Tour in Surface Science Techniques
Contents

- Medical: Quick Impressions
- Why Surface?
- One detailed example: XPS
  - Conditions, information,
  - Ingredients:
    1-Source 2-Surface 3-Spectrom
  - 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
380°C, 1 atm, air

Binding Energy (eV)
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 → image
  - collimating (signal↓ -> 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

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(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) → 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