X-Ray Photoelectron Spectroscopy

KNMF Karlsruhe NANO MICRO Facility

X-ray photoelectron spectroscopy (XPS) is the most widely used surface analysis technique to provide both quantitative atomic concentration and chemical state information of the detected elements. X-ray irradiation of surfaces results in the emission of photoelectrons whose energies are characteristic of the elements. The information depth is approximately 5–7 nm. Angle-resolved XPS offers non-destructive resolution of structures within the XPS sampling depth, e. g. layer ordering, composition and thickness can be determined. Moreover, XPS can be utilized for sputter depth profiling to characterize thin films and multi-layer systems by quantifying matrix-level elements as a function of depth. The gas cluster ion source additionally enables sputter depth profiling of organic materials while preserving the chemical information.

Contact

See KNMF website or contact the KNMF User Office.

Features

K-Alpha & K-Alpha+ XPS Instruments

- Mono AlKα X-ray source, spot size 30–400 µm (spatial resolution)
- Energy resolution < 0.5 eV FWHM Ag $3d_{5/2}$
- Rapid snap map chemical imaging (K-Alpha+)
- Ion gun for sputter depth profiling, 100–3000 eV Ar^+ ion energy (K-Alpha)
- Mono Atom and Gas Cluster Ion Source (MAGCIS), Mono Ar^+: 500 eV to 4 keV, Cluster Ar^+: 2 keV to 8 keV, cluster size: 75 up to 2000 atoms (K-Alpha+)
- Charge neutralisation system
- 50 x 60 mm^2 sample stage, sample height max. 15 mm
- Glove-box for atmosphere-contact free sample transfer: O_2 < 1ppm, H_2O < 1ppm (K-Alpha)

ESCA 5 / Alpha 110 analyser

- MgKα/AlKα dual anode X-ray source
- Energy resolution < 0.85 eV FWHM Ag $3d_{5/2}$ (MgKα)
- Angle resolved XPS
- Ion gun for sputter depth profiling, 300–3500 eV Ar^+ ion energy
- Max. sample dimensions 15 x 15 x 2 mm^2
- In-situ sample cooling and heating (-190–500 °C)
- Residual gas analysis (mass range 1–300 amu)

Limitations/constraints

- All elements are detectable except for H and He
- Sample has to be a solid at RT and stable under vacuum conditions, powders are possible
- Depending on the chemical composition samples might be sensitive to X-ray irradiation

Typical results

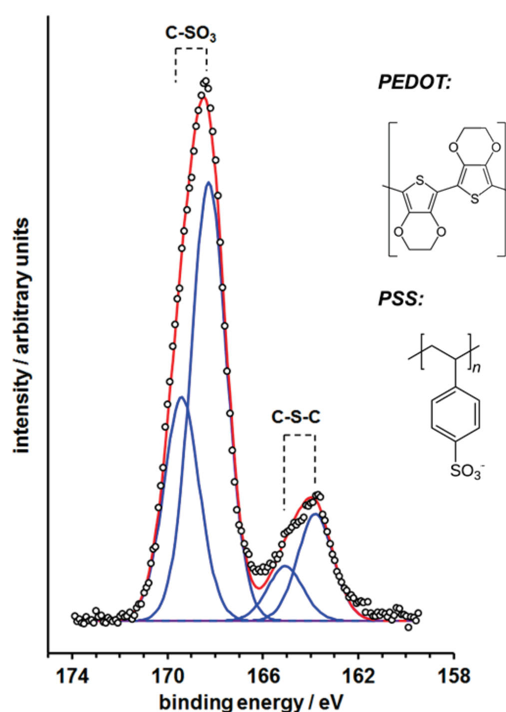

Fig. 1: Non-degraded S 2p XPS spectrum of a PEDOT:PSS thin layer after 1000 s Ar_{1000}^+ cluster ion sputtering using the K-Alpha+ MAGCIS source at 8 keV energy.

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Typical results (continued)

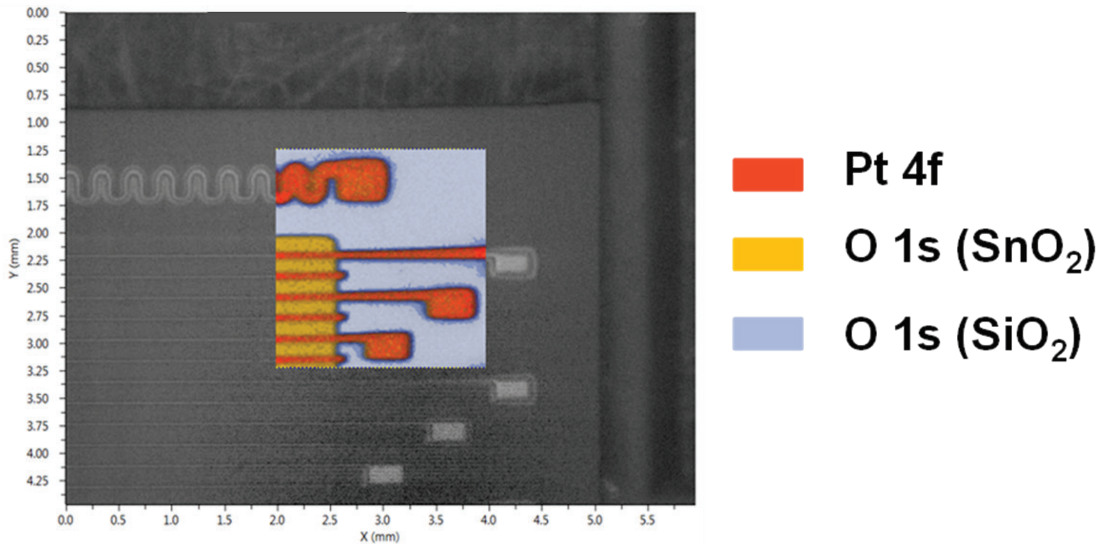

Fig. 2: Rapid snap map chemical image and respective overlaid video image of a gas sensor micro array (SiO_2 chip substrate, SnO_2 detector field subdivided by 50 µm Pt electrodes).

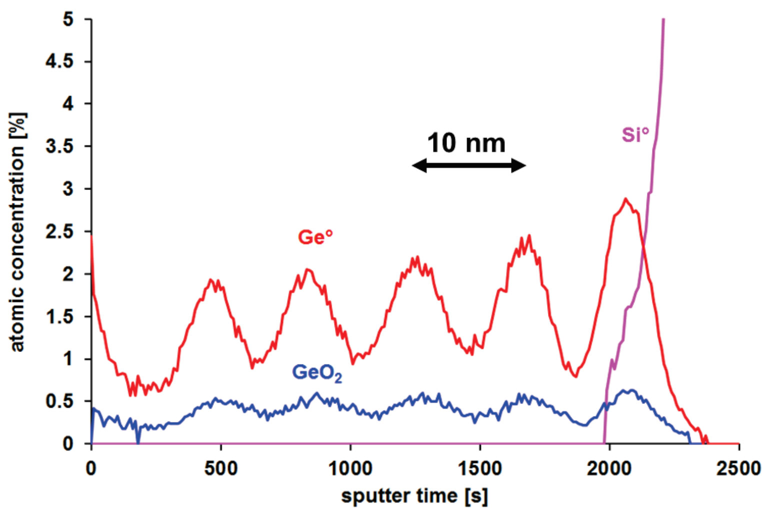

Fig. 3: Mono Ar^+ ion sputter depth profile of a sputter deposited Ge-SiO_2/SiO_2 multilayer system.

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