Sissejuhatus pinnaanalüüsi meetoditele

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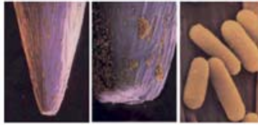
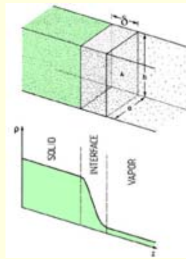
Mis on pind?



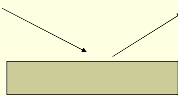
Nööpnõela pea erinevatel suurendustel



Pinna spektroskoopia

Võimaldavad saada informatsiooni pinna keemilisest koostisest (mõni Å ~ 10-d Å)

- Footonid, elektronid, ioonid või neutraalsed molekulid.



1-keV elektronid tungivad umbes ~ 25 Å sügavusele,
sama energiaga footonid tungivad aga ~ 10^4 Å

Põhilised pinna analüüsi meetodid:

X-ray Photoelectron Spectroscopy (XPS)

Ultraviolet Photoelectron Spectroscopy (UPS)

Auger Electron Spectroscopy (Auger)

Rutherford Backscattering Spectrometry (RBS)

Secondary Ion Mass Spectroscopy (SIMS)

Electron Energy Loss Spectroscopy (EELS)

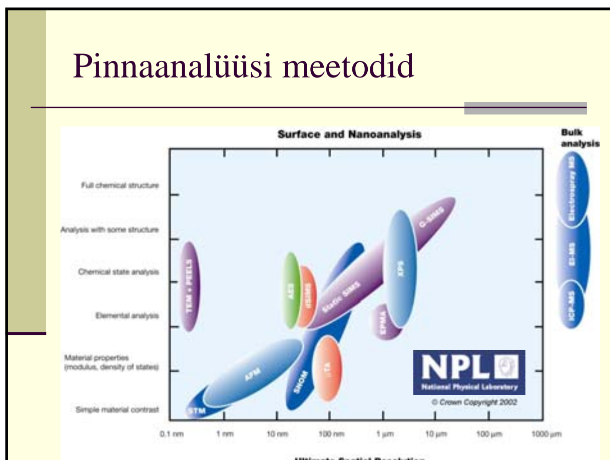
Pinnaanalüüsi meetodid

Method and Common Acronym	Primary Beam	Secondary Beam
X-ray Photoelectron Spectroscopy (XPS), or Electron Spectroscopy for Chemical Analysis (ESCA)	X-ray photons	Electrons
Auger Electron Spectroscopy (AES)	Electrons, or X-ray photons	Electrons
Ultraviolet Photoelectron Spectroscopy (UPS)	UV photons	Electrons
Secondary Ion Mass Spectrometry (SIMS)	Ions	Ions
Laser Microbe Mass Spectrometry (LMMS)	Photons	Ions
Electron Microbe (EM)	Electrons	X-ray photons

Pinnaanalüüsi meetodid

Analytical Technique	Signal Measured	Elemental Range	Depth Resolution	Surface info.
SIMS (secondary ion mass spectrometry)	Secondary Ions	H-U	5 - 30 Å	Chemical composition Chemical structure
TOF-SIMS (time-of-flight SIMS)	Secondary Ions	H-U, Large Organic Molecules / Cluster Ions	2000 Å (Scanning Mode)	Adsorbate bonding
TEM (transmission electron microscopy)	Transmitted Electrons X-Rays	Na-U EDX	N/A	
FE-SEM, EDX (field emission SEM)	Backscattered or Secondary Electrons and X-Rays	Na-U	1 - 5 micrometres	
ISS (ion scattering spectroscopy)	Ions	H- U	monolayer	atomic structure chemical composition
AES/SAM (Auger electron spectroscopy, scanning Auger microscopy)	Auger Electrons	Li-U	1 - 5 nm	chemical composition
ESCA/XPS (electron spectroscopy for chemical analysis, X-ray photoelectron spectroscopy)	Photoelectrons	Li-U	1 – 10 nm	chemical composition chemical structure
RAIRS (reflection-absorption infra-red spectroscopy)	IR photons	organic, some inorganics	monolayer	Adsorbate bonding
STM (scanning tunnelling microscopy)	-	solid surfaces	upper most atoms	physical topography
Analytical Technique	**Signal Measured**	**Elemental Range**	**Depth Resolution**	**Surface info,**

Pinnaanalüüsi meetodid



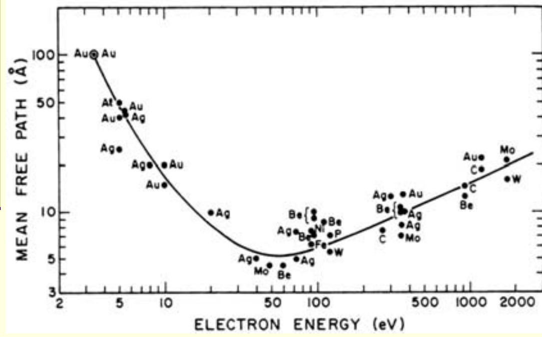
Primaarse kiire energiad

UPS	hν < 100 eV tüüpiliselt 10-45 eV
XPS	100 eV < hν < 2000 eV
Fotoelektron spektroskoopia (PES), mis kasutab sünkrotronkiirgust	5 eV < hν < 5000 eV

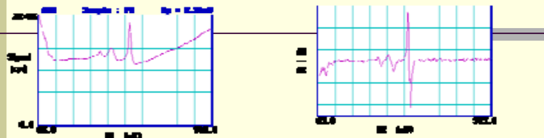
Primaarse kiire allikad

UPS	He gaaslahenduse lamp 21.2 eV
XPS	Mg K_α = 1253.6 eV Al K_α = 1486.6 eV Ti K_α = 2040 eV
PES	Sünkrotronkiirgus 5 – 5000 eV

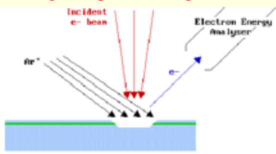
Elektronide sissetungimise sügavus



Auger Electron Spectroscopy (AES)

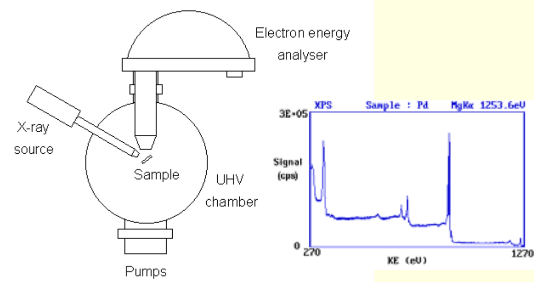


Auger Depth Profiling



Pinda pommitatakse fokuseeritud elektronkiirega, mõõdetakse emiteerunud Auger elektronide kineetilist energiat

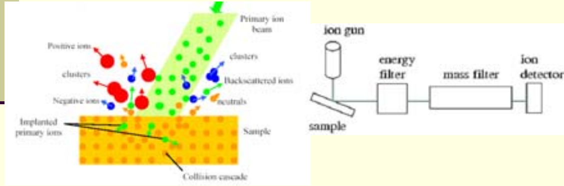
X-ray photoelectron spectroscopy (XPS)



Secondary Ion Mass Spectroscopy (SIMS)

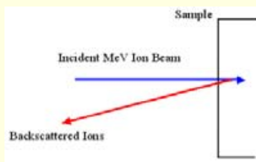
➢**Ioonid energiaga 1-15 keV** pommitavad objekti pinda

➢**Sekundaarsed ioonid** kannavad negatiivset, positiivset või neutraalset laengut ning neid analüüsitakse massispektromeetriga.



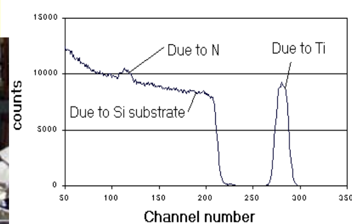
Rutherford Backscattering Spectrometry (RBS)

He⁺ ioonidega (energia > 2 MeV) pommitatakse pinda. Osaliselt hajuvad ioonid pinnakihilt tagasi. Neid ioone analüüsitakse tahke keha detektoriga. Võib saada nii pinna elementkoostise kui ka jaotuse sügavusse.



Rutherford Backscattering Spectrometry (RBS)

RBS aparatuur



RBS spekter TiN kihist räni pinnal

Rutherford Backscattering Spectrometry (RBS)

Detekteerimise piirid:

z < 20	1-10 at%
20 < z < 70	0.01 – 1 at%
z > 70	0.001 at%

Lahutusvõime sügavusse: 20 – 200 Å

Kokkuvõtte pinnaanalüüsi meetoditest