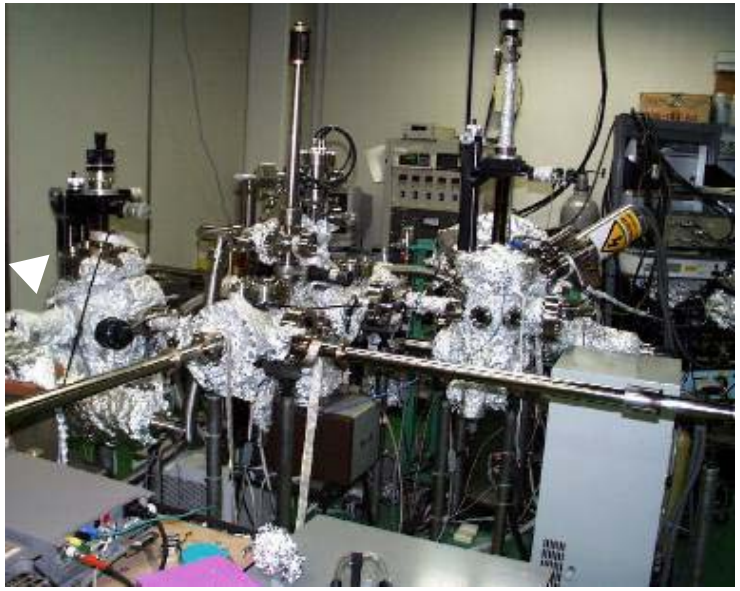
G-COE Lecture

Photoemission Spectroscopy: Principles and application



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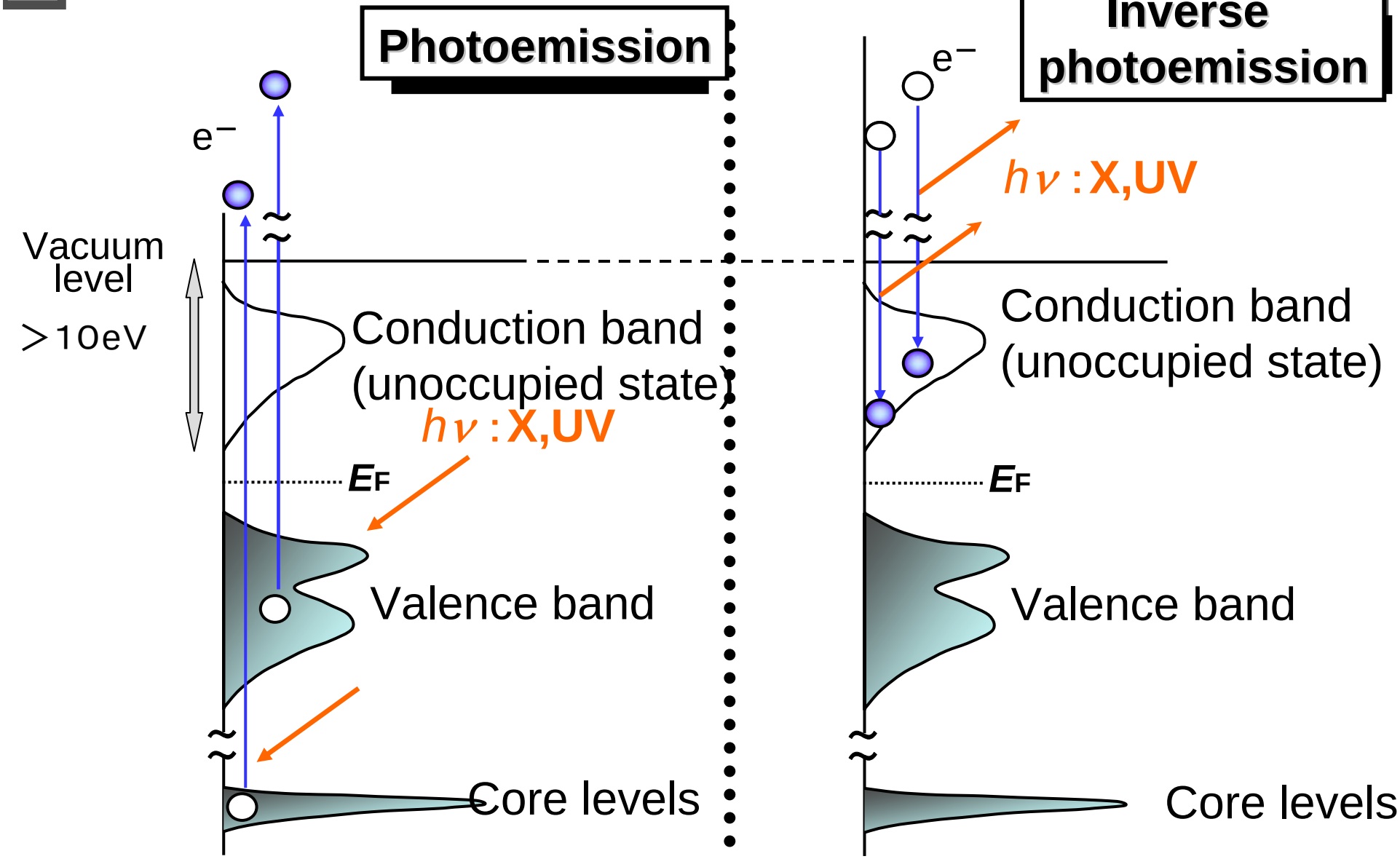
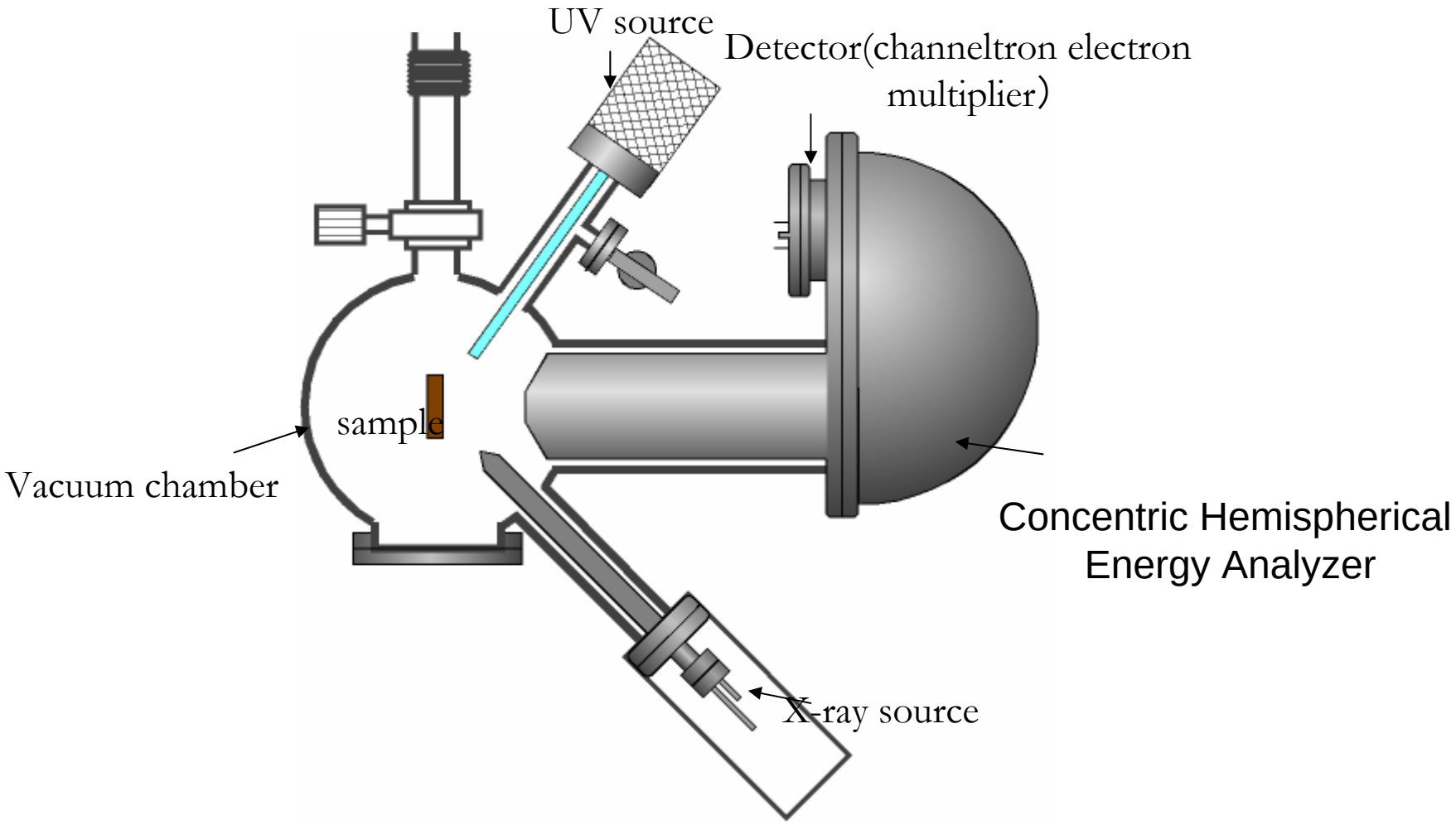
Principle


Photoemission
Inverse photoemission
e⁻
e⁻
Vacuum level
>10eV
Conduction band (unoccupied state)
hν : X,UV
hν : X,UV
EF
EF
Valence band
Valence band
Core levels
Core levels

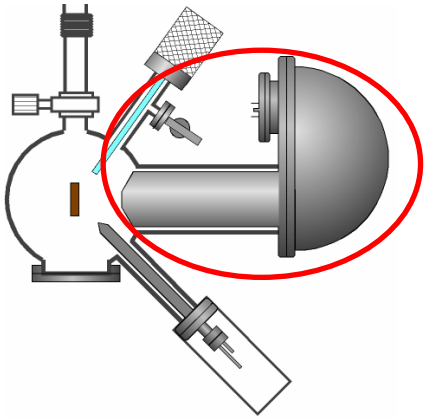
Apparatus


UV source
Detector(channeltron electron multiplier)
sample
Vacuum chamber
Concentric Hemispherical Energy Analyzer
X-ray source

Energy Analyzer (CHA-type)

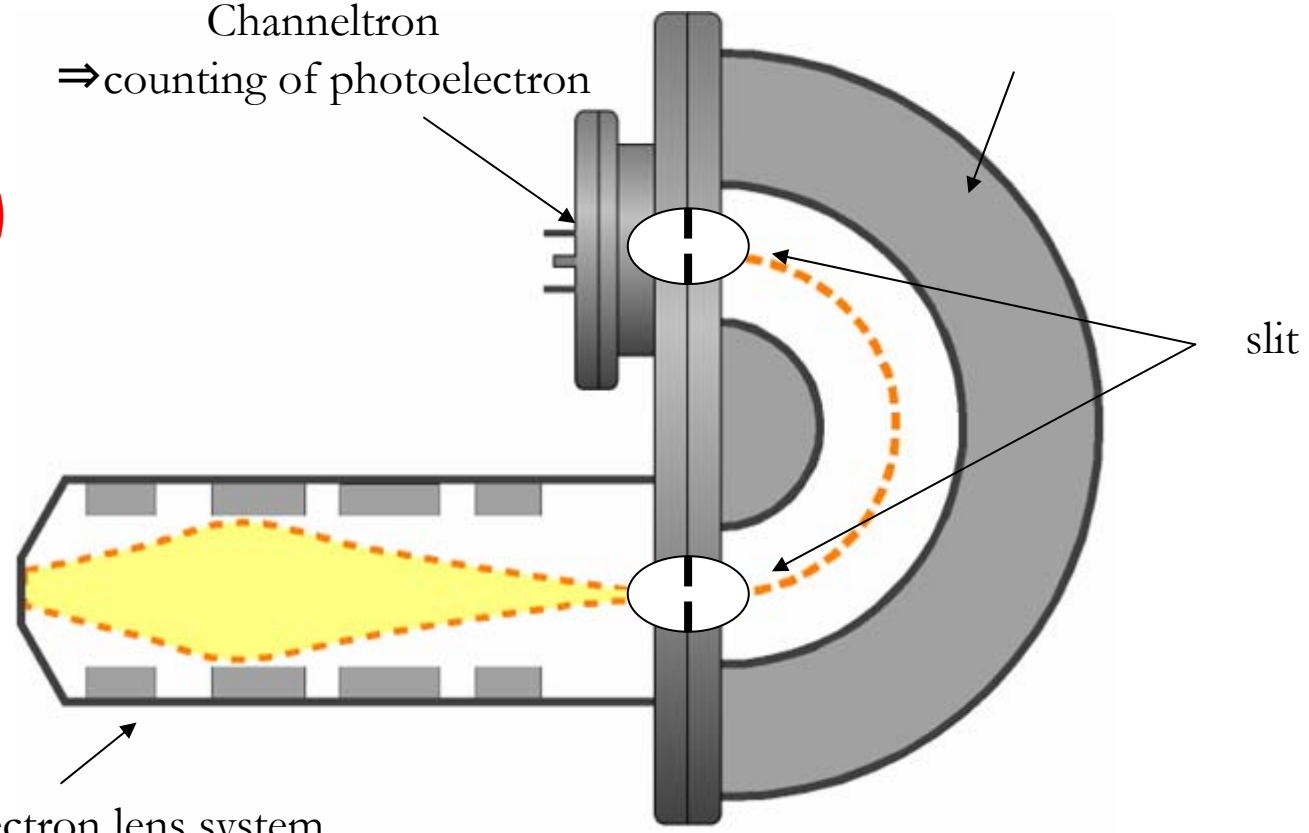
Concentric Hemispherical Energy Analyzer

⇒analysis of electron energy



Channeltron

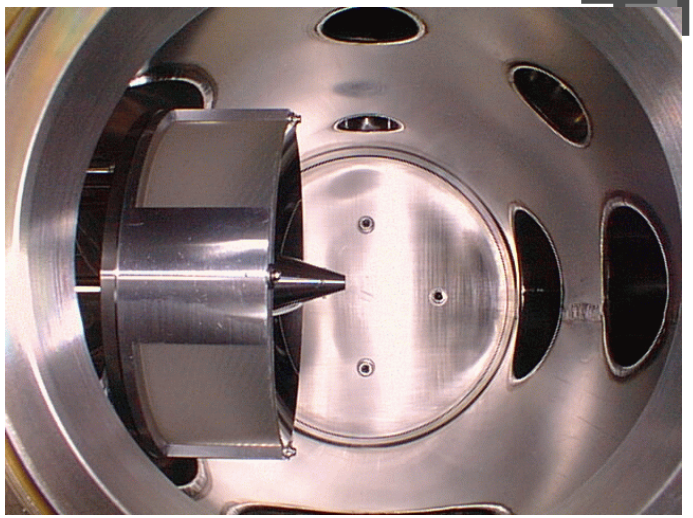
⇒counting of photoelectron

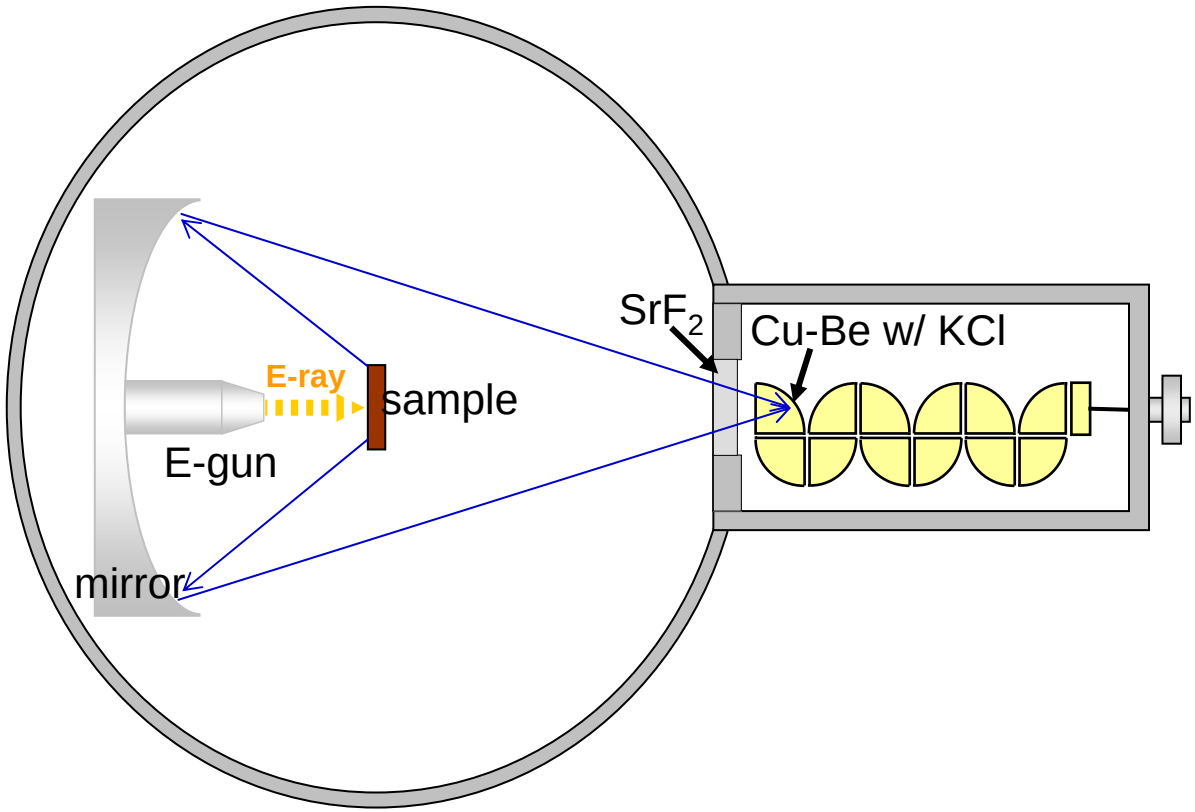


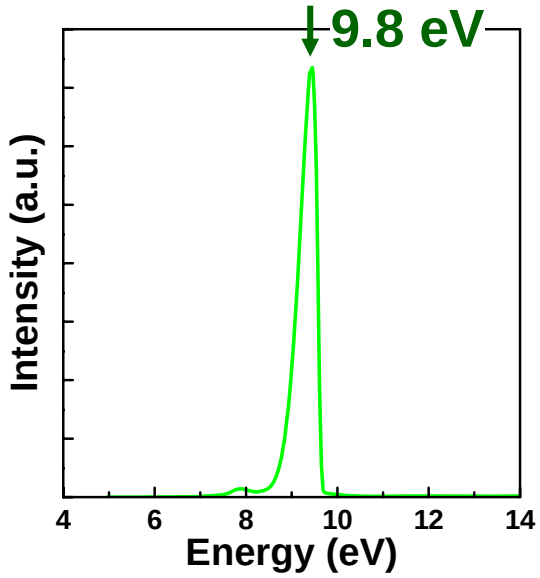
Electron lens system

⇒ converge / energy control of incident electron

Inverse photoemision Apparatus (BIS mode)







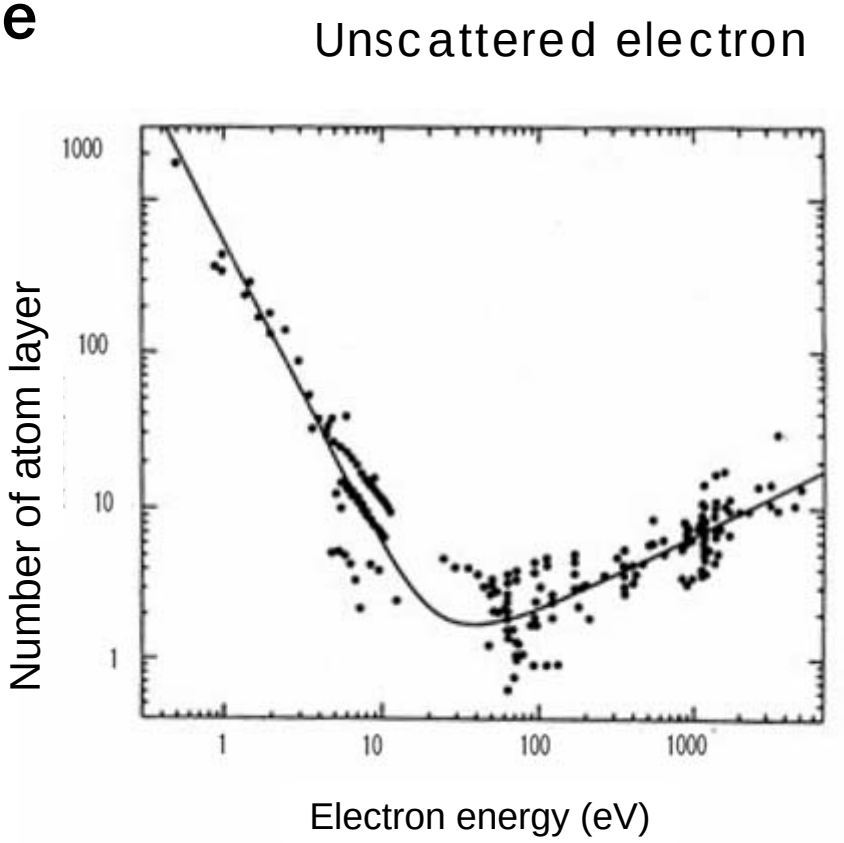
Sample preparation

- Clean surface is indispensable !

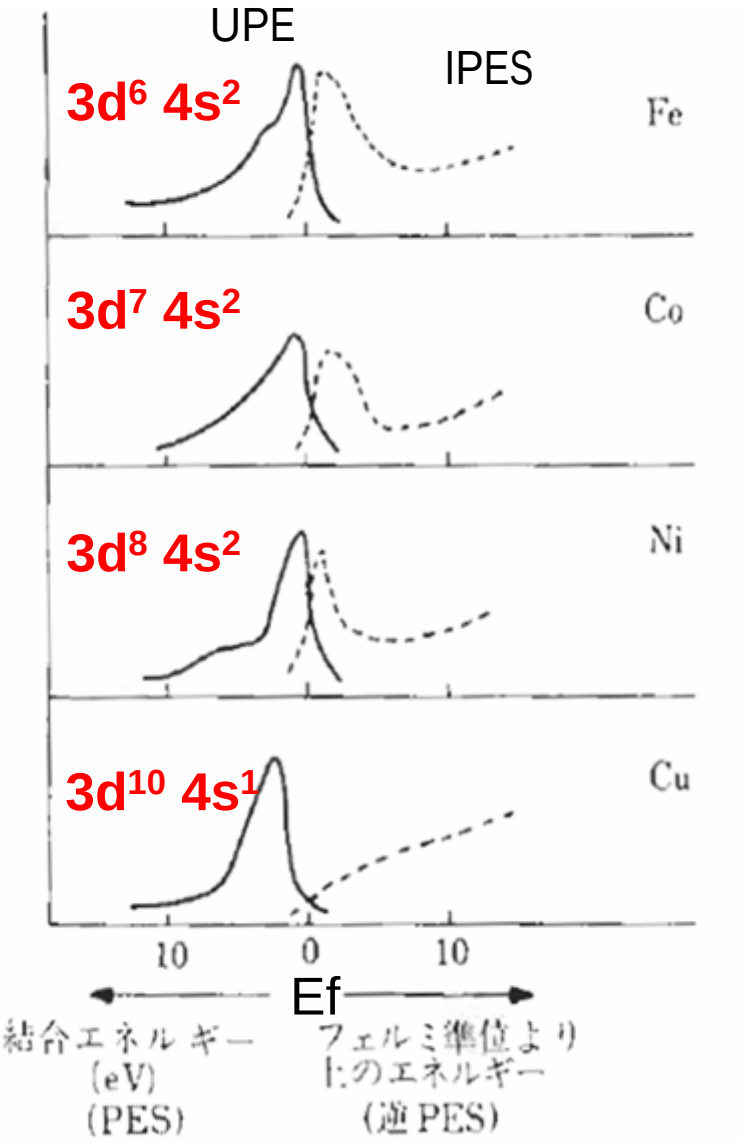
⇒electron escape depth is limited to below 1-2 nm from the top surface

○bulk sample：cleavage, filing

○thin film：ion sputtering

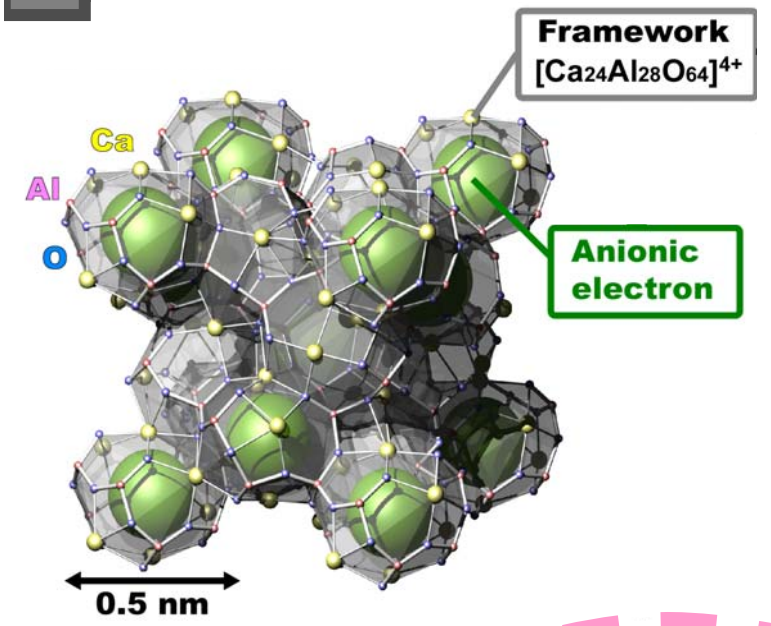


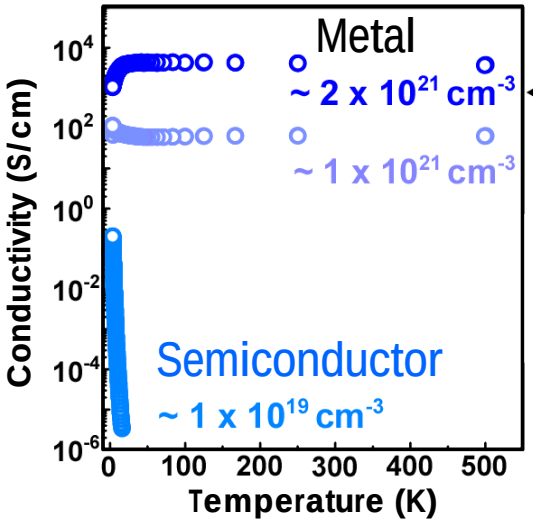
Example (UPS + IPE)



P.A. Cox
The Electronic Structure and Chemistry of Solids (Oxford)

What is C12A7 electride?

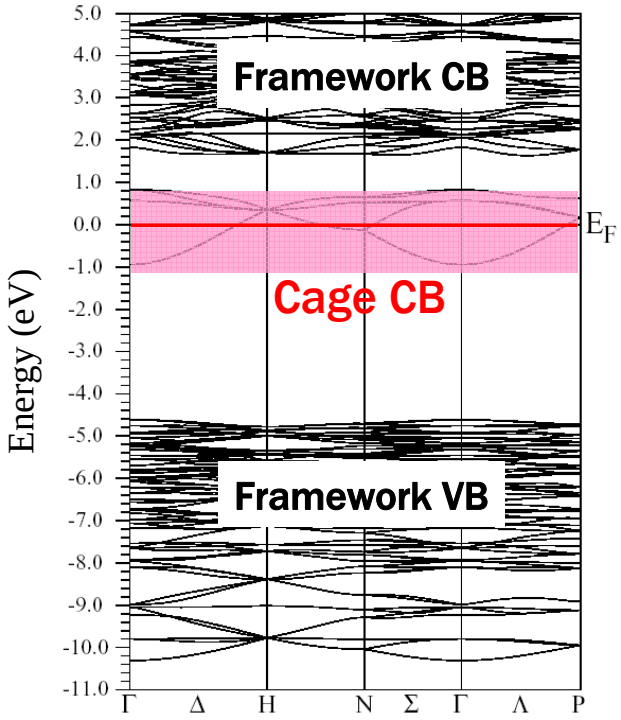




Maximum density
1 electron / 3 cages

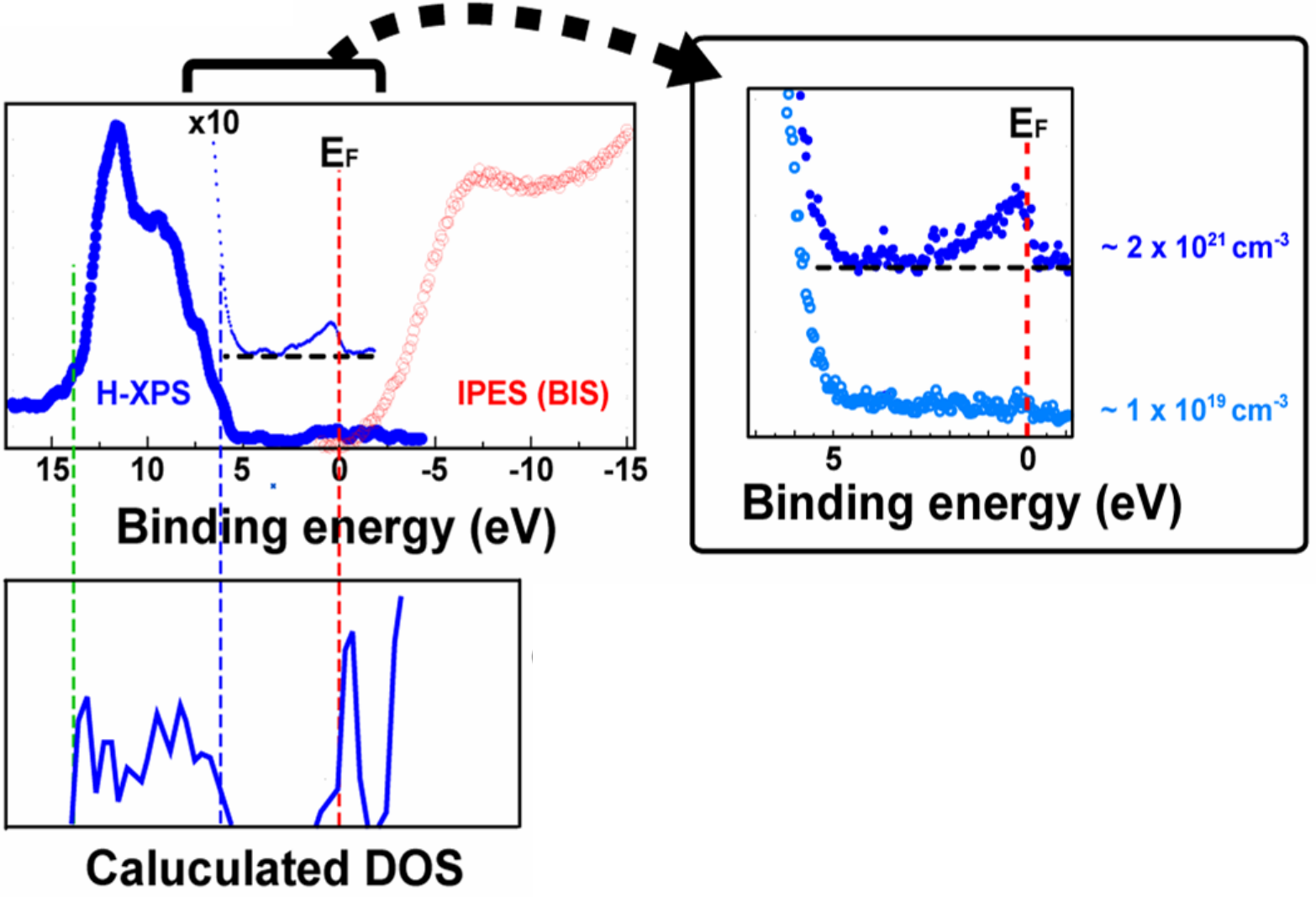
$[Ca_{24}Al_{28}O_{64}]^{4+}(O^{2-})_2$ → $12CaO \cdot 7Al_2O_3$

$[Ca_{24}Al_{28}O_{64}]^{4+}(e^-)_4$ → C12A7:e⁻



Matsuishi et al Science

Observation of Cage CB by HAXPES



P. V. Sushko et al. *J. Am. Chem. Soc.* **129** 924-951 (2007)

Xe (I) 8.4 eV UV source