XPS at Lehigh

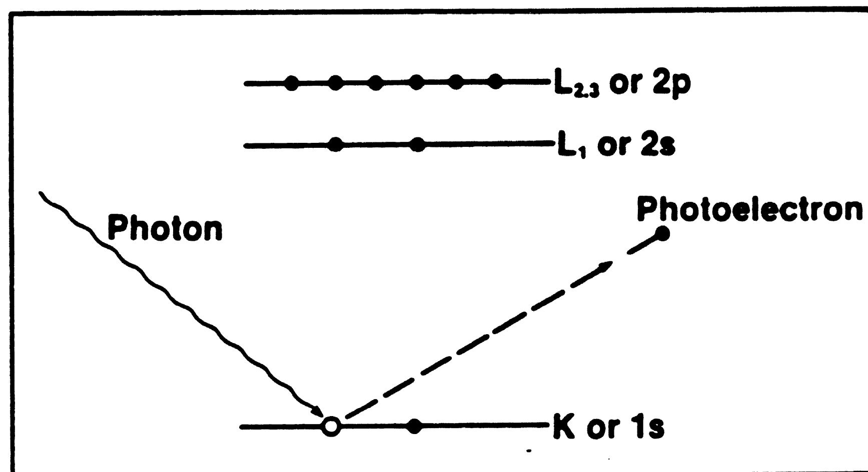
Dr. Alfred C. Miller

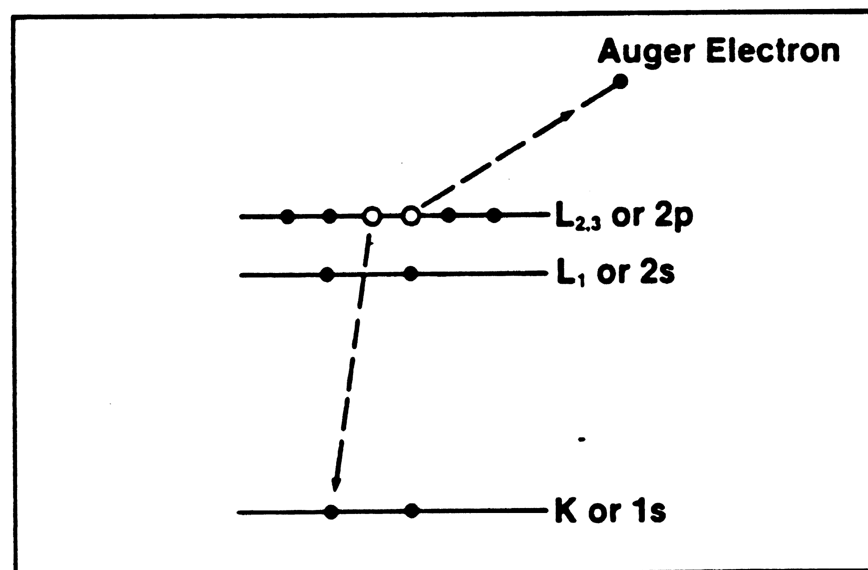
Overview

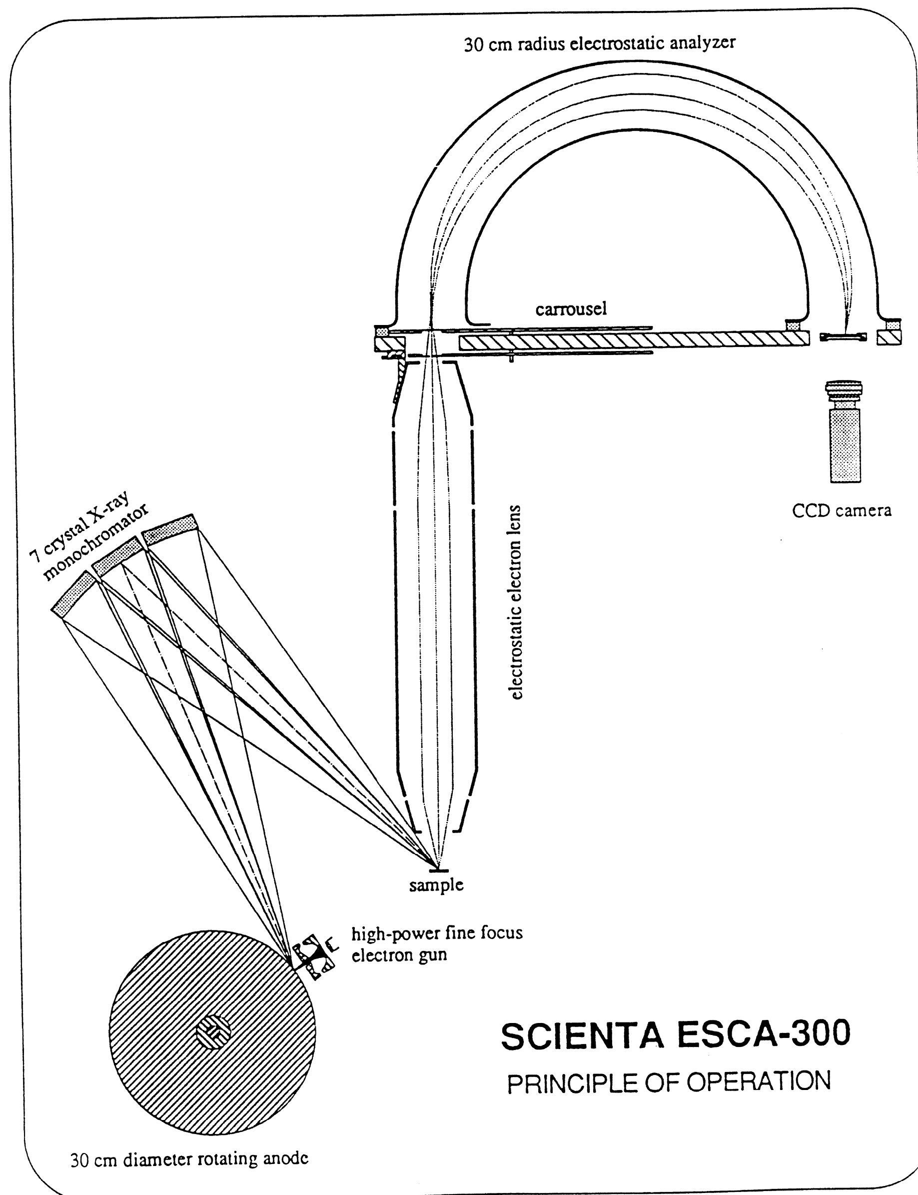
- Principles
- Instrumentation
- Examples
- Limitations
- Resources at Lehigh

Principles of XPS and AES

Maximum escape depth for electrons is less than 10 nm



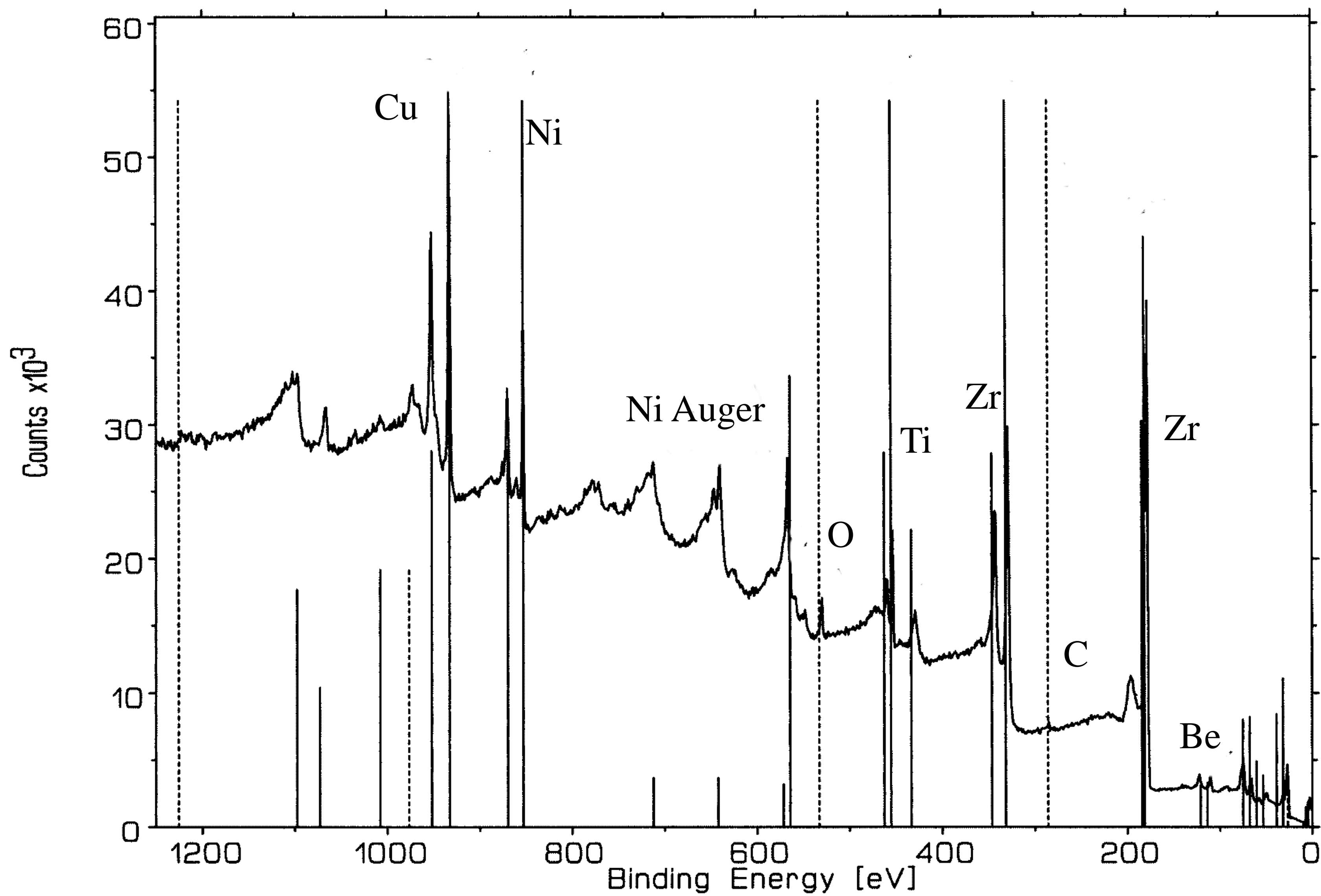



30 cm radius electrostatic analyzer
carrousel
CCD camera
7 crystal X-ray monochromator
electrostatic electron lens
sample
high-power fine focus electron gun
SCIENTA ESCA-300
PRINCIPLE OF OPERATION
30 cm diameter rotating anode

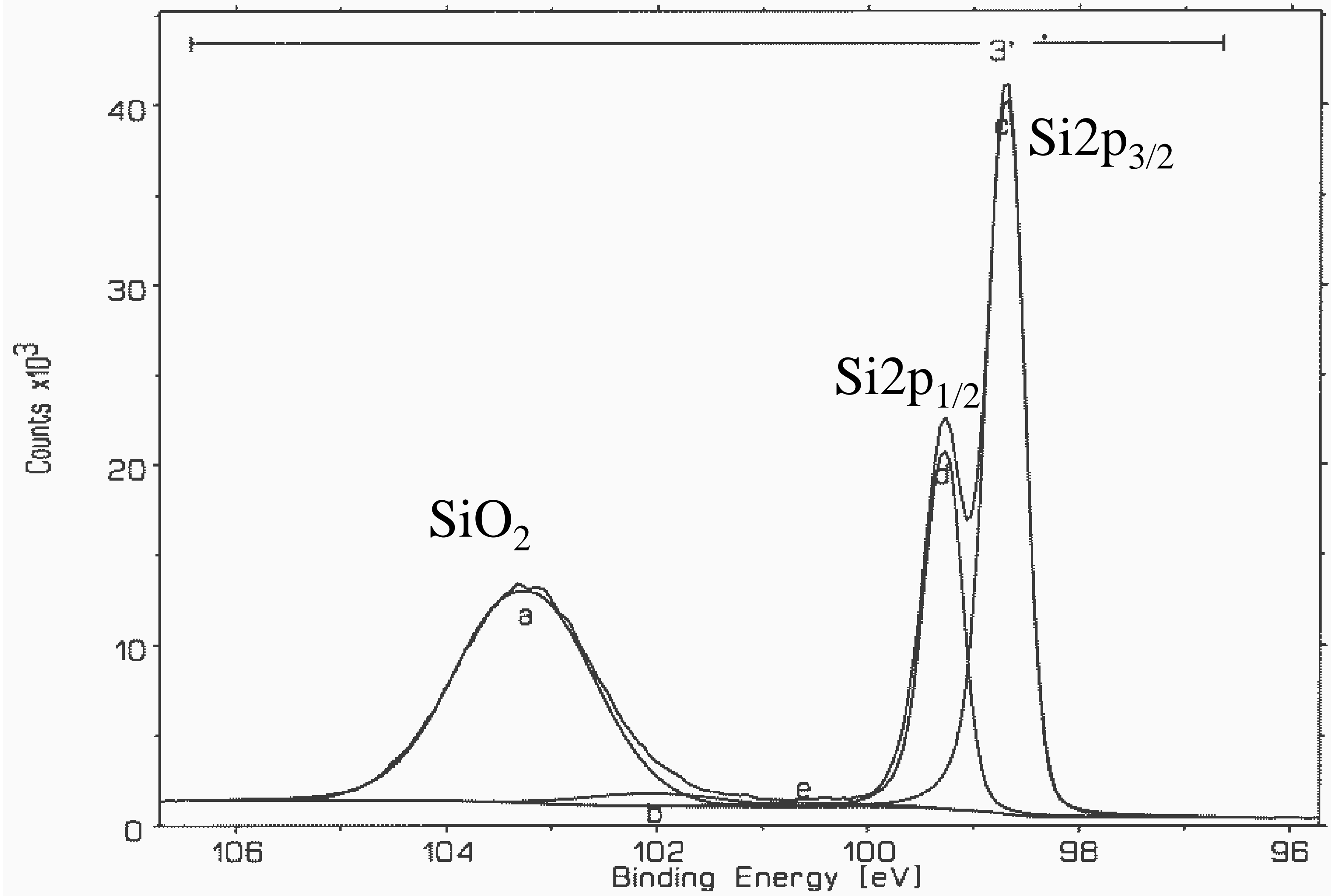
Spectral information

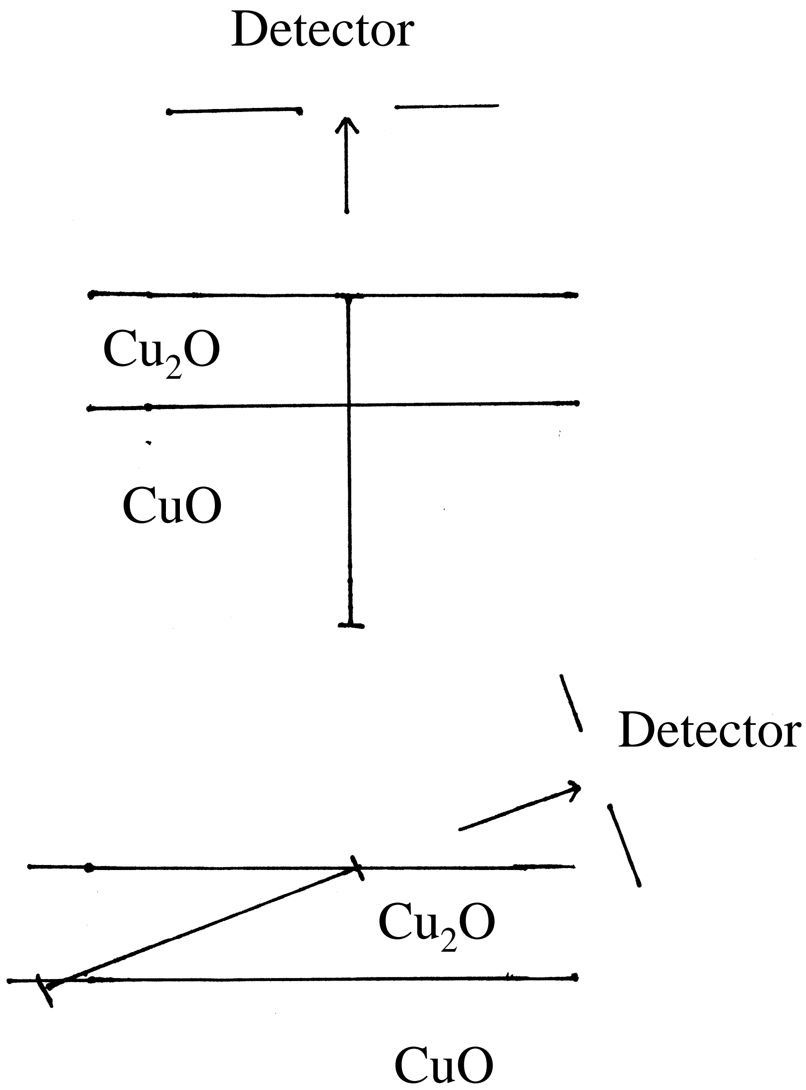
- Elemental identification
- Chemical state
- Quantitative surface composition
- In-Depth Composition (ARXPS, sputter depth profiles)
- Lateral distribution of surface elements and chemistry (XPS imaging)

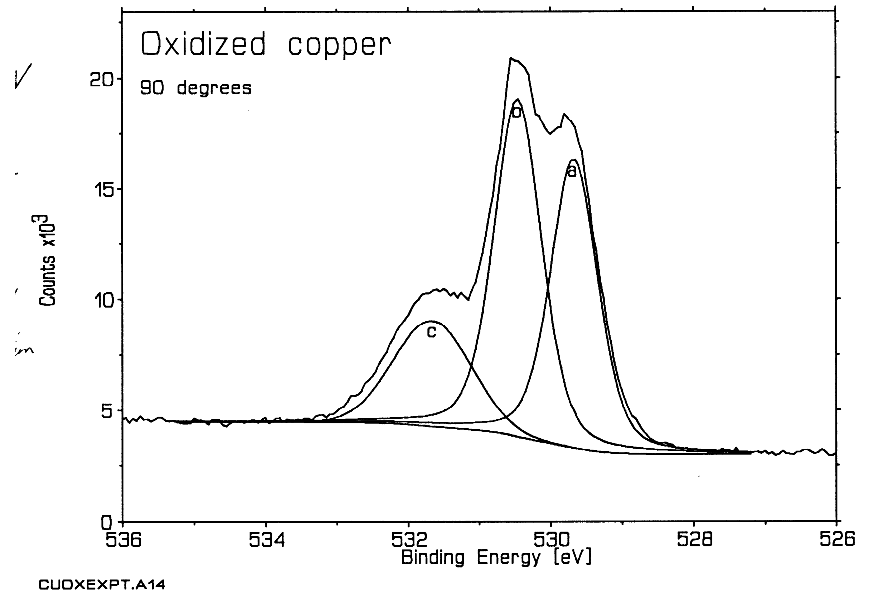
Zr41.2Ti13.8Cu12.5Ni10Be22.5

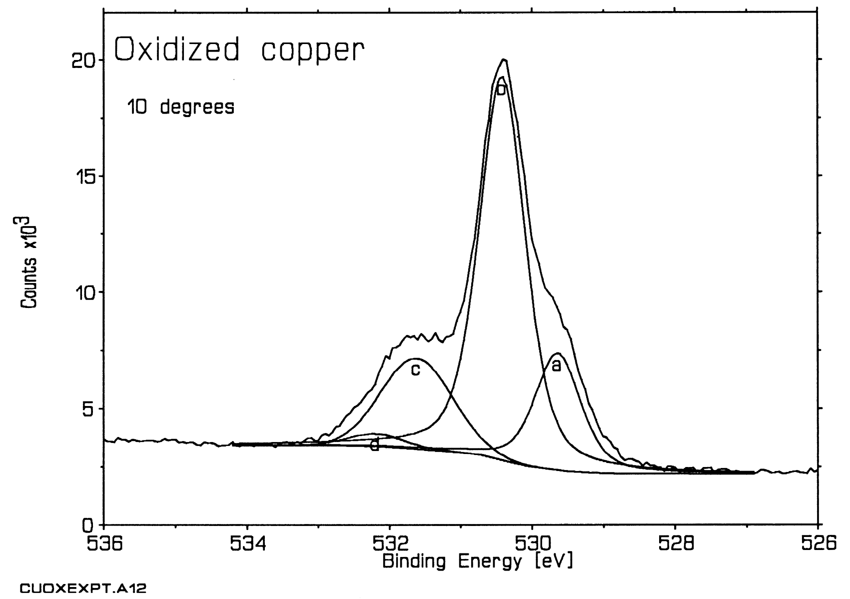


Thin oxide on Si



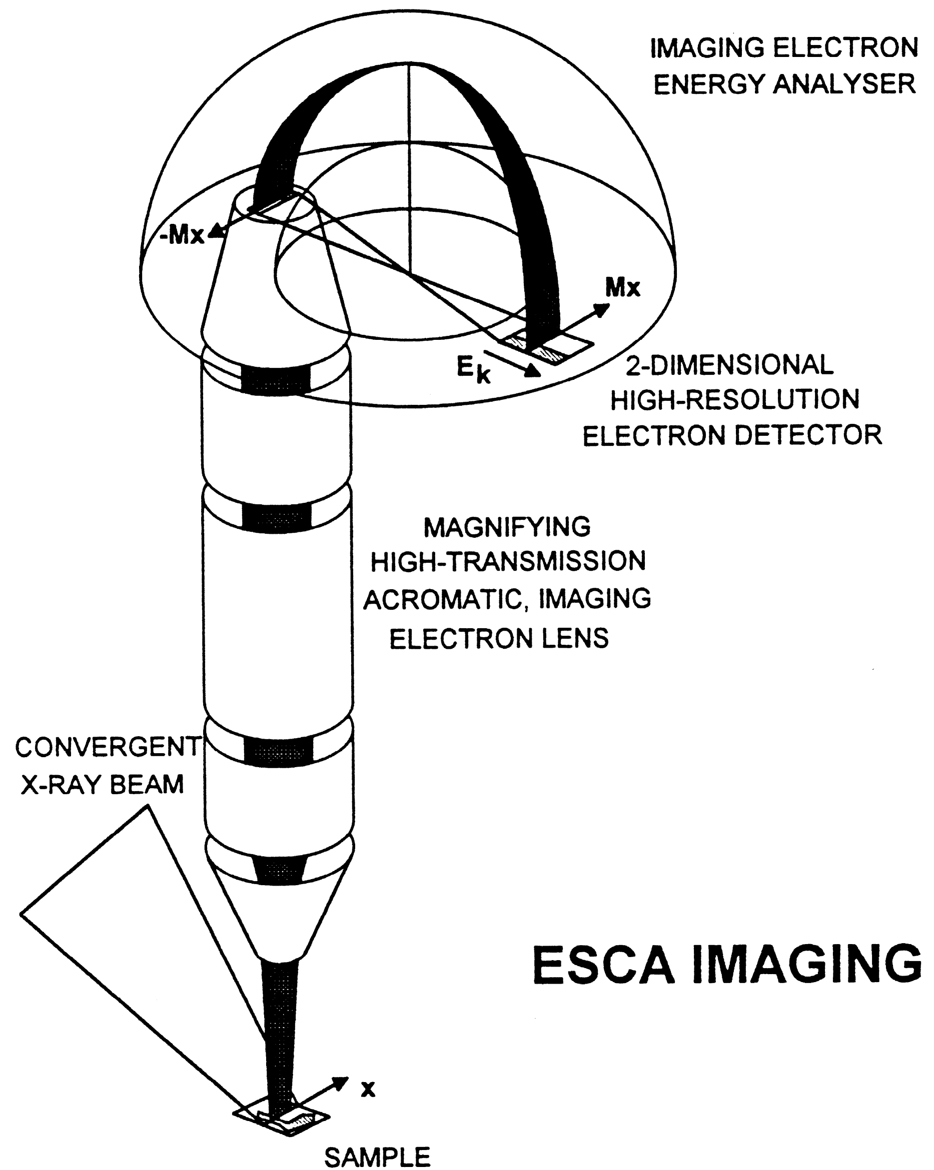

Detector
Cu2O
CuO
Detector
Cu2O
CuO


Oxidized copper
90 degrees
Counts x10^3
Binding Energy [eV]
CUOXEXPT.A14

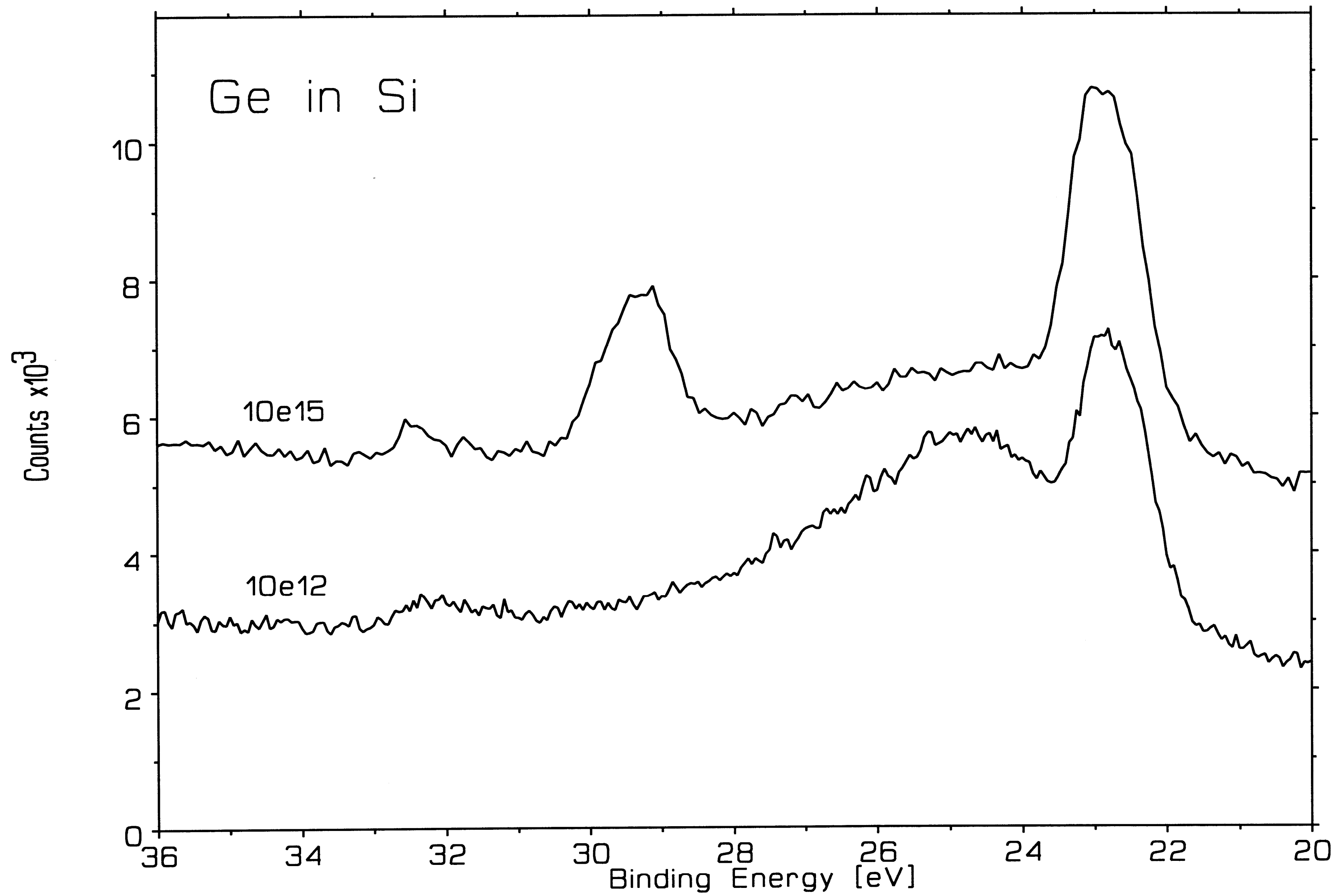

Oxidized copper
10 degrees
Counts x10^3
Binding Energy [eV]
CUOXEXPT.A12

XPS imaging

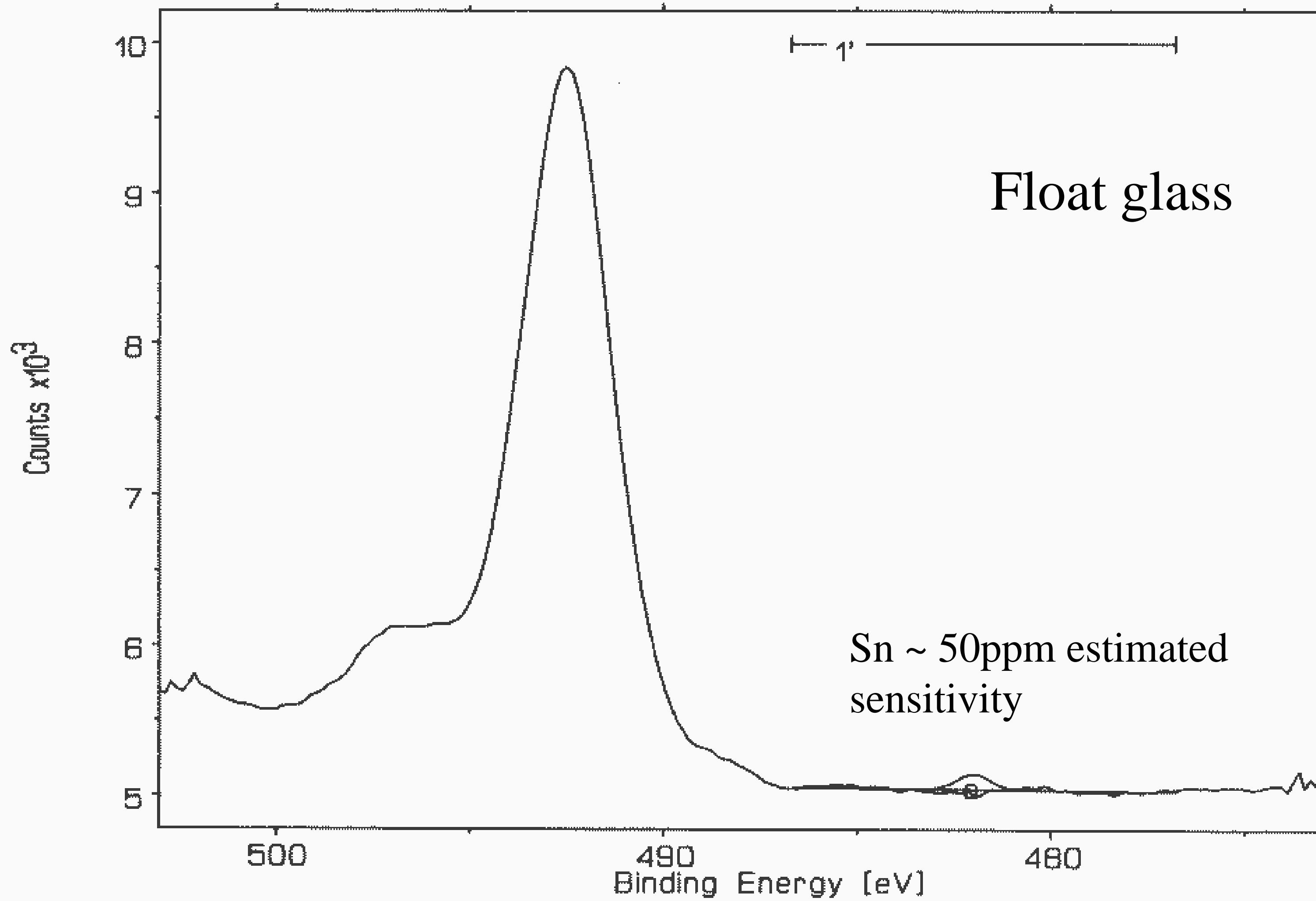
Edge resolution of
3 microns or less
for the best instruments



Detection Sensitivity- Ge implanted in Si

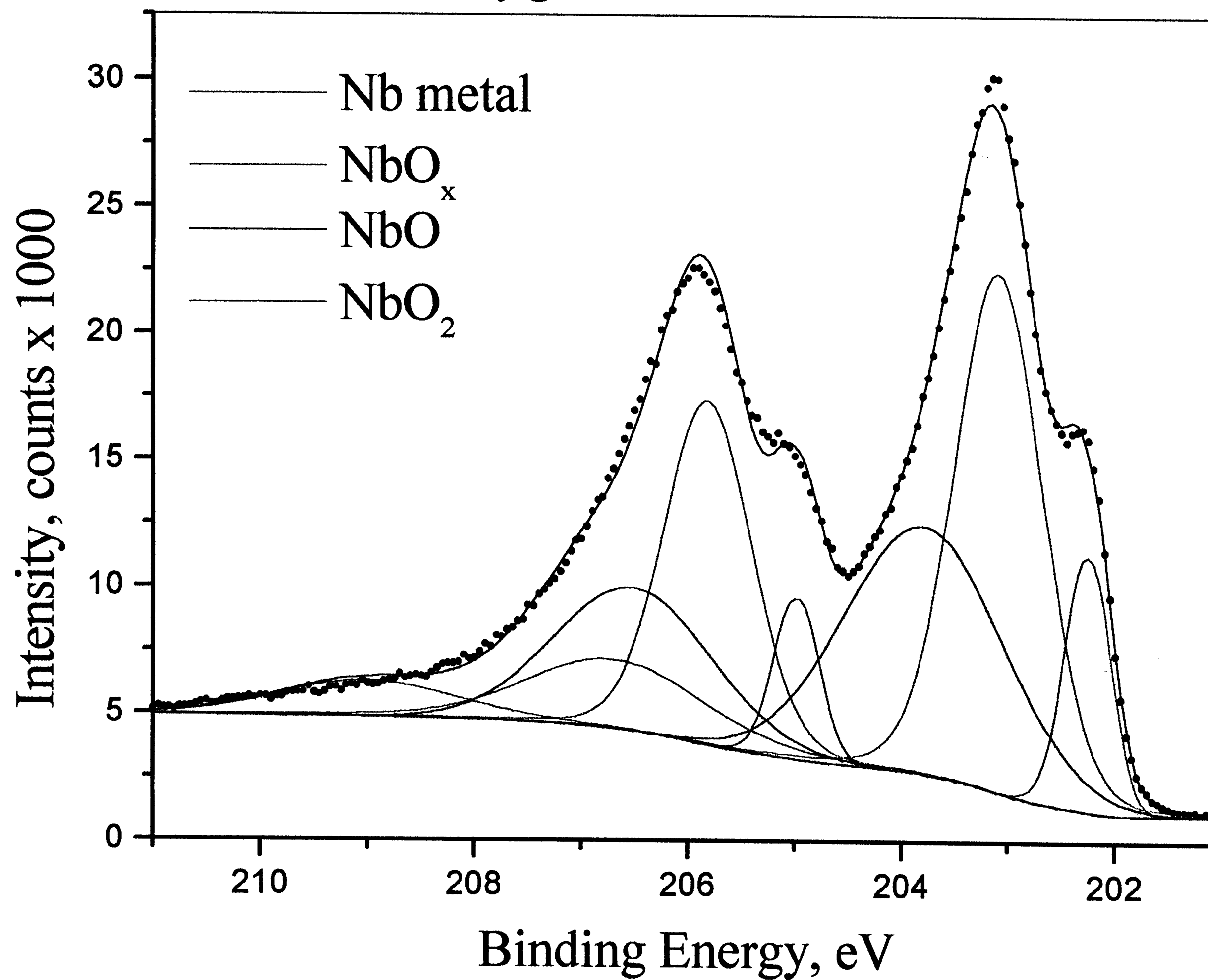


Detection Sensitivity

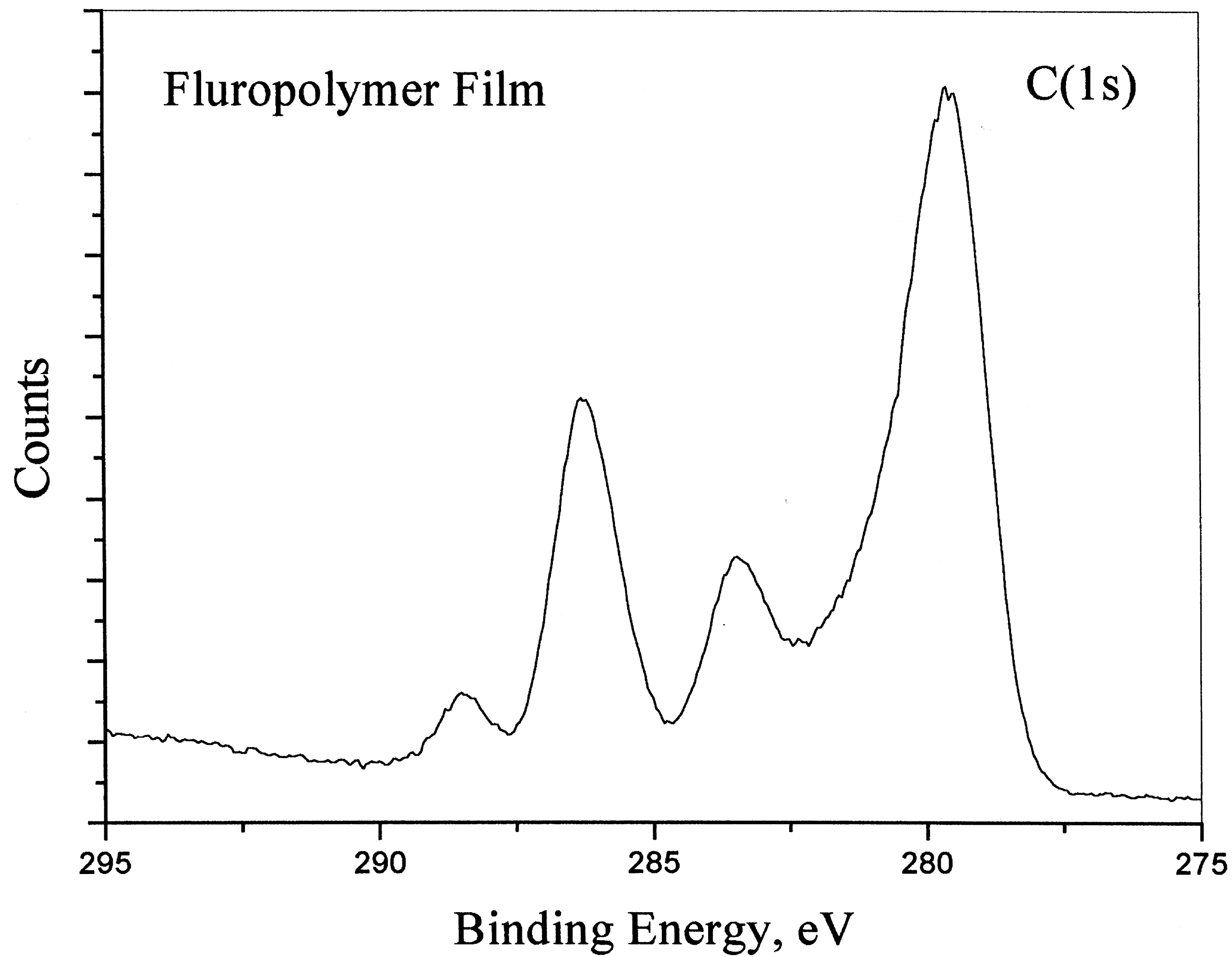


Metals

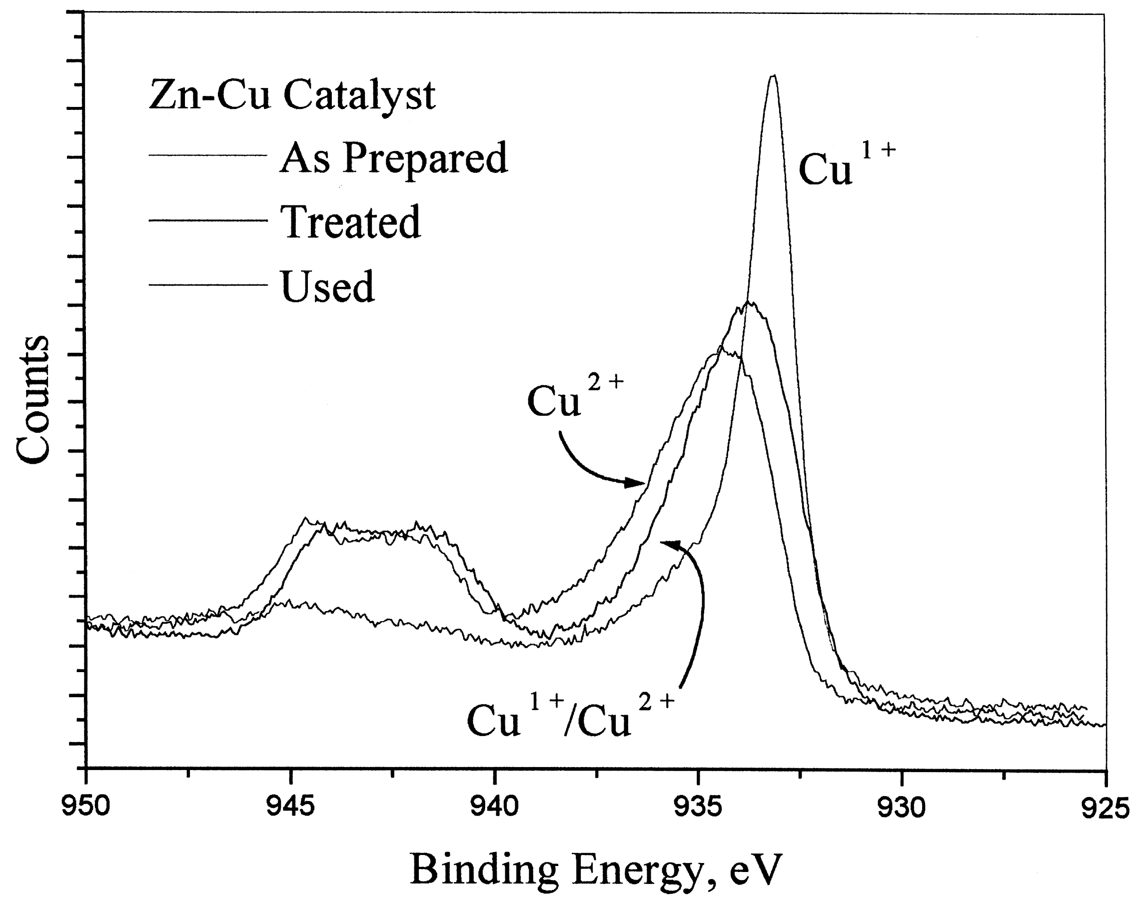
5×10^{-4} Pa oxygen at 973K for 45 minutes



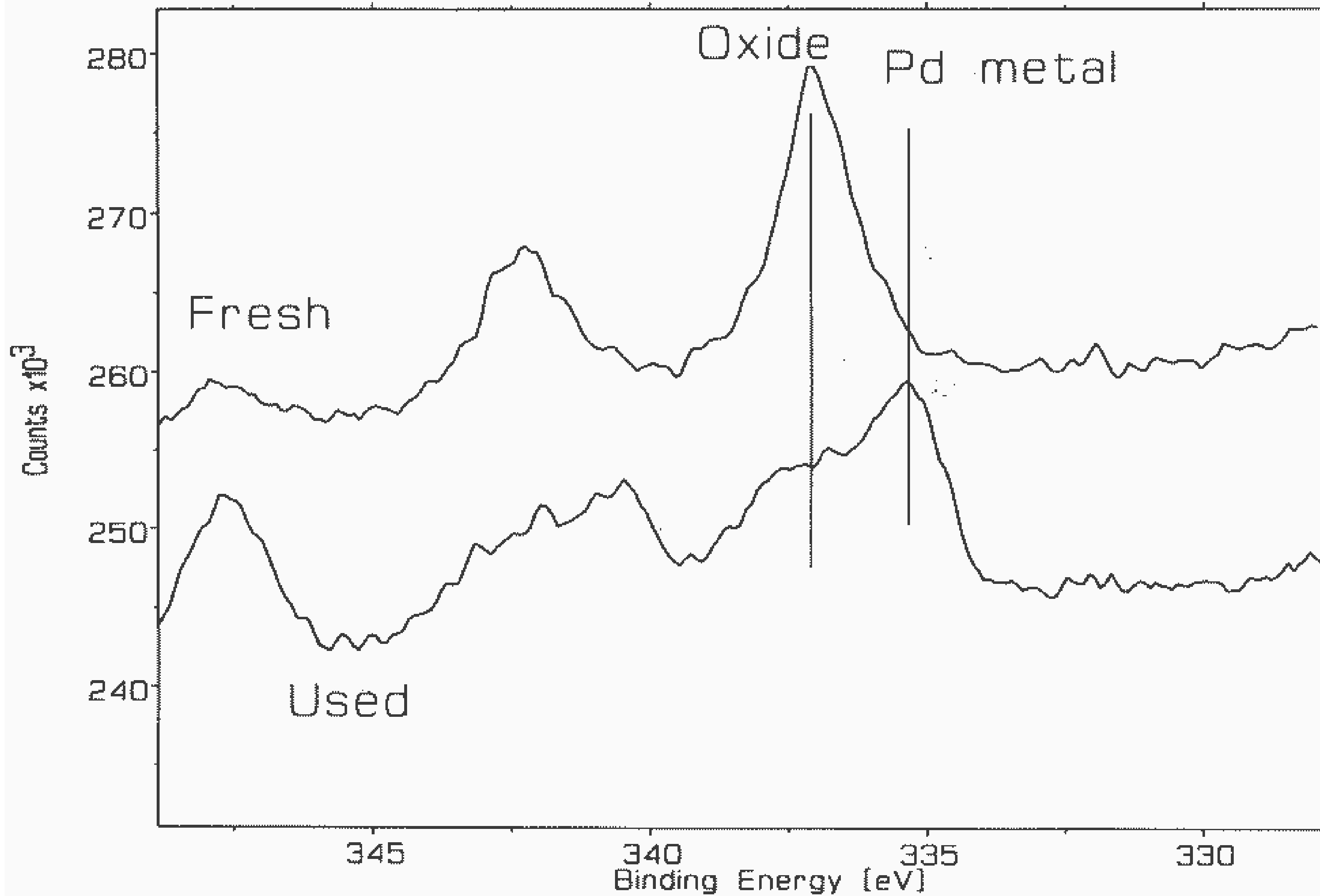
Polymers



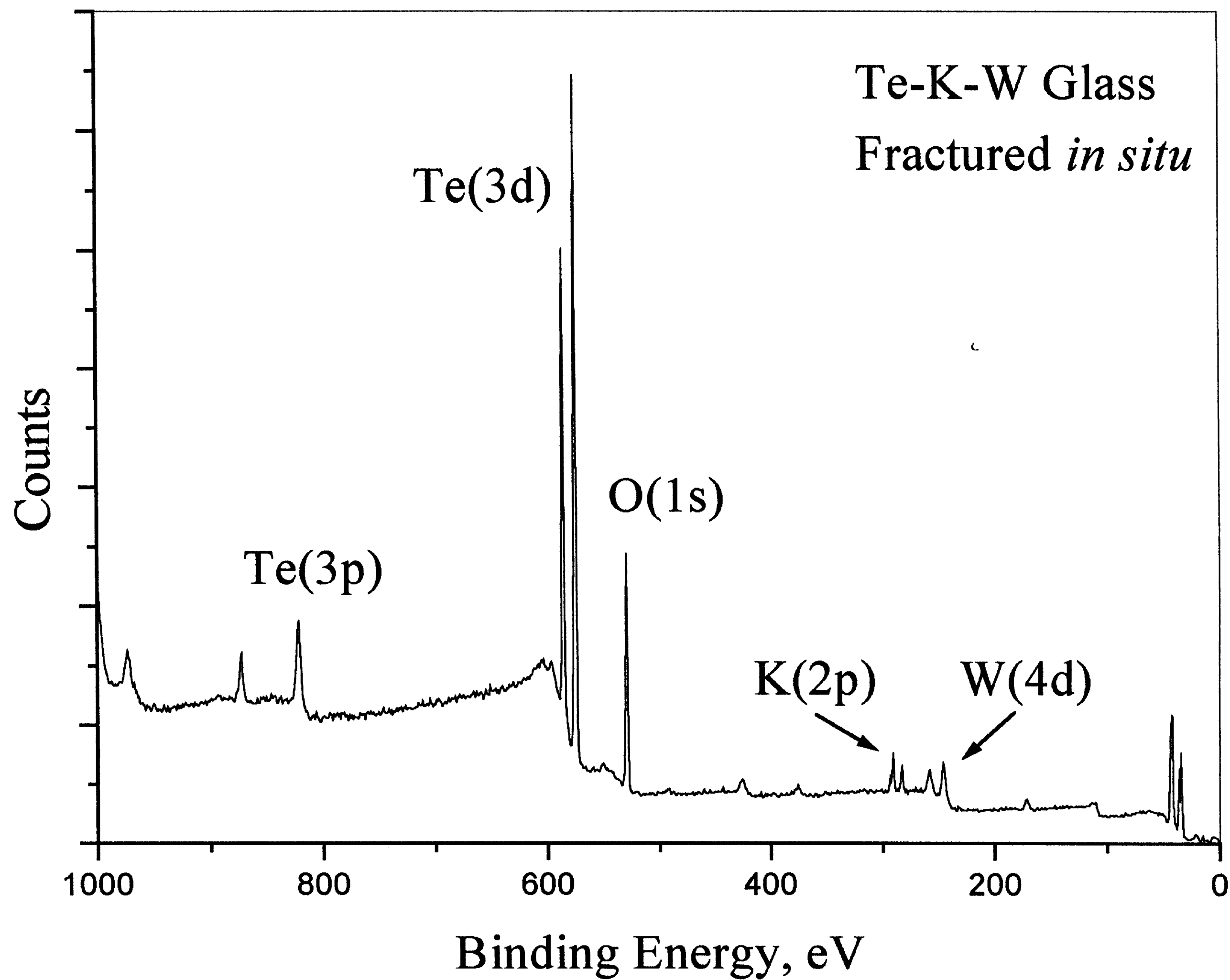
Catalysts



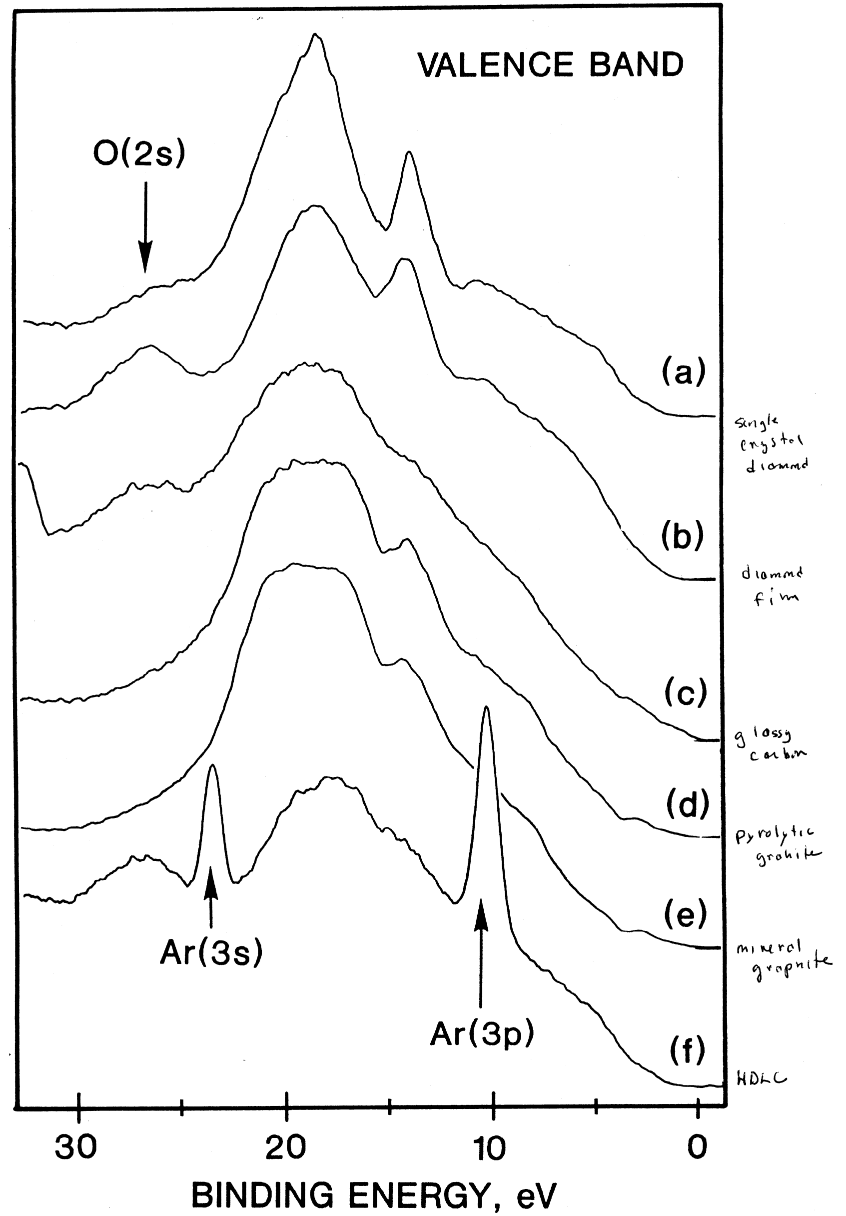
Pd loading of 0.05 wt.%



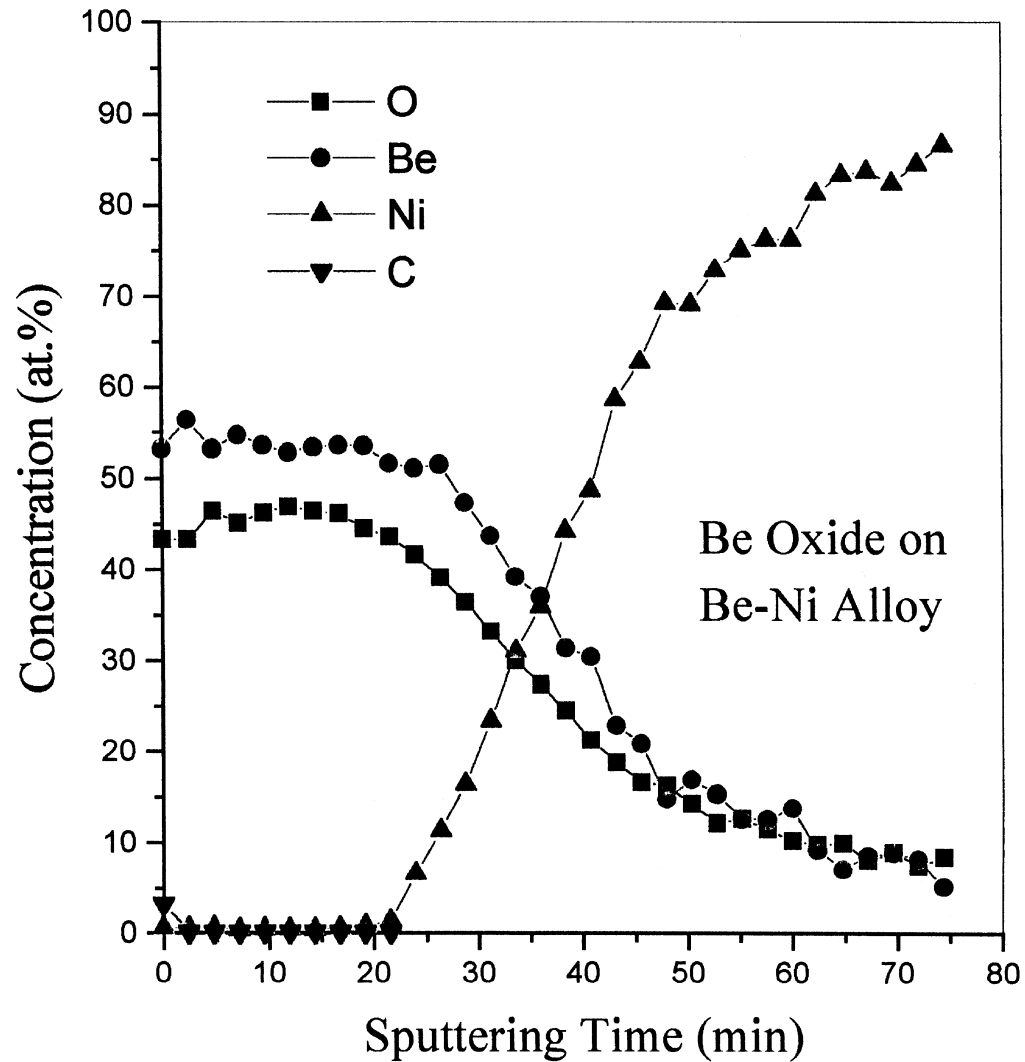
Insulators

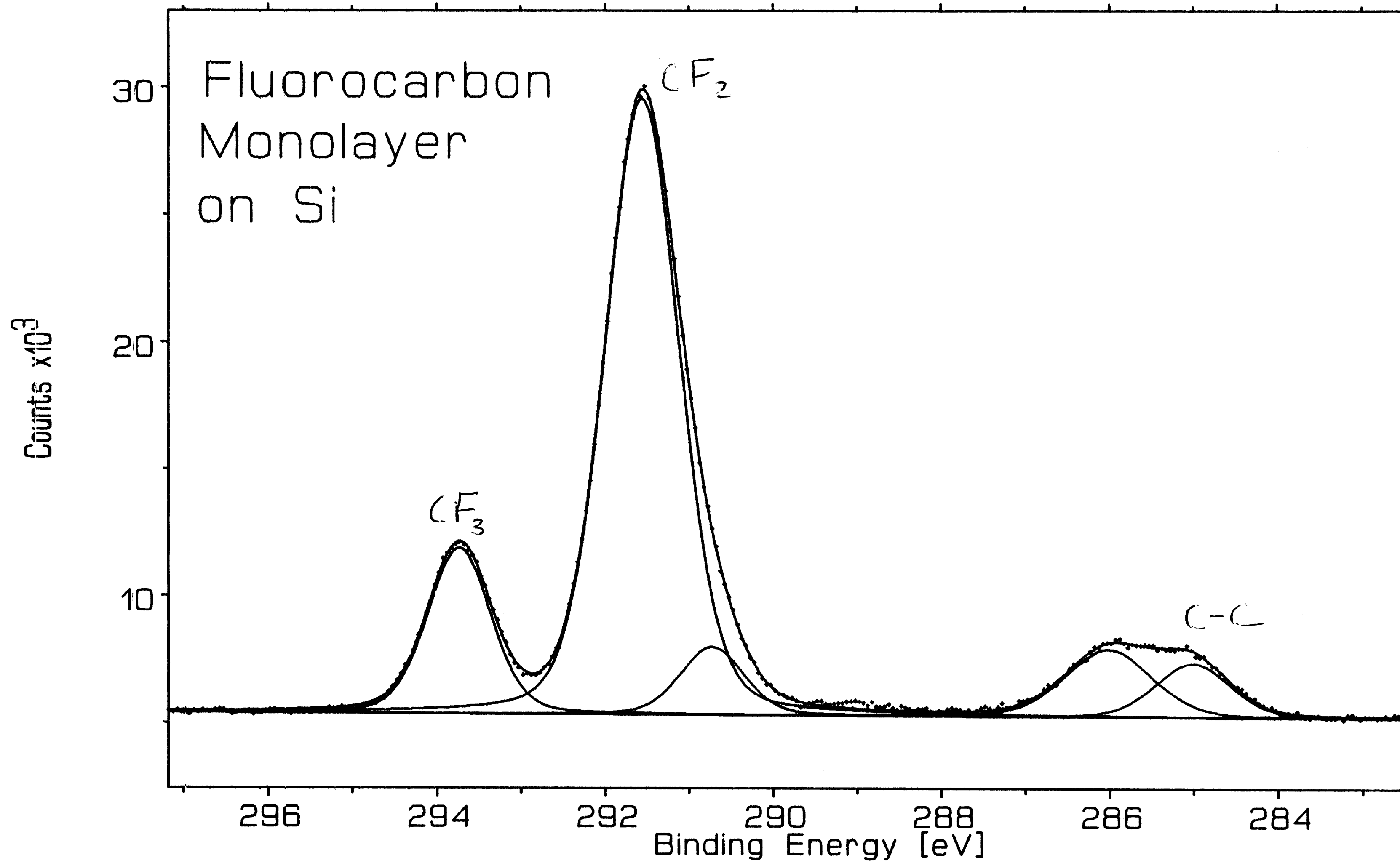


Valence Band

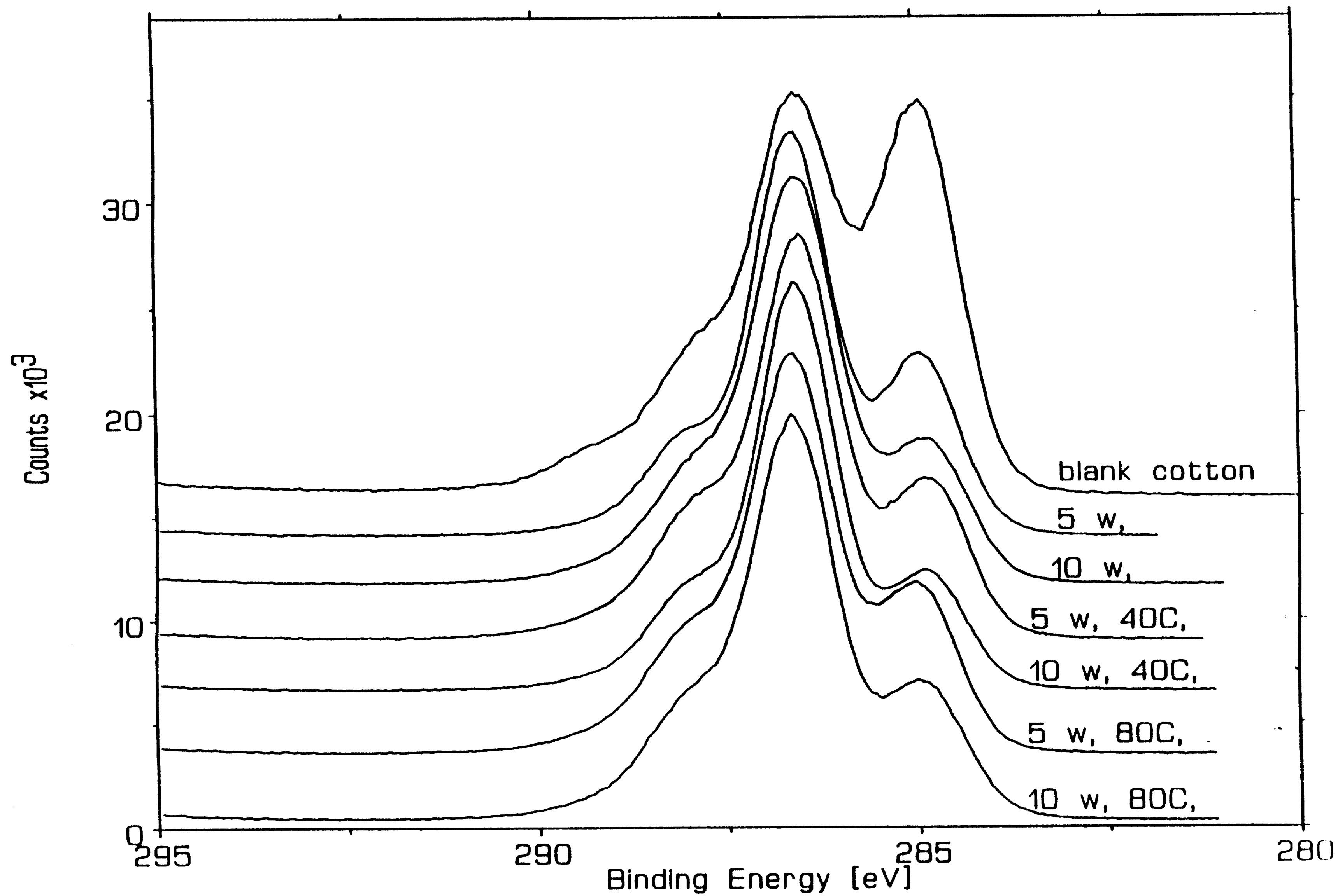


Depth Profiles




Fluorocarbon
Monolayer
on Si
CF2
CF3
C-C
30
20
10
Counts x10^3
296
294
292
290
288
286
284
Binding Energy [eV]
CHAUD-03.A01 1995-10-12 16:48 INT Lehigh University

Effects of washing on cotton



Advantages

- Sensitive to 2-20 monolayers
- Can detect ca 10^{-3} atomic fraction
- Is especially useful for chemical shifts from the same element in different compounds
- Is the least destructive of the surface analysis techniques
- Has sensitivity range within a factor of 20
- Has minimal sample charging

Limitations

- Has moderate lateral resolution
- Is slower for sputter depth profiling than other methods

Lehigh Scienta ESCA300

Instrument features

- High power rotating anode x-ray source
- Multi-element monochromator
- High throughput analyzer and lens
- Channel plate detector
- Small spot and imaging capability
- Automated stage for multi-position analyses
- Charge compensation for insulators

Lehigh Scienta ESCA300

- In-situ heating and cooling
- Fracturing and scraping
- Argon ion etching
- Thin film deposition
- Gas exposures (low and high pressures)
- Residual gas analysis
- LEED available