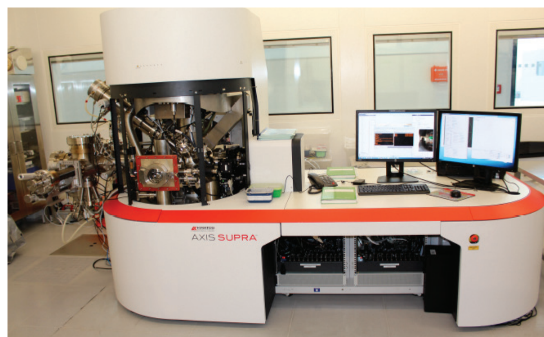
X-ray Photoelectron Spectroscopy

KRATOS Axis Supra



Load lock | Main chamber | Surface science station

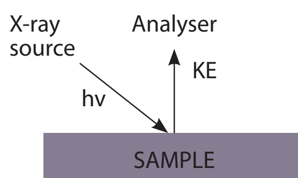
DESCRIPTION

XPS (X-ray Photoelectron Spectroscopy) is a method for characterisation of surfaces and ultra thin films. X-ray beam irradiates location on a sample from which electrons are emited and some of them are collected in the analyser. In spectroscopy mode, analyser changes continuously energy of electrons which are counted by channel plate detector. From obtained XPS spectrum (number of counted electrons vs. binding energy), elemental and also chemical composition of the sample surface can be determined. Parallel imaging mode is based on parallel collection of electrons on one specified energy and their 2D projection on channel plate detector. Obtained image contains chemical information and could be used to set precise location for spectroscopy of small area. Whole system has to be operated under Ultra High Vacuum conditions (pressure ~10^{-9} mbar or less) to prevent collisions of electrons with other particles before they reach the detector.

PRINCIPLE

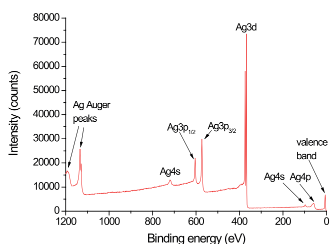
hv ... energy of incident X-ray beam
KE ... kinetic energy of emited electron
BE ... binding energy which is necessary to emit electron from atom shell

$$BE = hv - KE$$



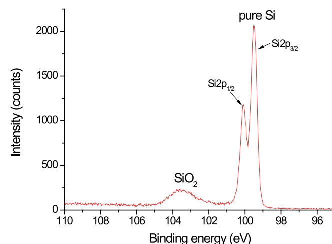
RESULTS

Survey spectrum of Ag clean sample



Sample surface was cleaned by ion beam etching Ar+ 5keV. Spectrum contains many Ag peaks but neither carbon nor oxygen peaks located at 285 eV, 530 eV, respectively.

Spectrum of Silicon substrate covered by native SiO_2



Spectrum shows detailed Si2p peak, which consists of two components: pure Si from substrate and SiO_2 from thin native oxide.

SPECIFICATION

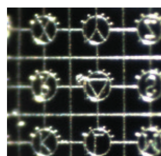
XPS

Spectroscopy	large area analysis 300×700 µm small area analysis 15 µm
Parallel imaging	lateral resolution 1 µm
Snapshot mode	quick spectrum measurement
Angle-resolved XPS	obtains spectra for different emission angles, which changes information depth
Line and map scan	this modes use deflection electrodes to scan over area of interest
Detection limit	0.1 to 1 atomic %
Depth resolution	up to 8 nm

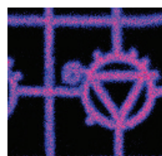
Other techniques

Ion beam etching	instrument is equipped by Ar cluster ion source which allows to clean sample surface or depth profiling
UPS	Ultraviolet Photoemission Spectroscopy - UV lamp is used instead of X-ray source. This technique provides information on valence levels and work function of materials
Surface Science Station	extra chamber which allows to prepare or modify samples and consequently move them into the main chamber for analysis without exposure samples to atmosphere

XPS parallel imaging of Au special grid



Optical microscope image of analysed location 800×800 µm



Parallel image obtained on Au4f peak using mode 400×400 µm

PUBLICATIONS

Manakhov, A. et al. Determination of NH2 concentration on 3-aminopropyl tri-ethoxy silane layers and cyclopropylamine plasma polymers by liquid-phase derivatization with 5-iodo 2-furaldehyde. *Appl. Surf. Science* **414**, 390-397 (2017).

Šik, O. et al. Low energy ion scattering as a depth profiling tool for thin layers - Case of bromine methanol etched CdTe. *Vacuum* **152**, 138–144 (2018).

Michlíček, M. et al. Homogeneity and penetration depth of atmospheric pressure plasma polymerization onto electrospun nanofibrous mats. *Appl. Surf. Science* **471**, 835–841 (2019).

MORE INFO

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