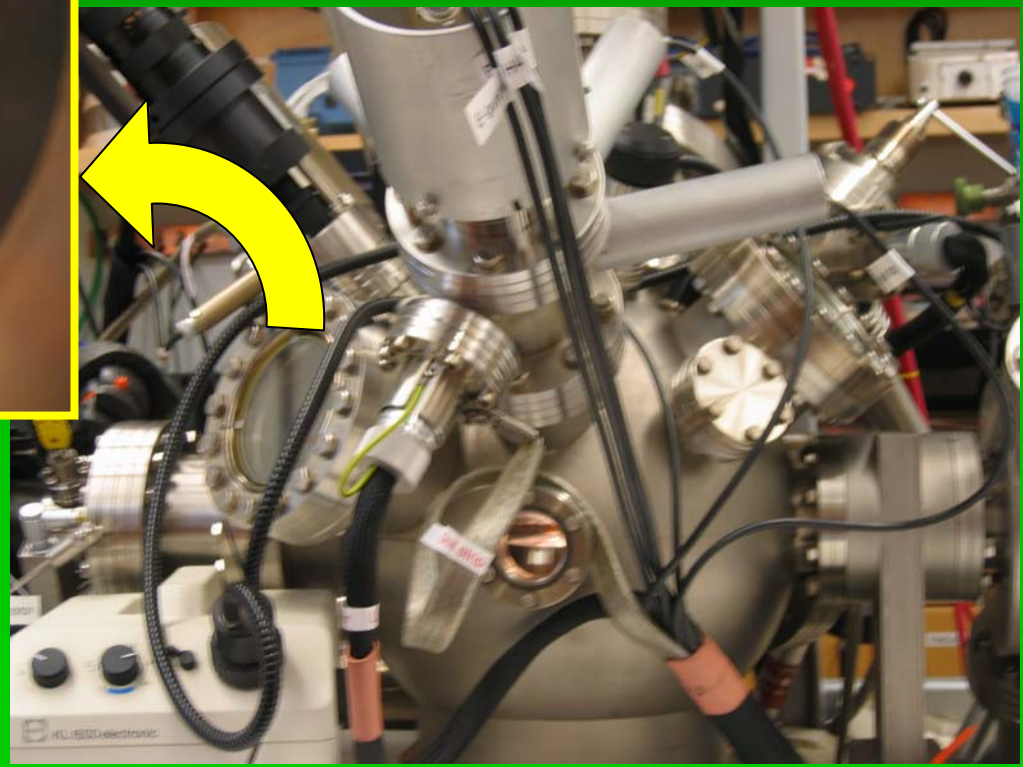
XPS





XPS

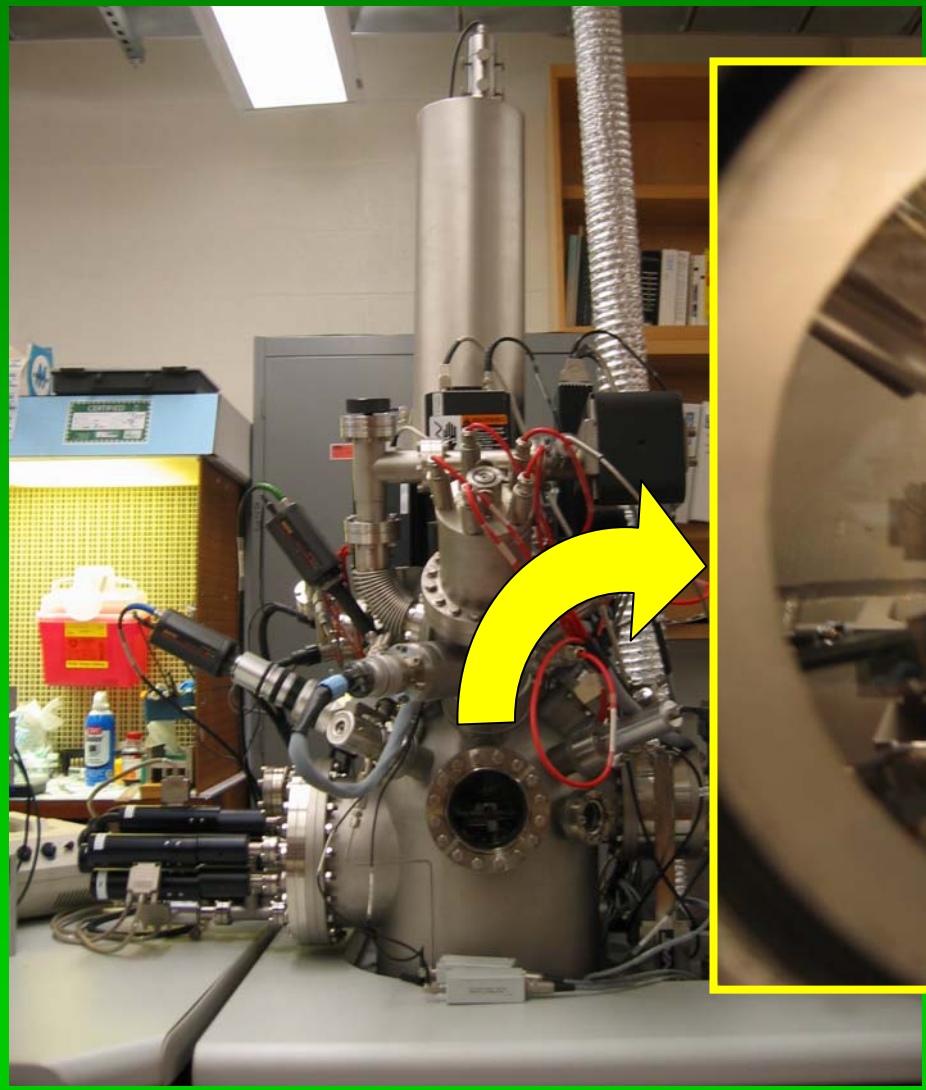


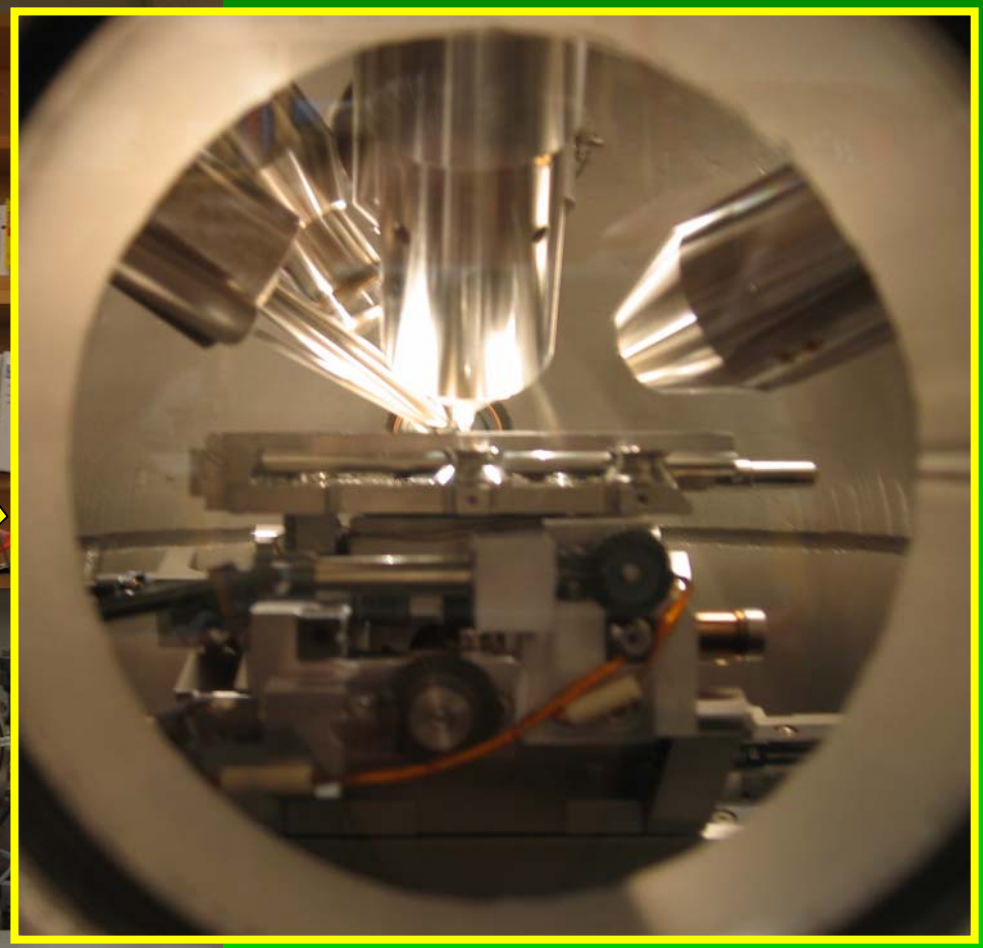


Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS)

- Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) is used to determine what type of elements are on a surface.
- The data from TOF-SIMS is the amount of fragments or pieces of molecules that are detected.
- Scientists look at the data to see if the fragments can be combined to form their compound.

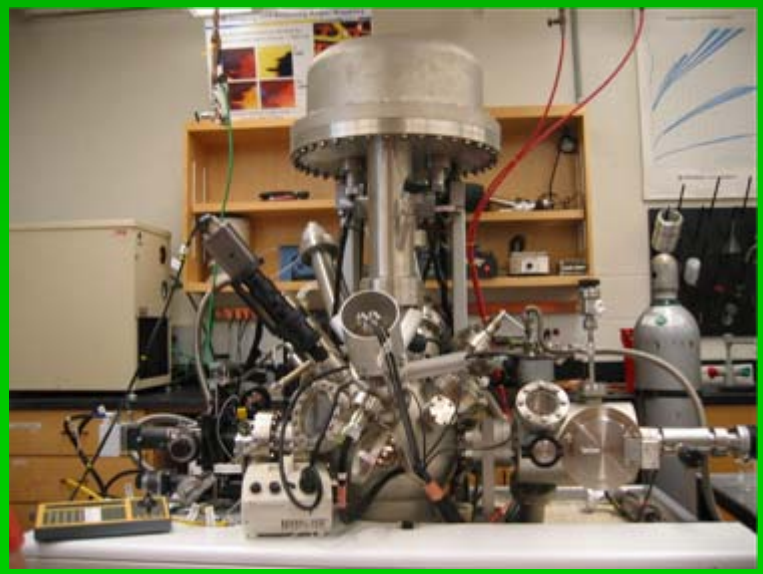
TOF-SIMS

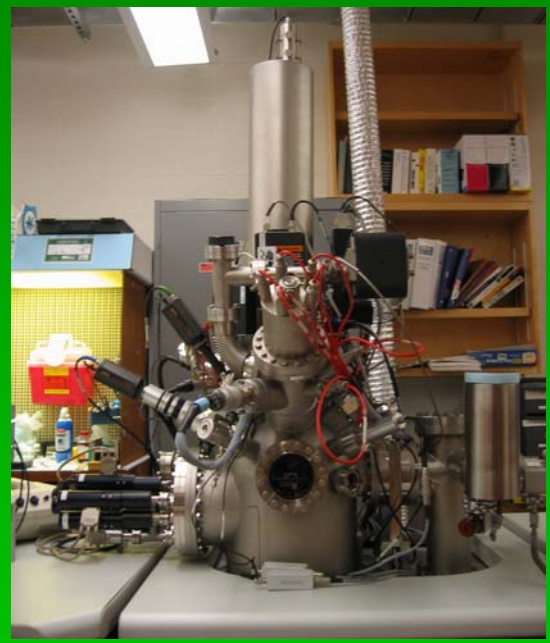




Any Questions?

Thank You!

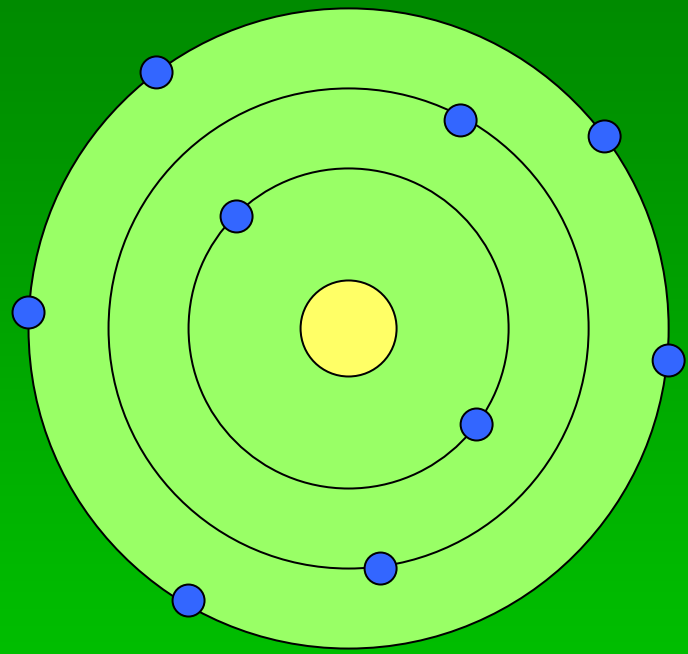




Additional Information

X-ray Photoelectron Spectroscopy (XPS)

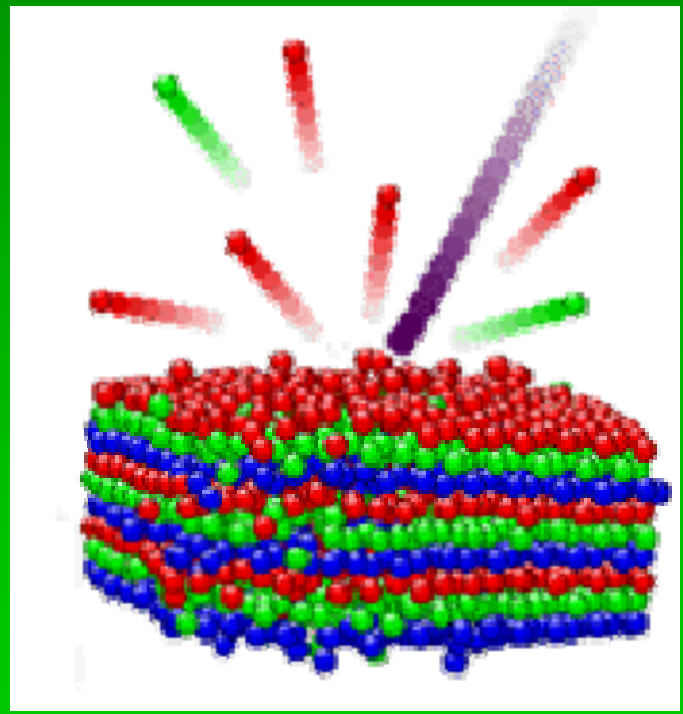
- An x-ray with high energy comes in and hits an atom on the surface.
- An electron from the inner electron shell flies out with a specific kinetic energy.
- The kinetic energy is detected and used to find the binding energy (energy of the atom when it is in a bond).



$$E_k = h\nu - E_b - \varphi_{sp}$$

Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS)

- Ions of Ga^+ or Cs^+ fly at the surface with high energy
- The initial ions (purple) penetrate the solid
- This causes secondary ions and fragments (green and red) to fly off of the surface.



Glove Box

- The glove box is not actually an instrument but is still a very important tool in chemistry.
- Glove boxes are used to store and measure out chemicals that react with water or air.
- The glove box is filled with nitrogen gas instead of air.
- Compounds are put in a special chamber next to the glove box and all of the air is sucked out.
- The chamber is filled with nitrogen gas and then the compounds can go inside of the glove box.

Glove Box