High Resolution XPS study of oxide layers grown on Ge substrates using synchrotron radiation

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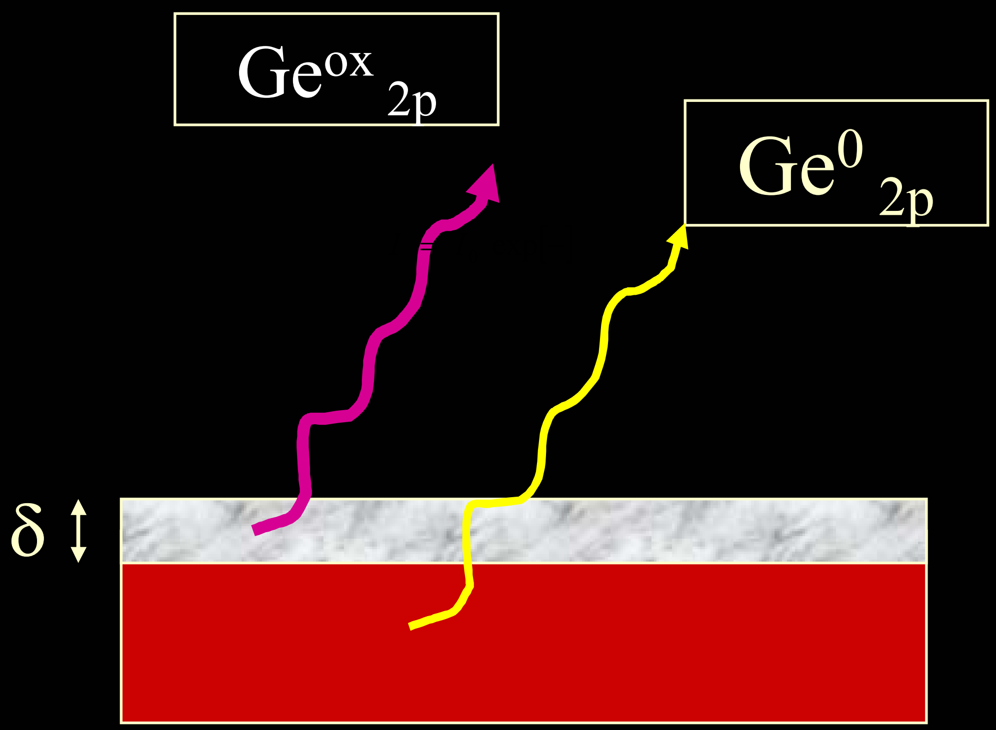
Outline

1. Conventional XPS monitoring of the oxide growth

2. High resolution XPS analysis
- Native Oxide
- Oxide layers obtained by dry oxidation

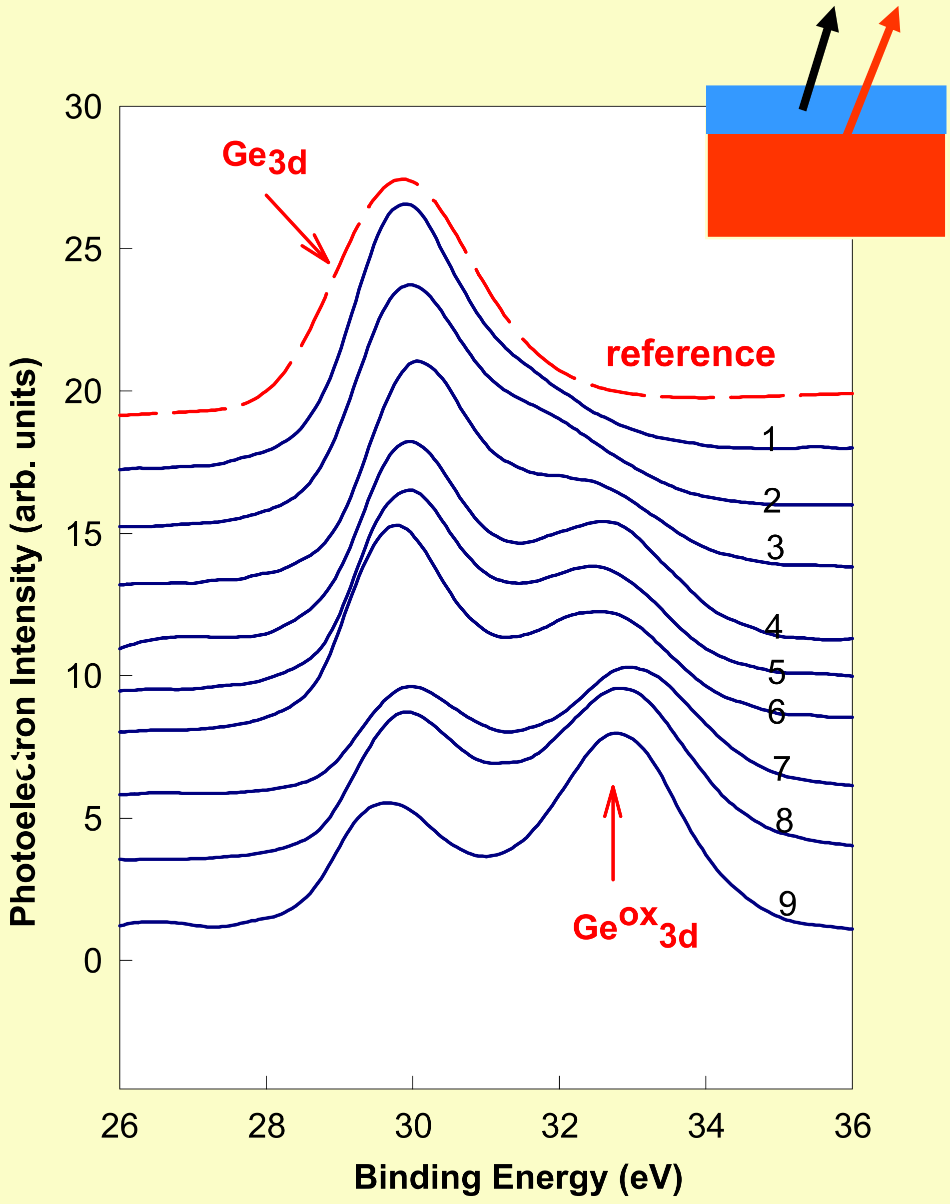
XPS Monitoring of the Oxide growth



$$I = I_0 \exp - \left[\frac{\delta}{\lambda \sin \theta} \right]$$

$$\lambda (Ge\ 2p) = 5.3\ ML$$

Conventional XPS anal;ysis



N. Tabet et al. 2001

XPS at ALS – Berkeley (Synchrotron radiation)

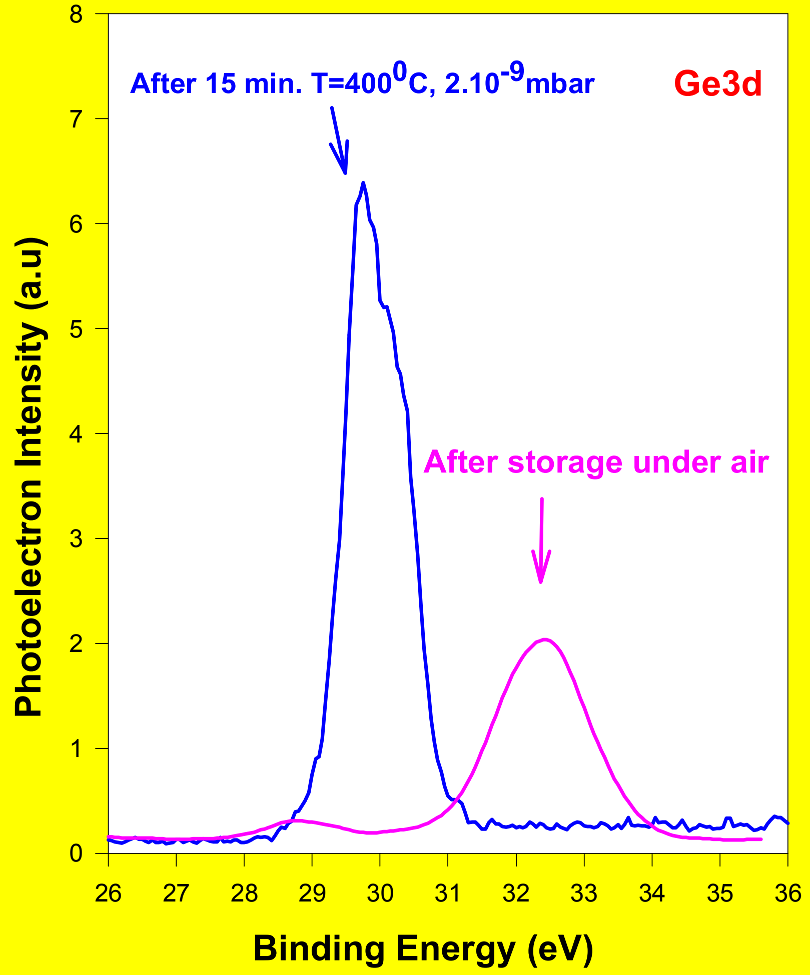
Beam line 9.3.2

$h\nu$ = 300-700 eV

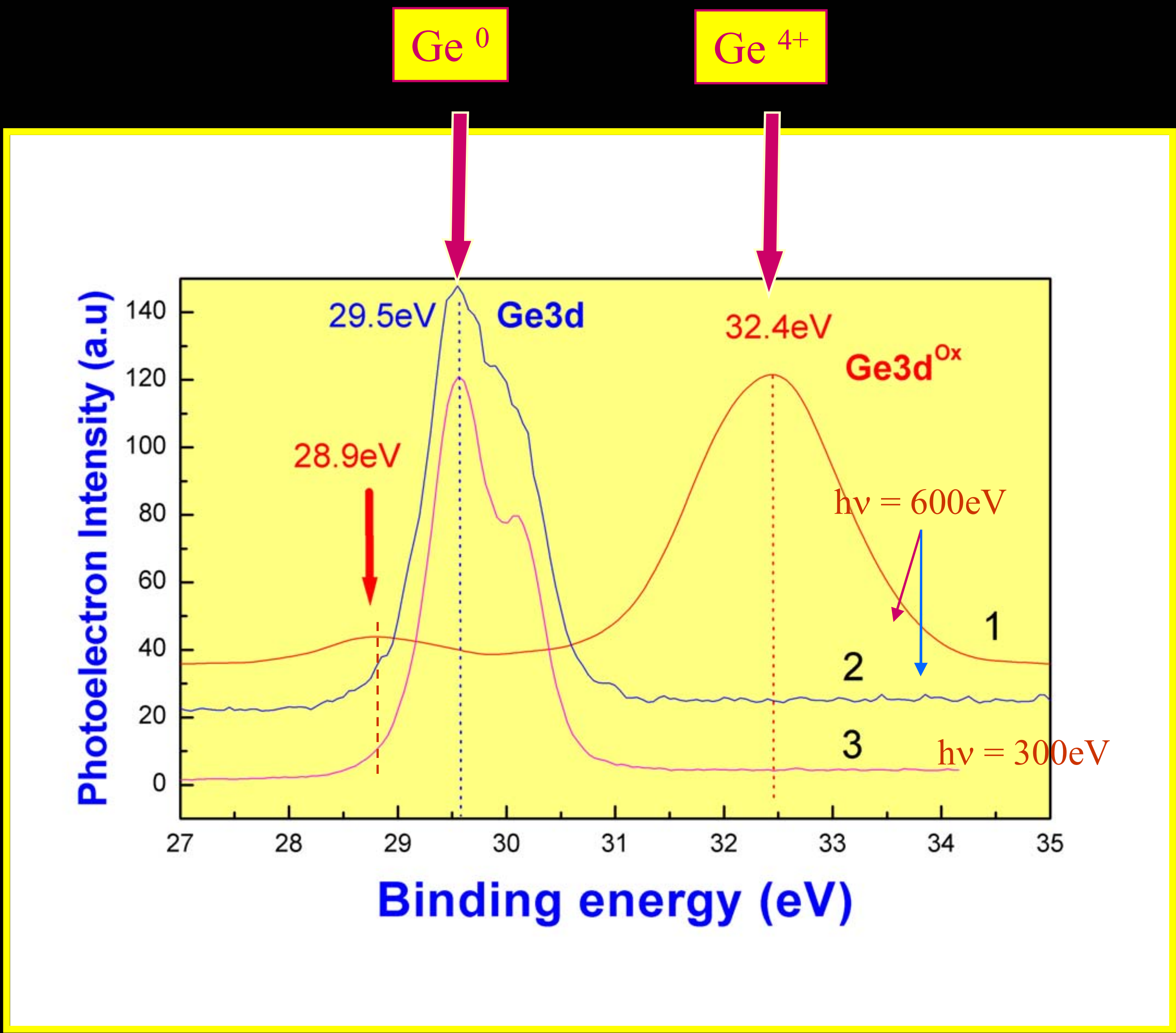
Energy Resolution: $E/\Delta E \sim 10000$

High Resolution XPS using Synchrotron radiation

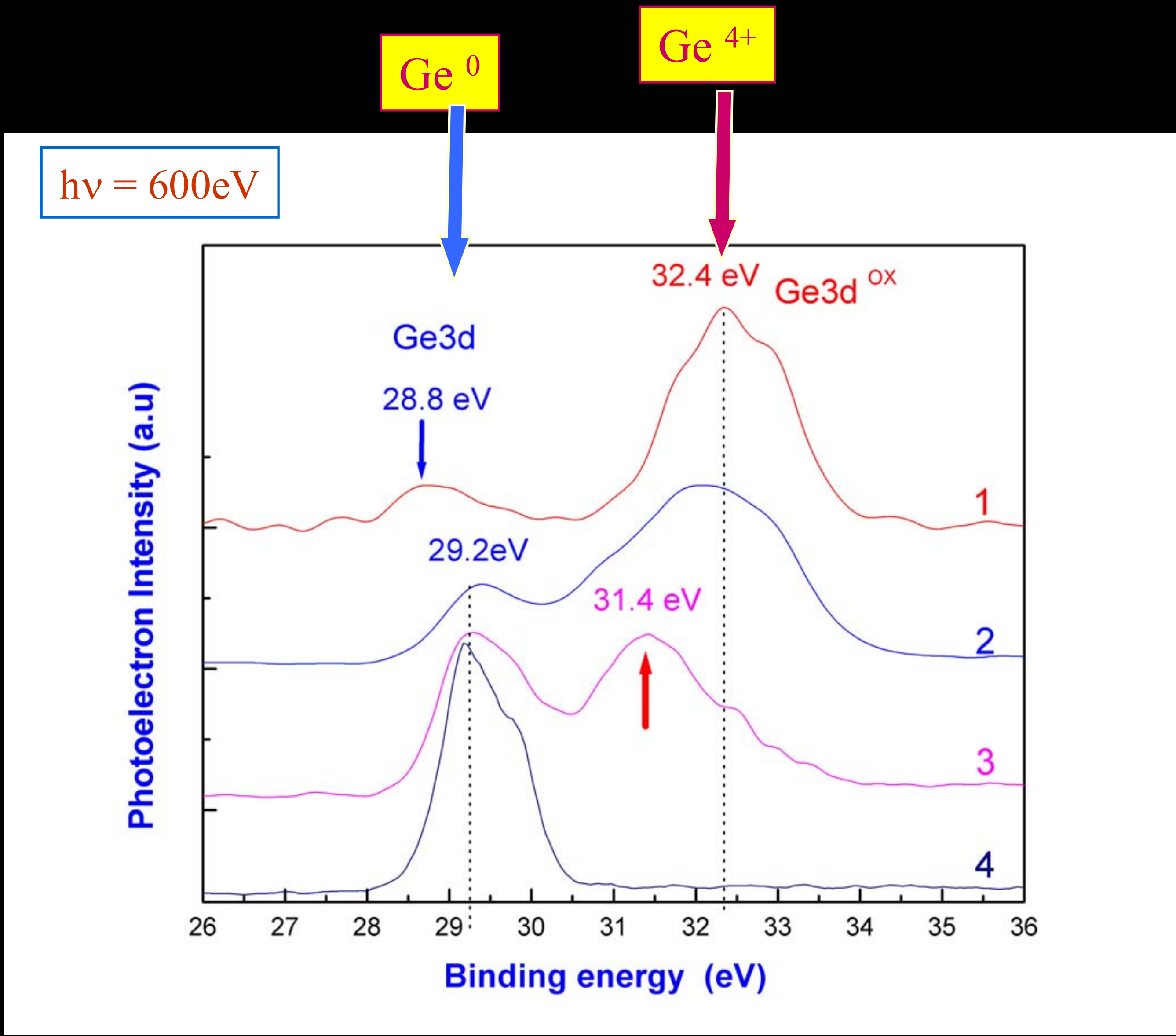
ALS- Berkeley, 2000



Native oxide on CP4 etched surface

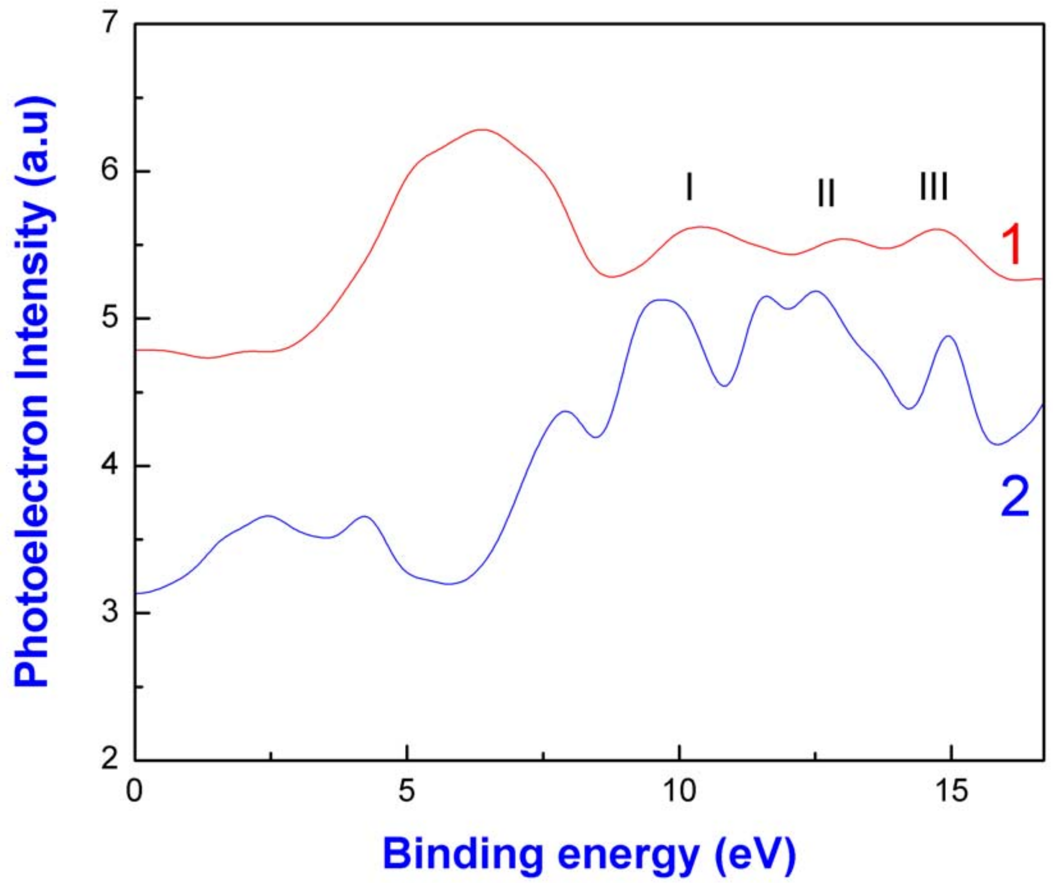


Native oxide on CP4 etched surface



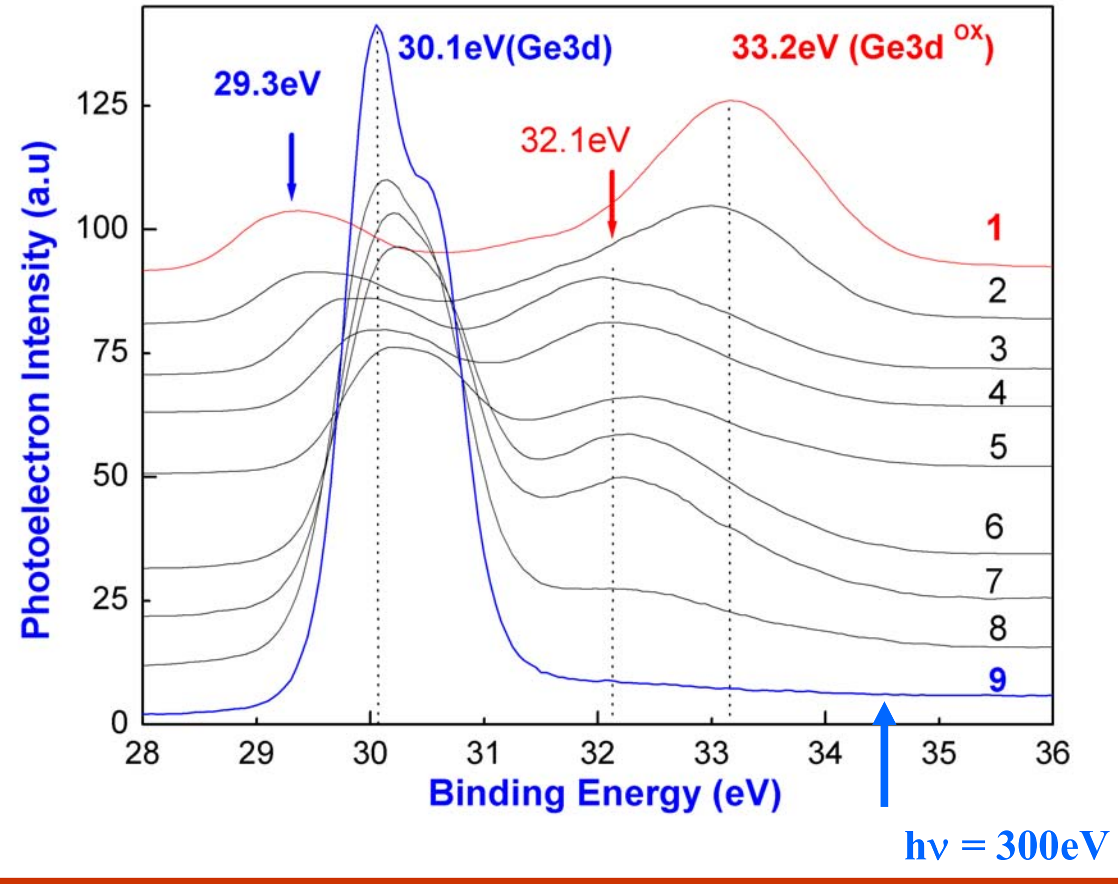
1. **Native oxide**
2. **After Ar Sputering, 1keV Ar+, PAr=10^{-5}mbar, 50min.**
3. **100min.**
4. **1.5keV, 60min.**

Valence Band



1. Native oxide
2. After Ar+ Sputtering, 1.5keV, PAr=10^{-5}mbar, 160min. Then T=315ºC, 20min.

Oxidized Ge(011) surface
T= 380ºC, t = 25min. PO_2 = 400Torrs

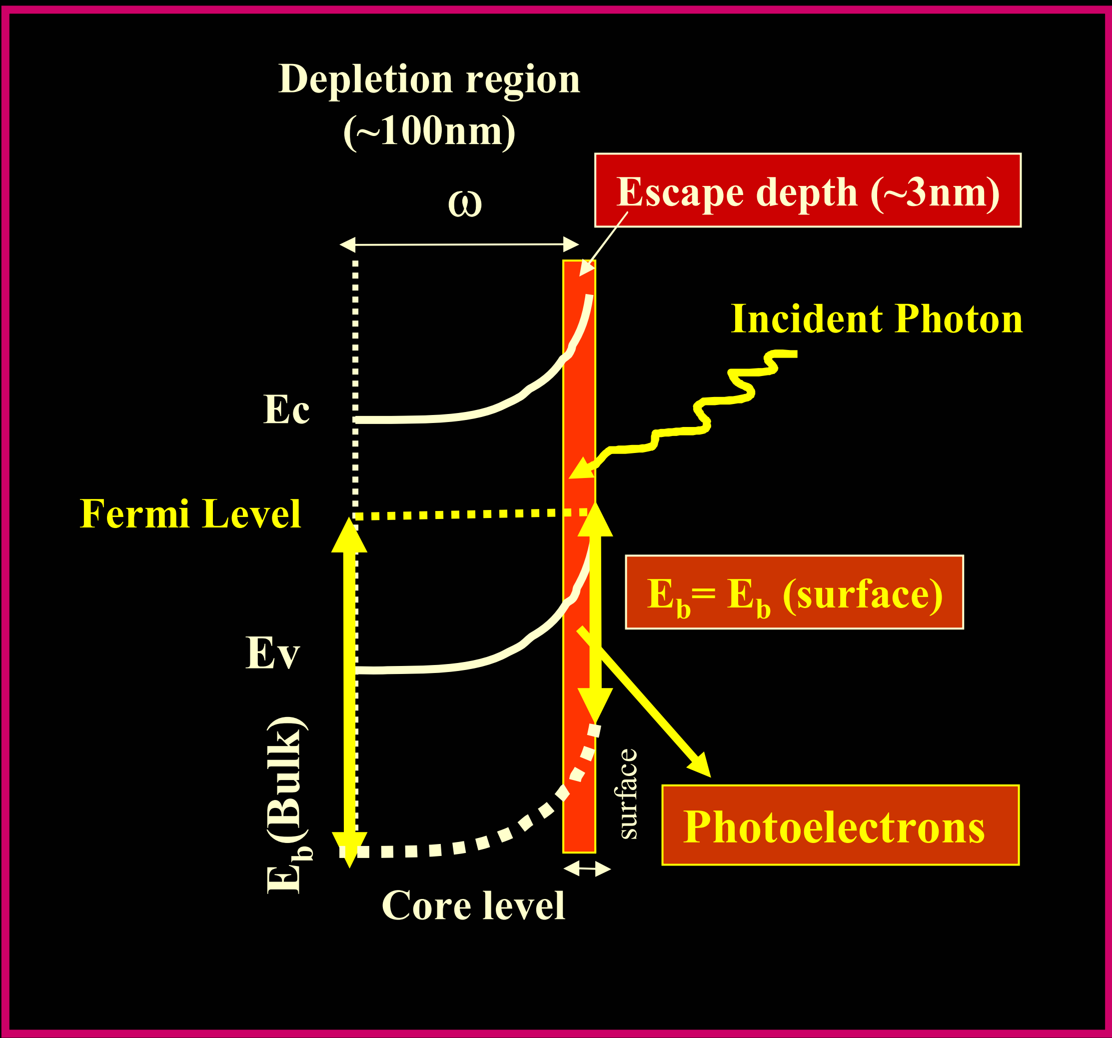


1: As oxidized surface

2-8: After successive Ar+ Sputtering cycles, hν= 650eV.

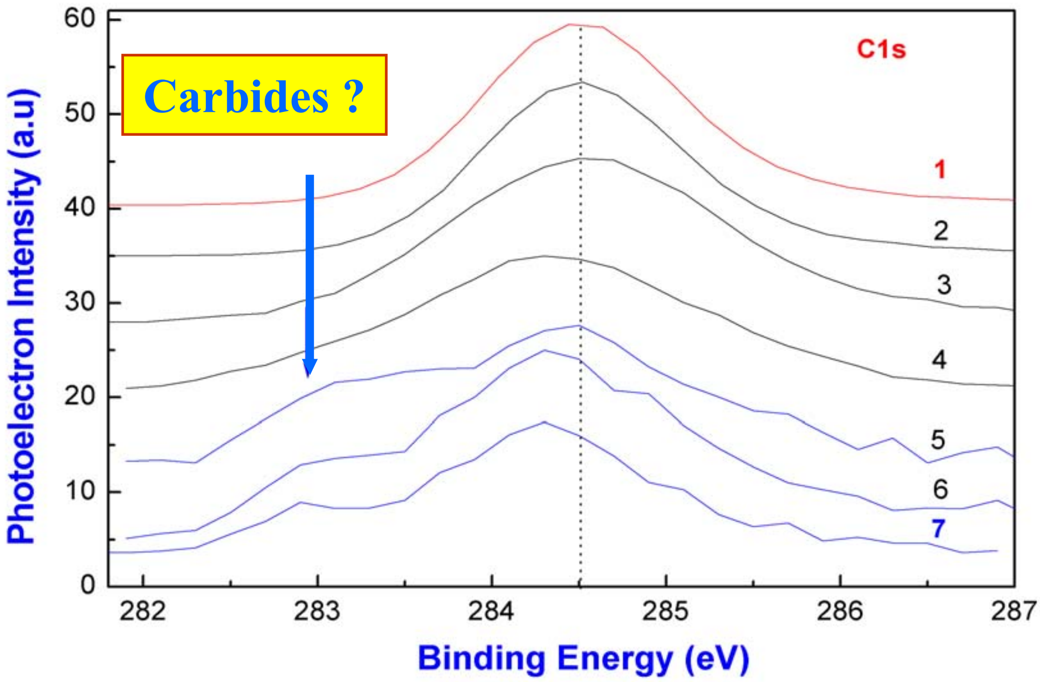
9: hν= 300eV

Surface Depletion Region and Core Level Energies



Oxidized Ge(011) surface

T= 380ºC, t = 25min. PO2 = 400Torrs



1: As oxidized surface

2-8: After successive Ar+ Sputtering cycles, hν= 650eV.

Conclusion

1. High density of Surface States at Ge/GeO2 interface and band bending confirmed

2. Lower oxidation state of Ge observed under sputtering.

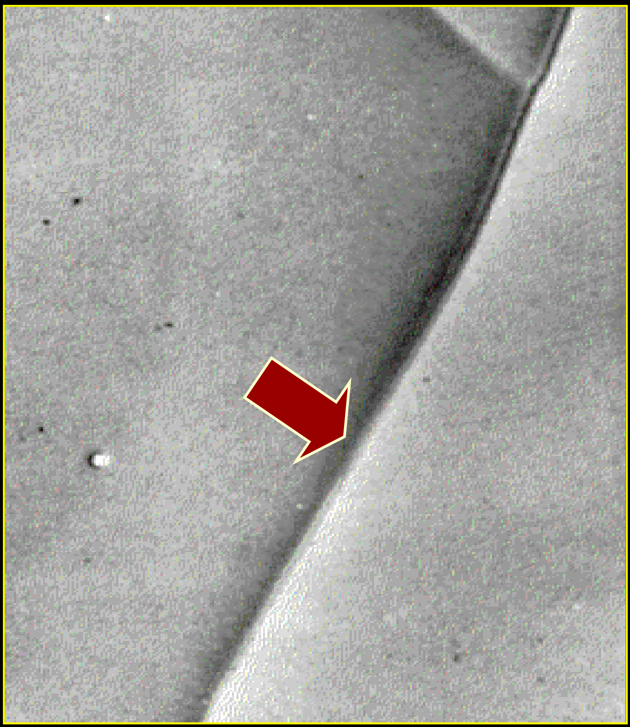
3. Carbides-like XPS signal at the Ge/oxide interface to be investigated

Thank you

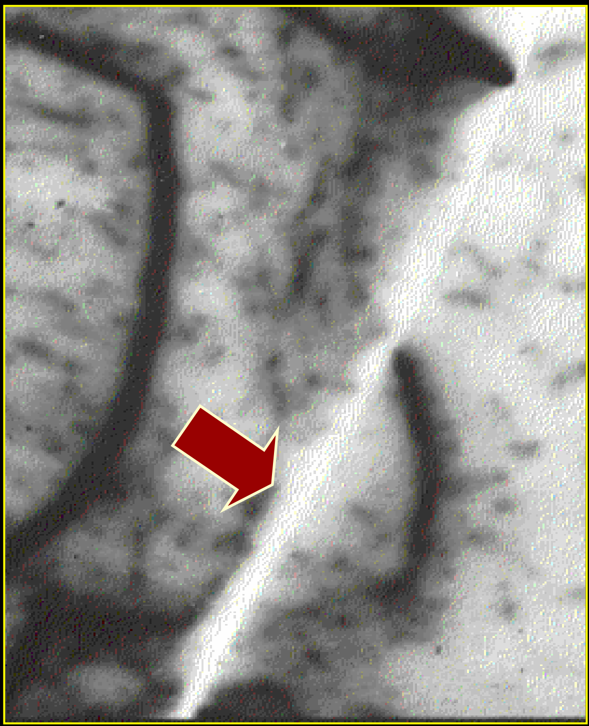
Study #2
Dopant Segregation at Germanium Surface

EBIC/Grain Boundary

SEM

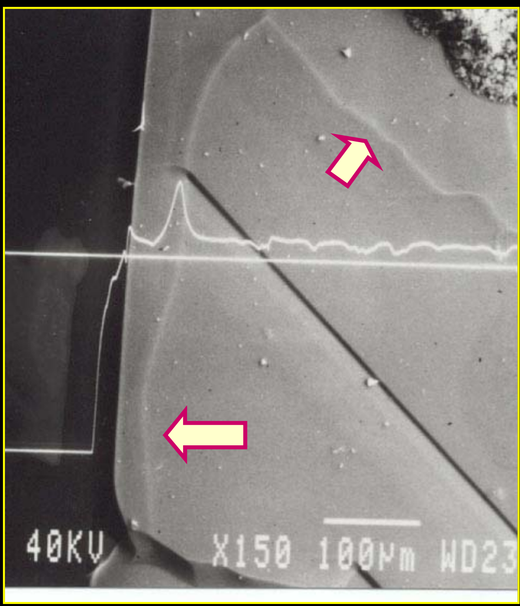


EBIC



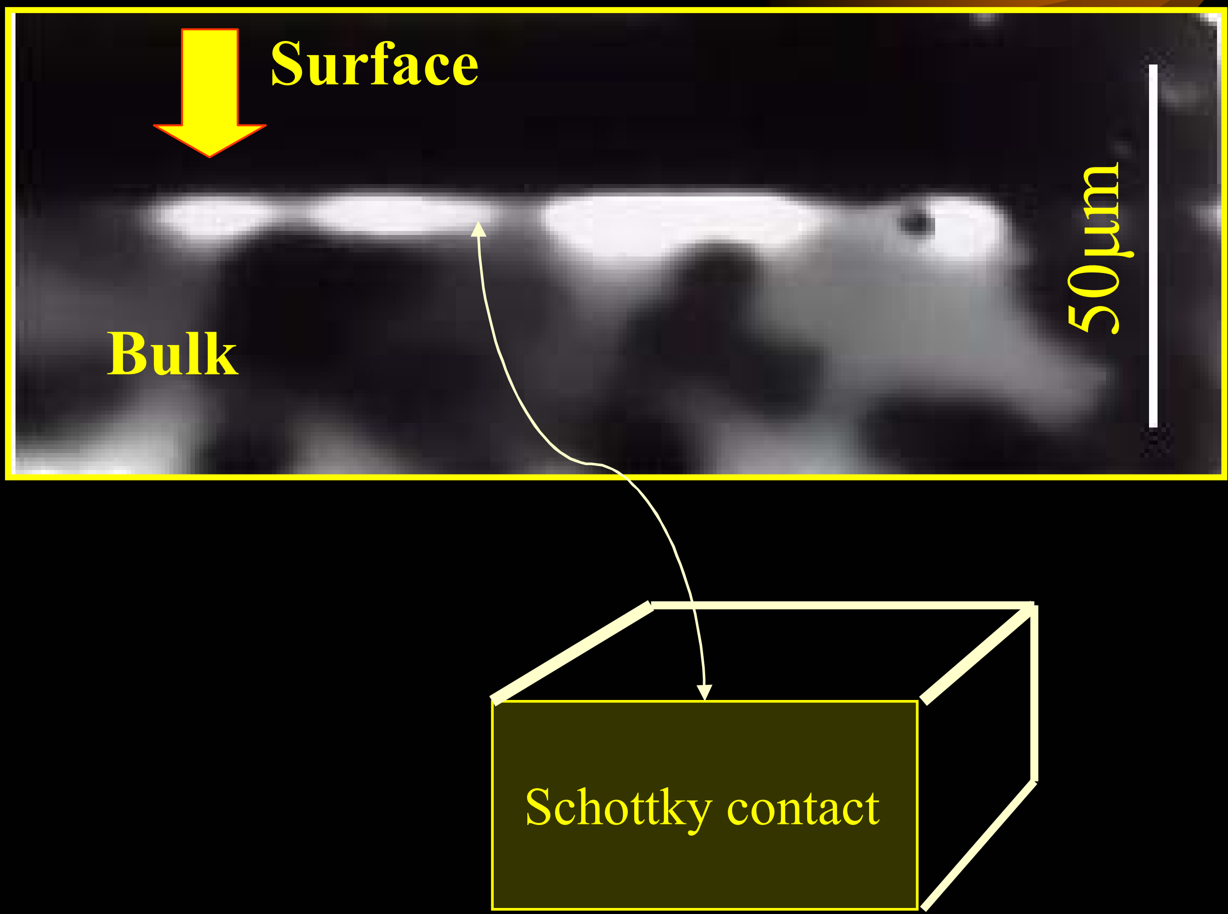
EBIC/Grain Boundary

SEM



EBIC

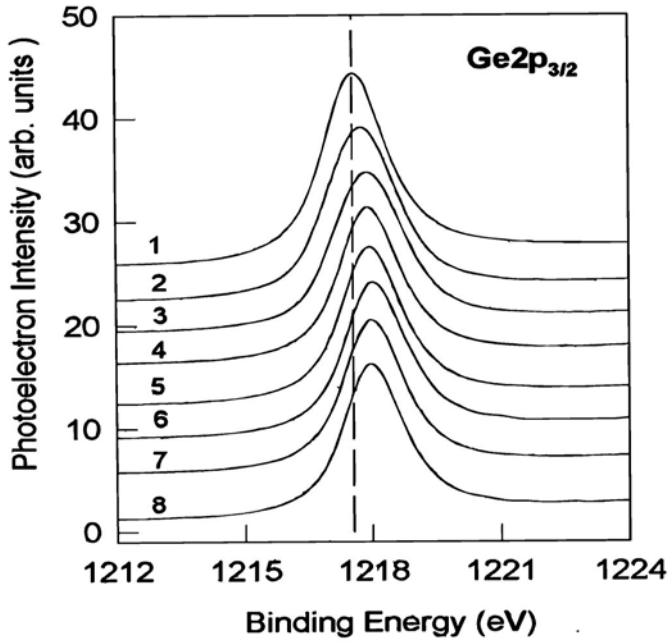
EBIC image of Dopant segregation



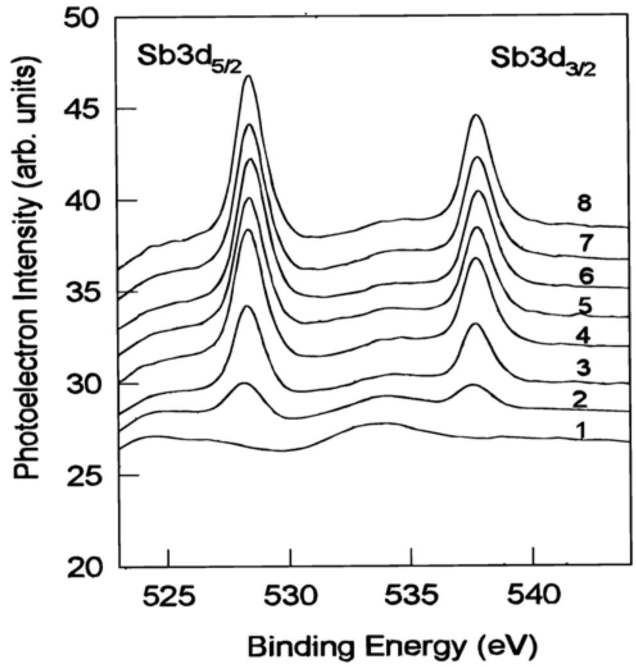
N. Tabet, BIAMS, 2000

Ar etched surface

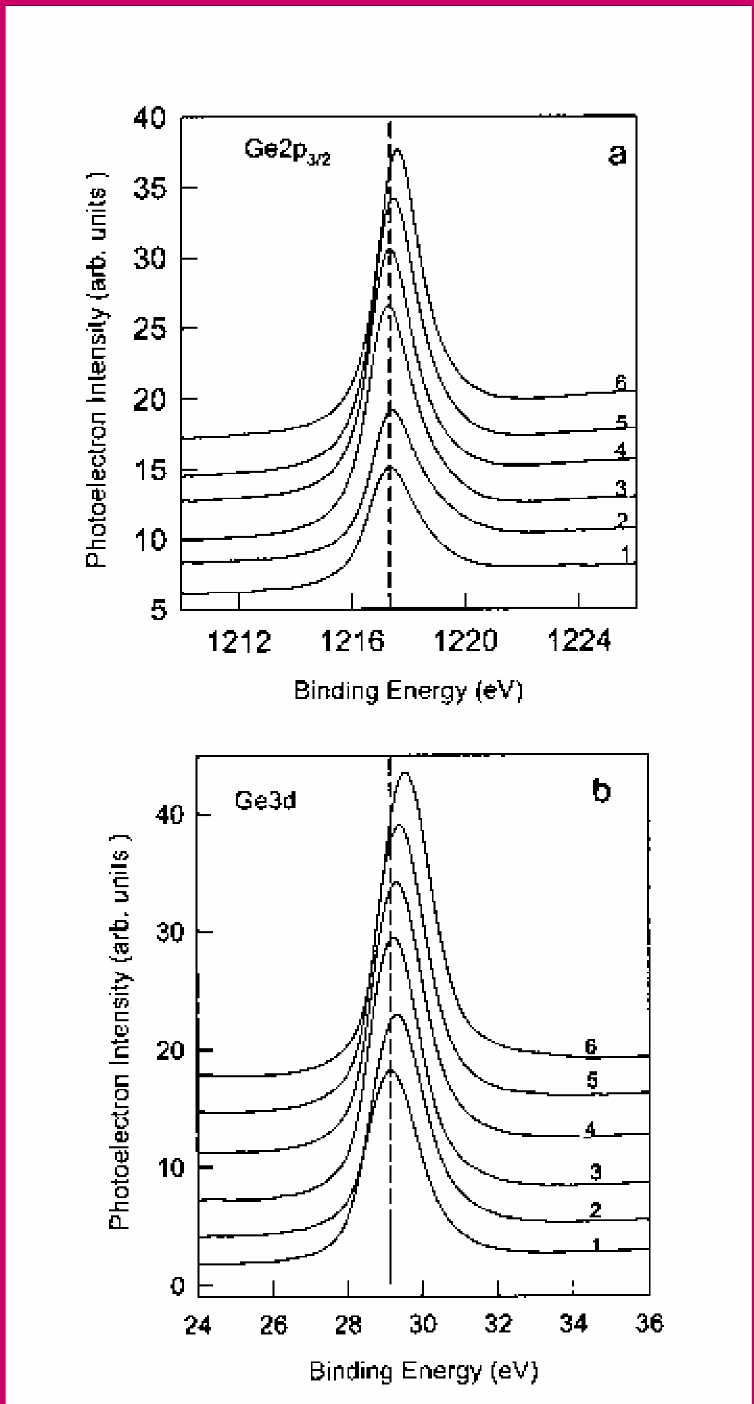
Ge2p3/2



Sb



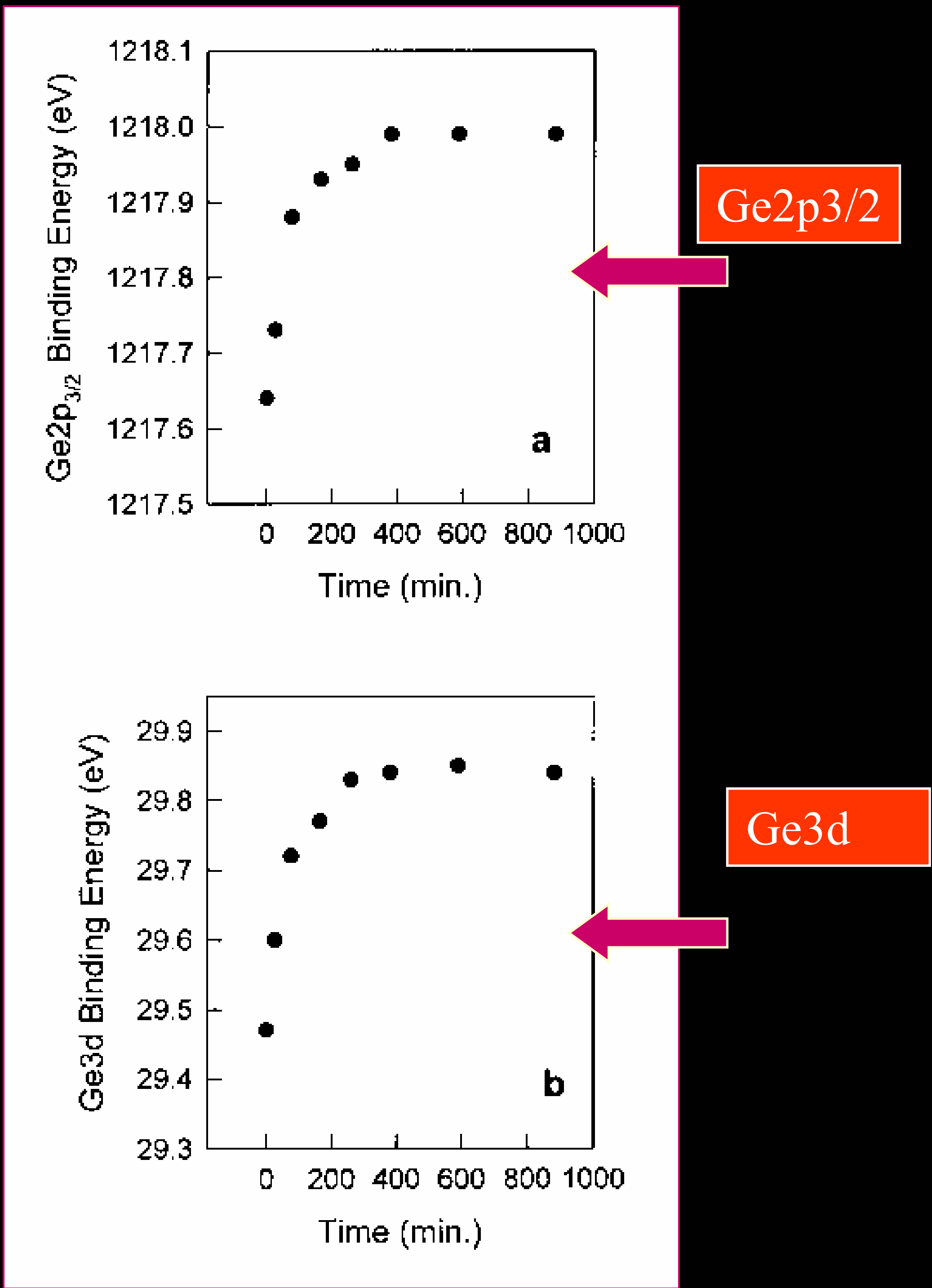
CP4 etched Ge surface



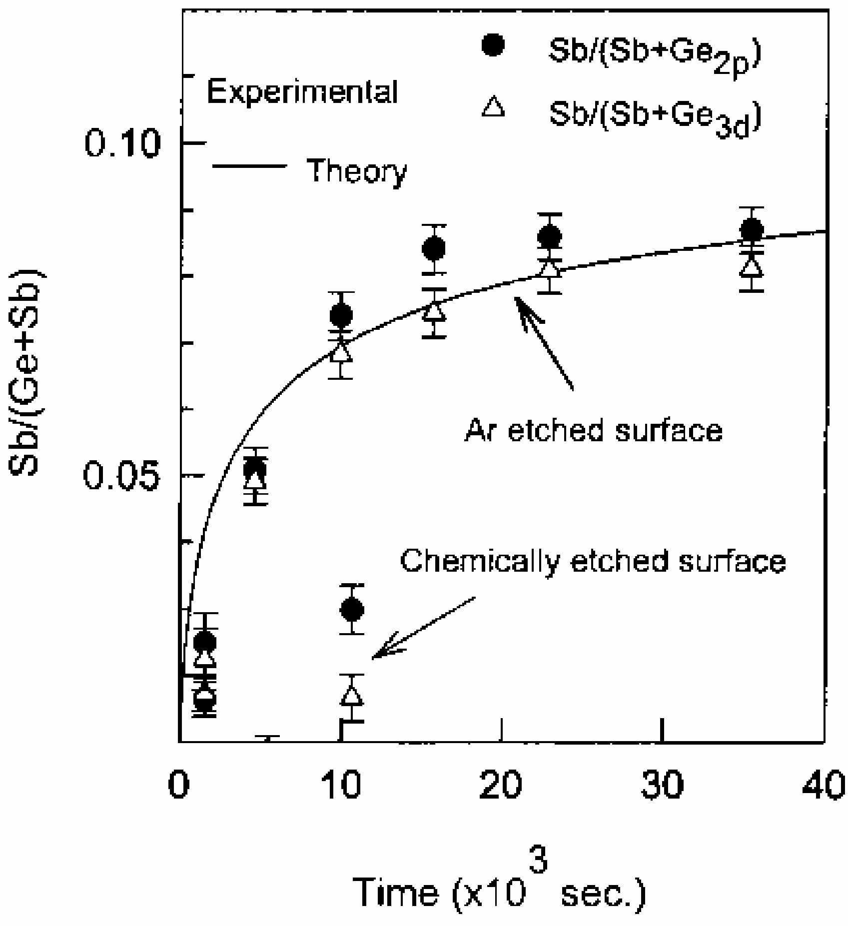
Ge2p3/2

Ge3d

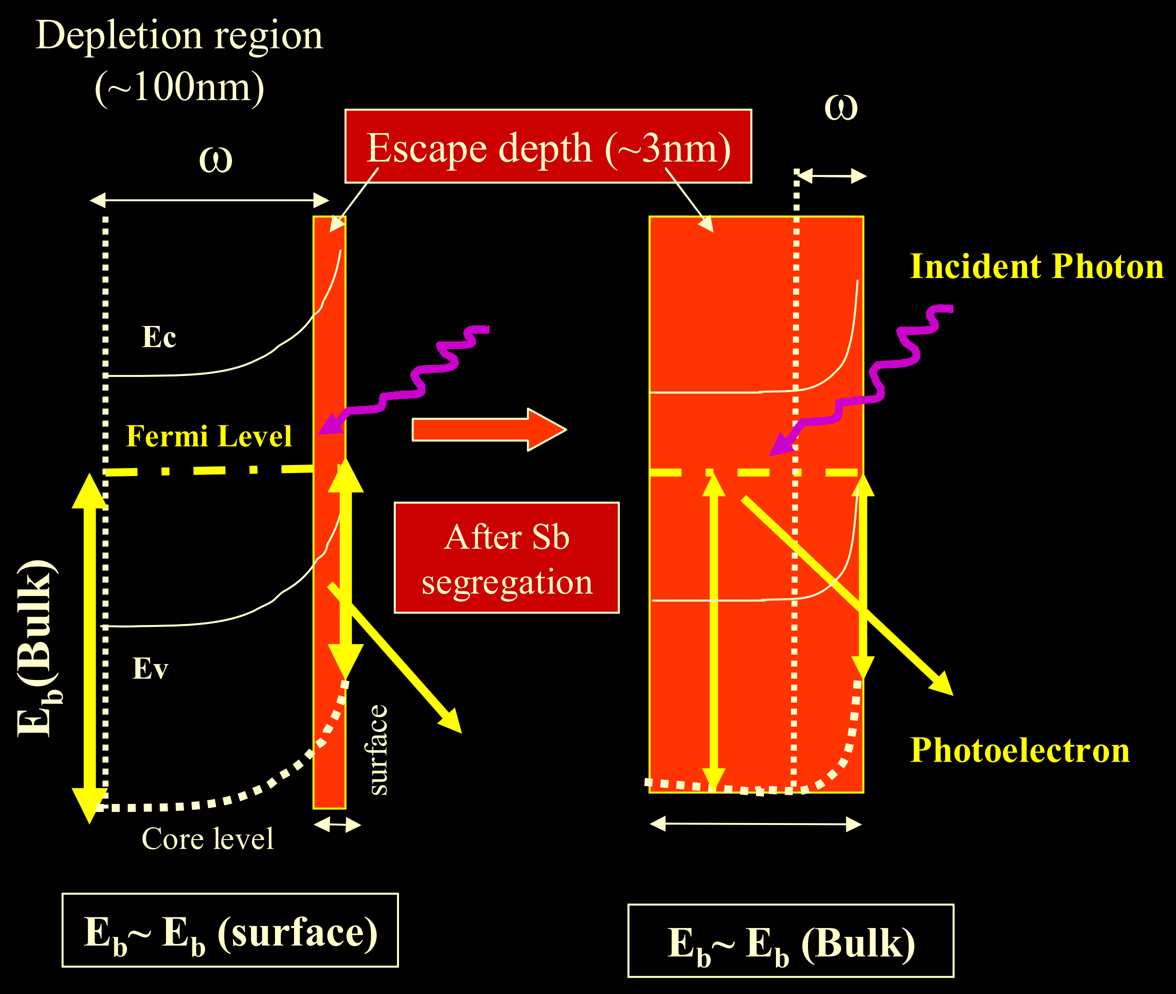
Binding Energy



Segregation kinetics



Surface Depletion Region and Core Level Energies



$$\omega = N_d^{-1/2}$$