

Tour in

Surface Science

Techniques

Contents

- Medical: Quick Impressions
- Why Surface?
- One detailed example : XPS
 - Conditions, information,
 - Ingredients:
 - 1-Source 2-Surface 3-Spectrum
 - Extensions
 - XPD, ARPES, SRPES, PEEM
- Other techniques
- Conclusion

Medical: quick impressions

almost always

- Living/ moving tissues
- Nondestructive testing
- Volumes to treat, image in 3D or project to 2D
- mm level imaging (nm with STM)

Why surface is interesting?

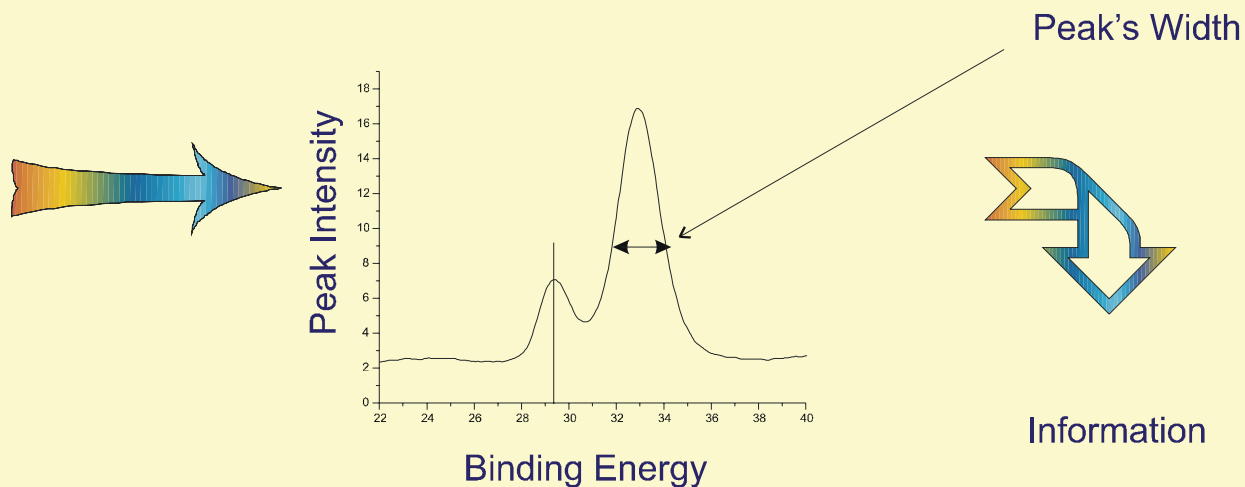
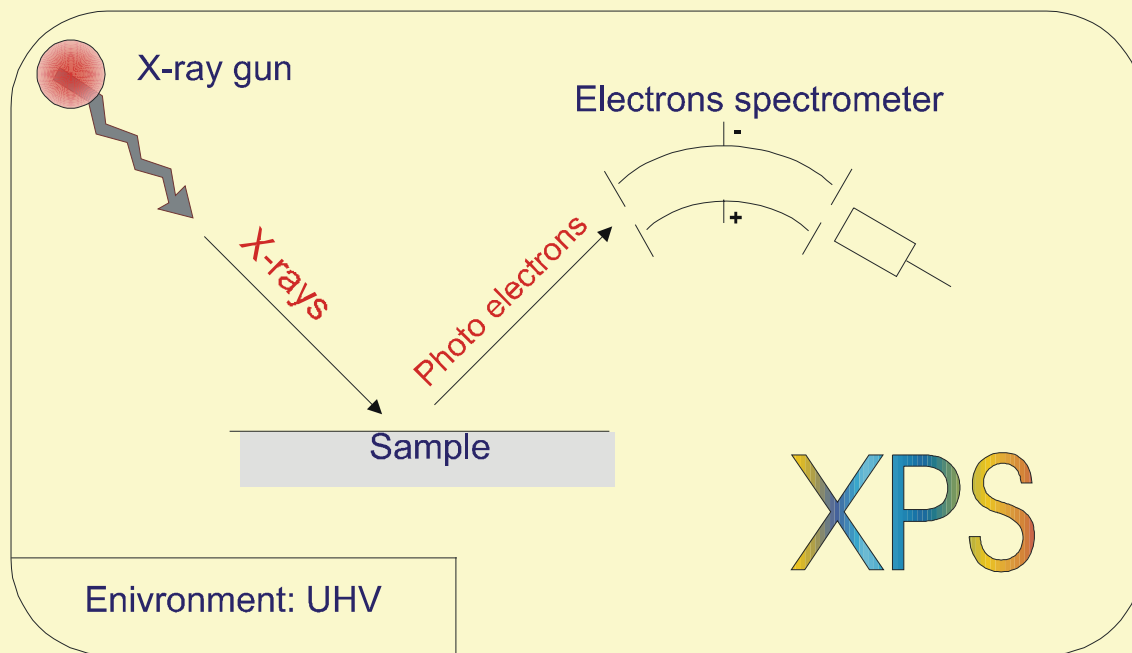
- Interesting physics:
 - half the volume is missing: laws are different
 - Oxidation and gas association phenomena
 - Layers growth, thin films
- The place where atoms are manipulated (STM)
- Important Applications
 - electronics industry: chips are in surface realm
 - Silicon, germanium...
 - catalysis -corrosion

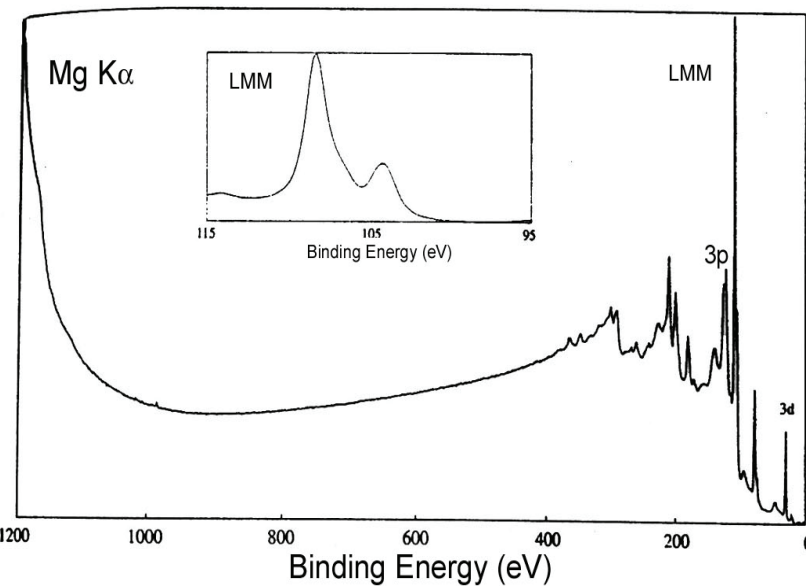
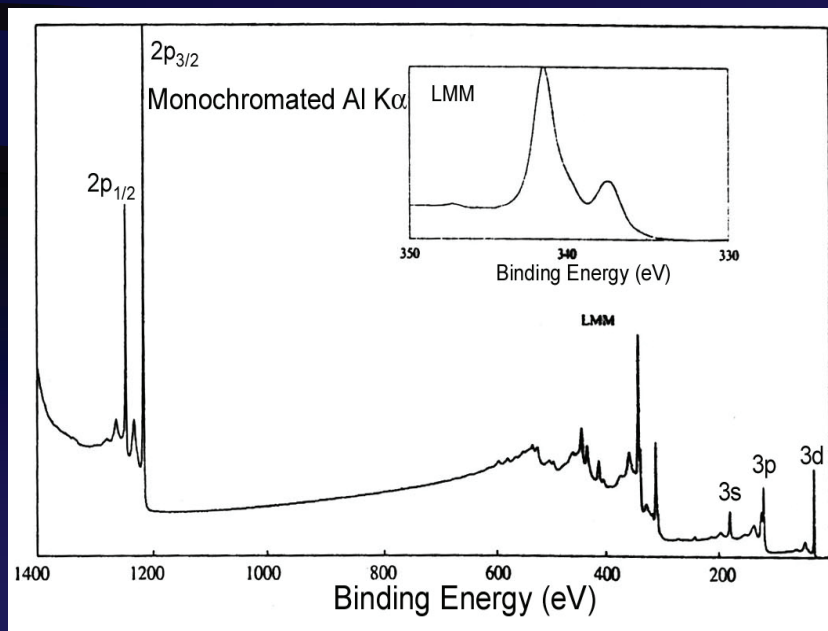
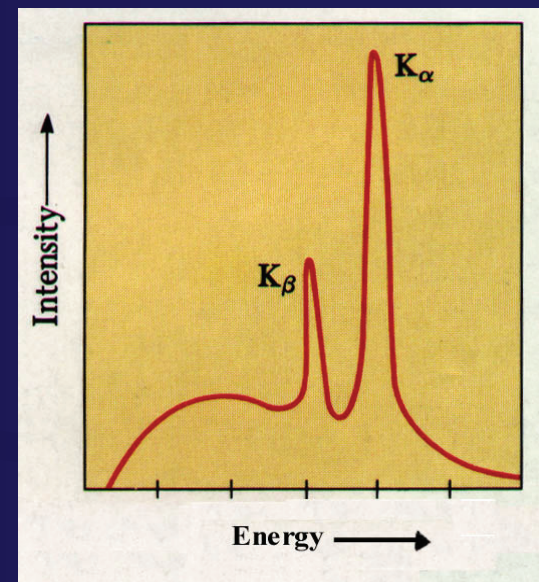
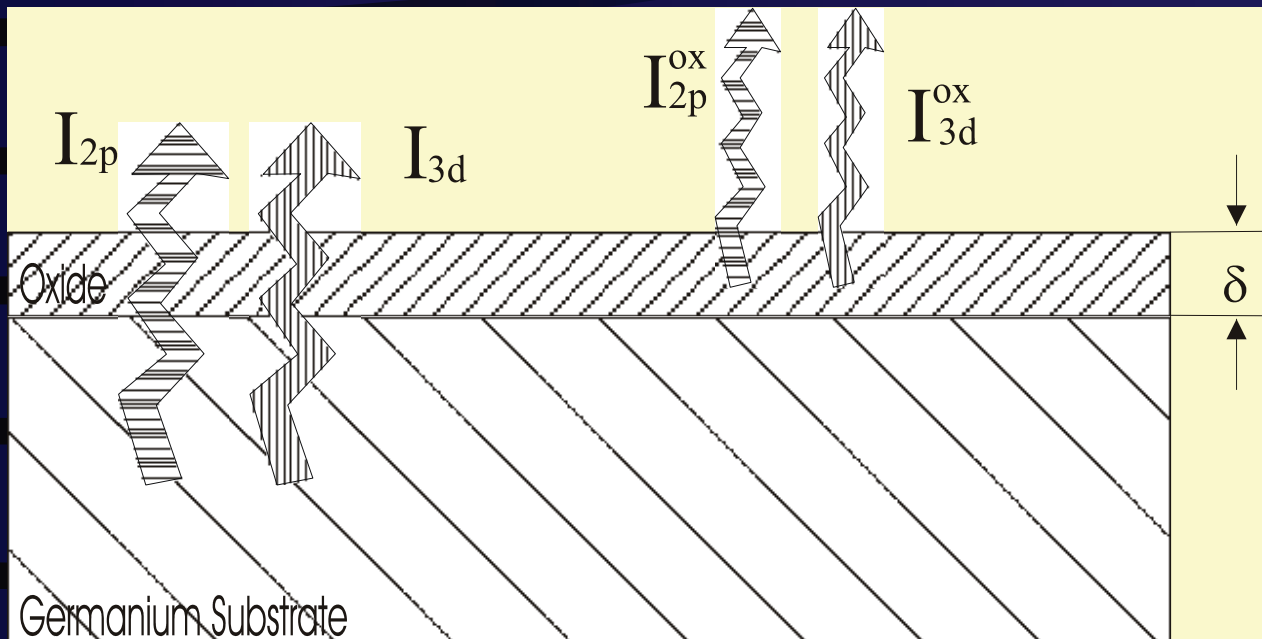
XPS:

X-ray

Photoelectron

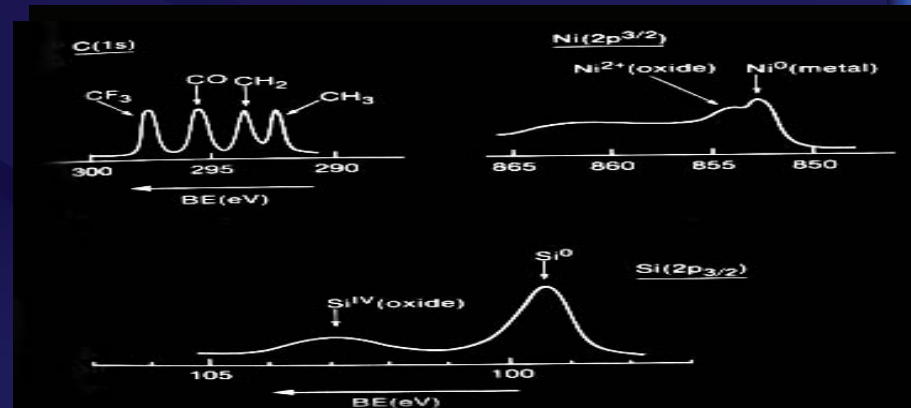
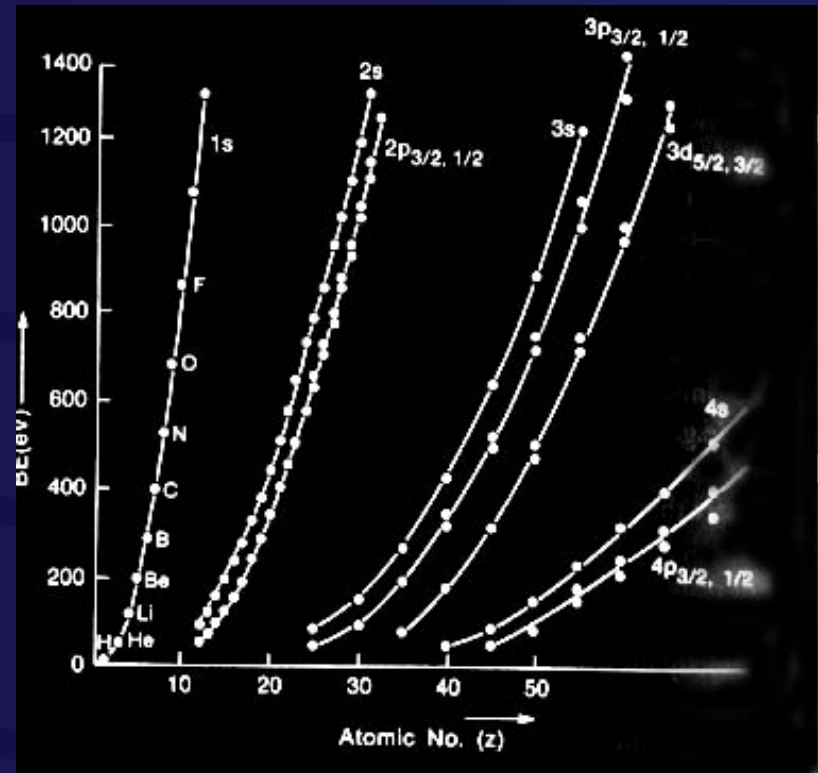
Spectroscopy

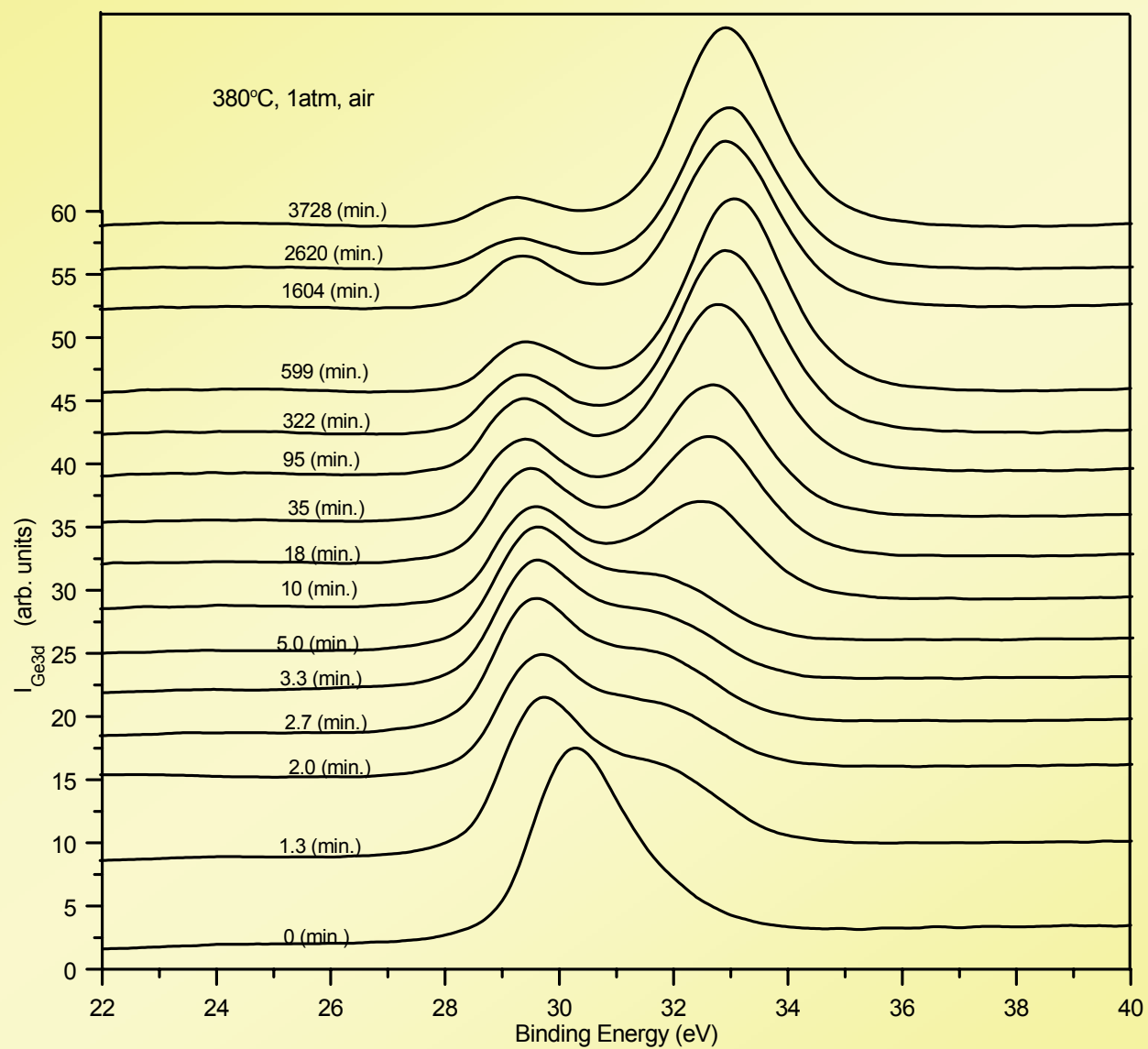




Elemental + Chemical Info

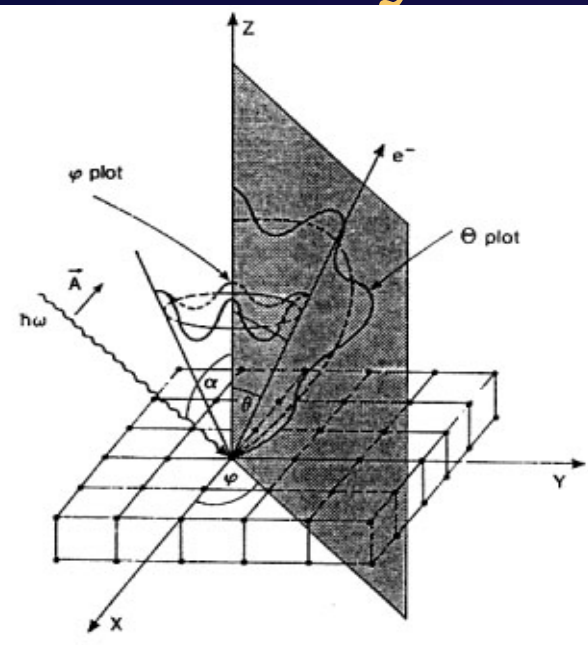
- n, l, LS :lines
“Finger print”
- chemical shifts
→ oxidation studies
→ catalysis poisoning
→ magnetic properties
- 1 - 10 nm depth
- 0.01 - 1 % tracing





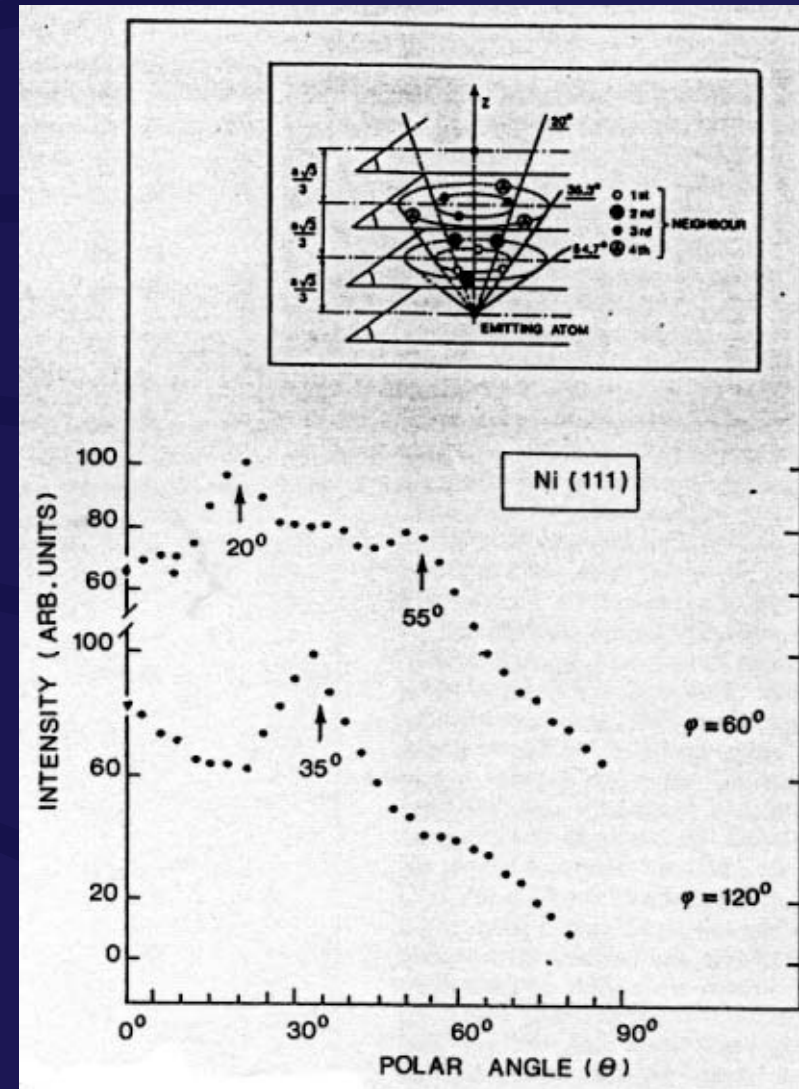
Extended techniques

X-ray Photoelectron Diffraction (XPD)

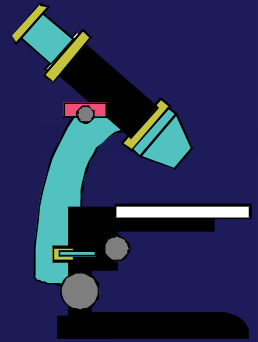


- Track angular variation of a certain peak intensity. It varies only if it belongs to the second layer

Consideration: preparation, propped depth, time
->surface structure + enhanced surface sensitivity



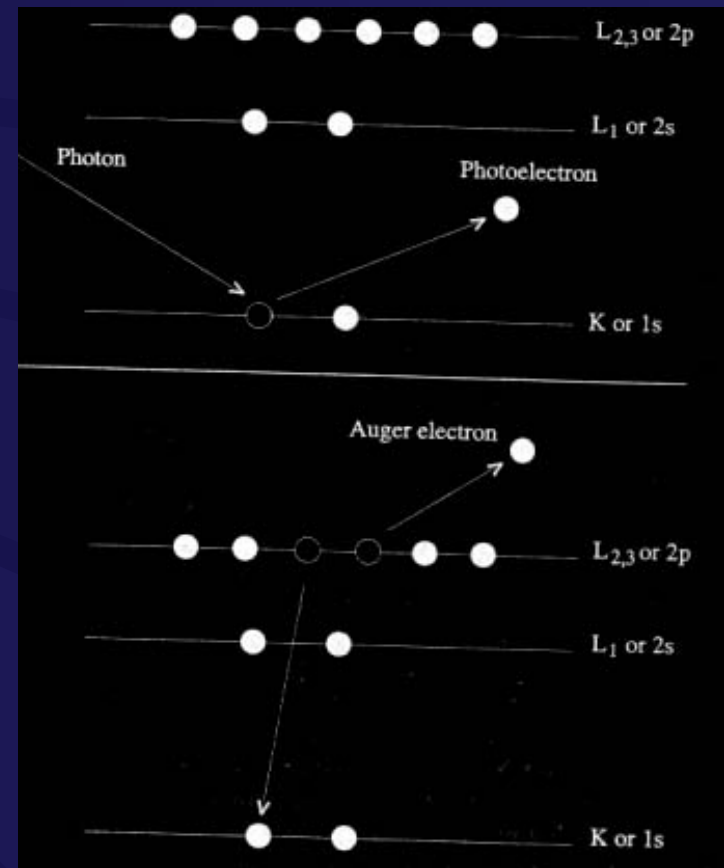
Photoelectron Emission Microscopy (PEEM)



- Focus x-rays $\rightarrow$ image
 - collimating (signal $\downarrow$ $\rightarrow$ synchrotron)
 - x-ray optics (under development)
- Advantage: Element specific, chemical status
- Applications:
 - diffusion, segregation, Shottky barrier

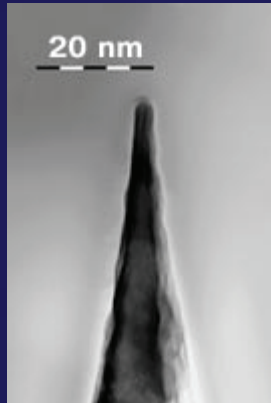
Auger process

- 3-e process, not $f(h\nu)$
 - X-ray or e-beam induced
 - Microscopy (SAM)
-
- fluorescence (by x-ray as TRXF)
 - 1 in 10^9 - 10^{12}

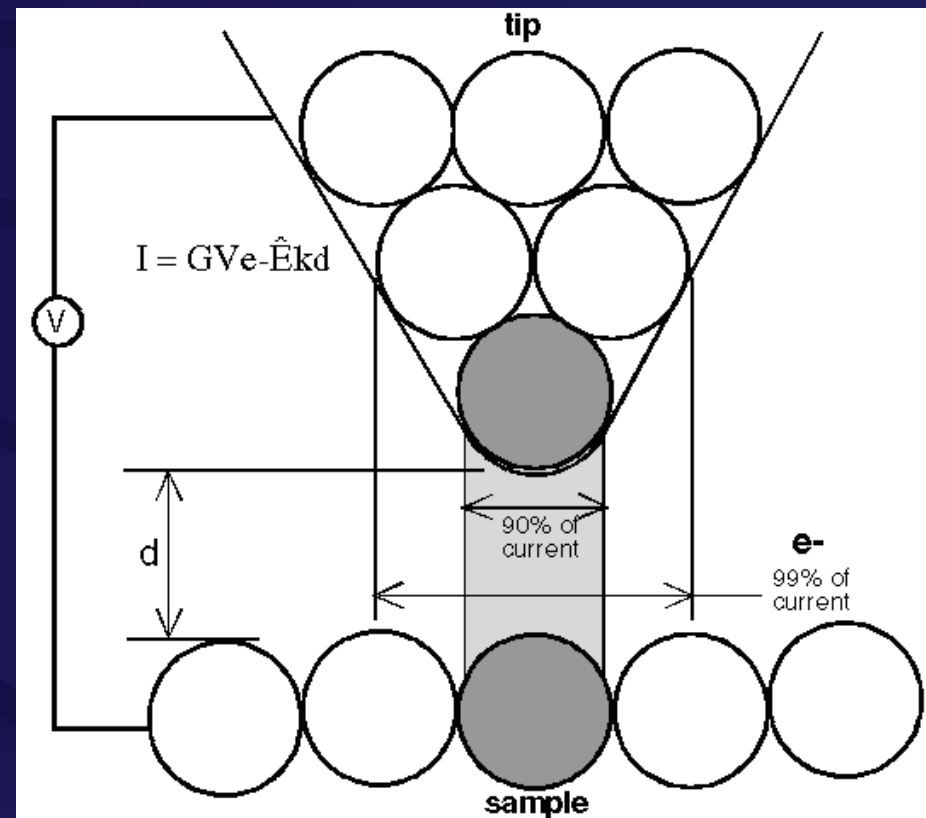


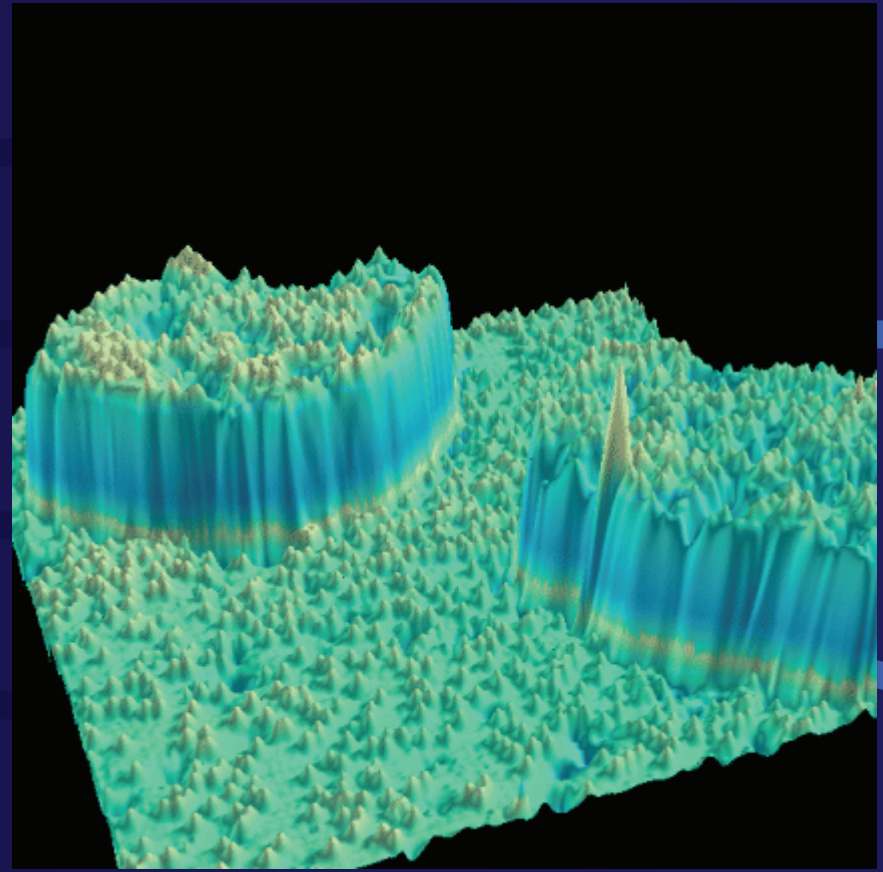
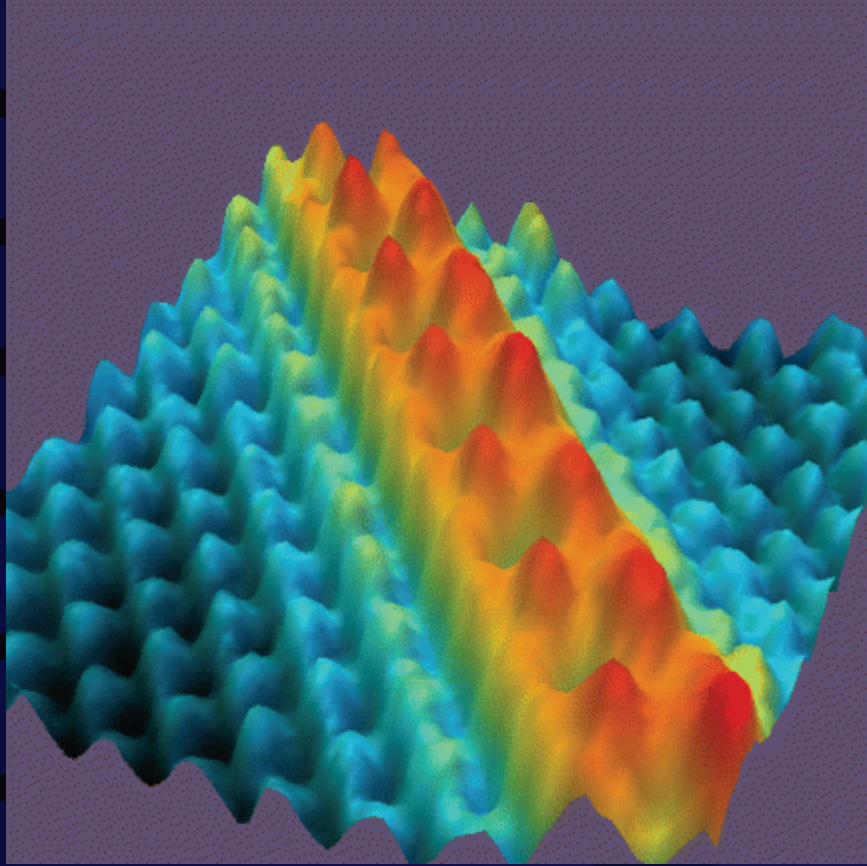
Other Surface Techniques

Scanning Probe Microscopy



- STM, AFM ...
- high (or even **atomic**) resolution
- atomically sharp tip
- raster a surface
- vary/fix current
voltage, move tactic
- tip material





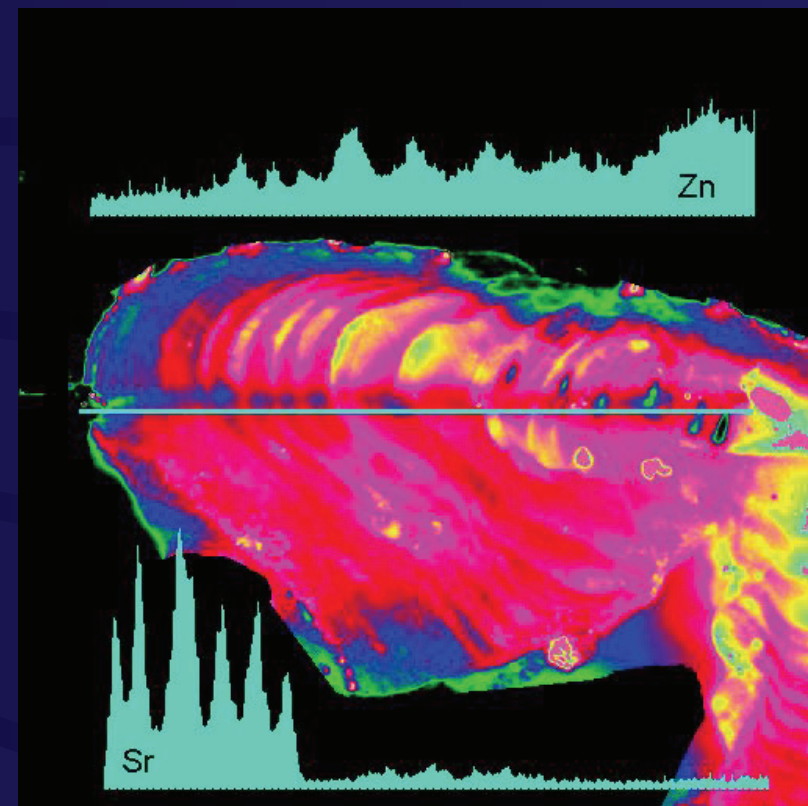
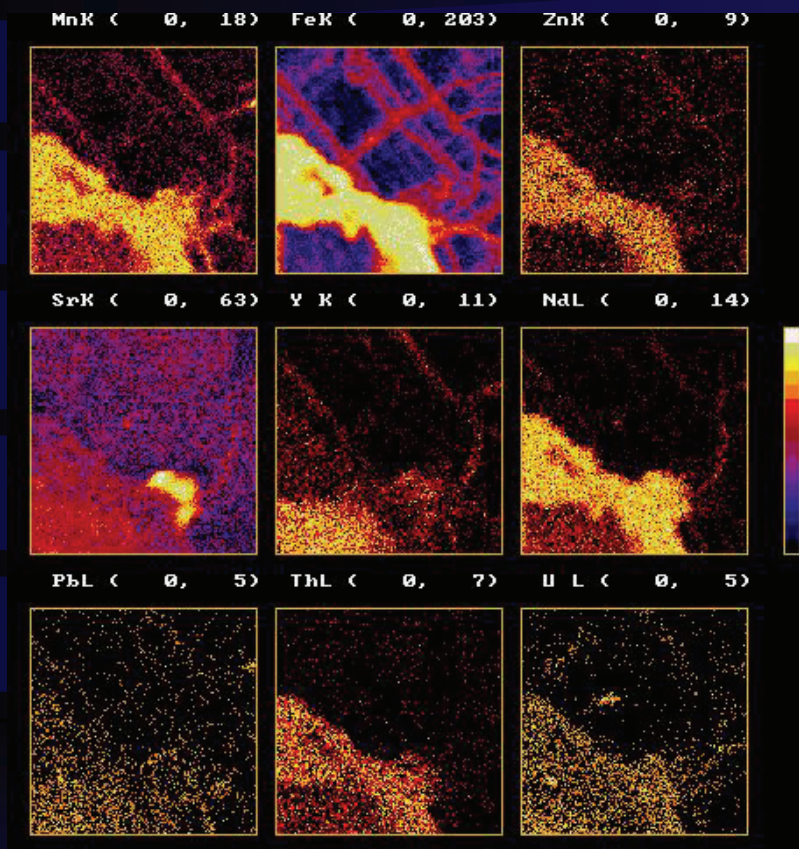
NIST

(left) single atomic zig-zag chain of Cs (red) on GaAs(110) surface.

(right) substitutional Cr impurities (small bumps) in Fe(001) surface

Proton-induced X-ray emission (PIXE)

- micro PIXE— images (now: 5 x 5 μm)
- 3 MeV protons (accelerator + focus) $\rightarrow$ inner vacancy – florescence
- trace analysis of elemental composition
- simultaneous multi-element (NDT!)
- multilayer --- **not** a surface technique
- Mineralogy, Geochemistry & Materials Science



Conclusion

- Microscopy with Spectroscopy feature
- **Medical:** interest, restrictions, *importance*
- **Material science:** diversity