

Low Energy Inverse Photoemission Spectroscopy for PHI VersaProbe III

Low Energy Inverse Photoemission Spectroscopy (LEIPS) for the PHI VersaProbe multi-technique instrument reverses the role of photons and electrons compared to Photoelectron Spectroscopy (PES), so one can determine the energy of unoccupied levels.

By applying a low energy/high intensity electron beam to a sample surface, the emitted photons in the nearultraviolet range are detected with high resolution and sensitivity, and low sample damage.





LEIPS spectrum of a $C_{_{60}}$ thin film sample measured at an electron energy of \leq 5 eV.



Spectrum of a C60 thin film sample measured at an electron energy of 10 eV for 10 and 60 minutes using the same target current.

- The BaO electron neutralizer source used for charge compensation in XPS, is also used as the LEIPS excitation source, and the bright low energy operation enables analysis of damage sensitive materials.
- A dedicated Bremsstrahlung Isochromat Spectroscopy detector (BIS) is used with a selectable photon energy range up to 4.88 eV.
- Optical bandpass filters can be switched easily (outside of vacuum) depending on the application, with selectable central wavelengths.





LEIPS spectrum of 10 nm copper phthalocyanine thin film on ITO measured with 3 different band pass filters (BPF) allows for the calculation of the electron affinity by extrapolating to zero onset energy.



UPS/LEIPS Spectra of ITO/10 nm CuPc

Measurement of Both the Occupied and Unoccupied Electronic Energy Levels of a Sample

Combining the energy measurement of the occupied (valence) level obtained by UPS and the energy of the unoccupied (conduction) level obtained by LEIPS provides the whole picture of the band structure for a semiconductor film:





- The ionization potential can be obtained from the highest occupied molecular orbital (HOMO) of the UPS measurement.
- The electron affinity can be obtained from the lowest unoccupied molecular orbital (LUMO) of the LEIPS measurement.
- From the difference in these two values, the semiconductor band gap energy can be calculated.

In-situ Measurement for XPS, UPS, and LEIPS

In the PHI *VersaProbe* multi-technique instrument, LEIPS, UPS, monoatomic Argon and cluster ion sputter sources, and neutralization beams are all aligned to the XPS measurement position, which allows for versatile and comprehensive in-situ measurements.



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