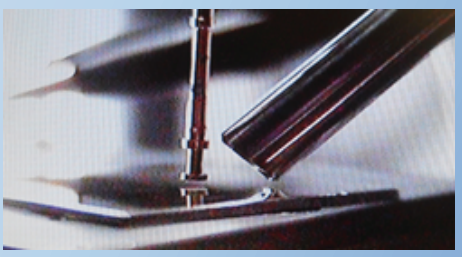
KP Technology Ltd

30 Years of Surface Analysis Experience

THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2008

Air Photoemission System

Model APS02



Air Photoemission System

Features

- Atmospheric pressure operation – with combined Kelvin Probe – unique in the world
- Measure absolute work function and ionization potential
- Access to density of states (DOS) information
- Estimate film thickness of materials
- High speed mode – measurement performed in seconds
- Low photon excitation energy (3.40 – 6.70 eV)
- Digital PC control of all system parameters
- Dual mode system with Kelvin Probe and 1-3 meV Work Function Resolution

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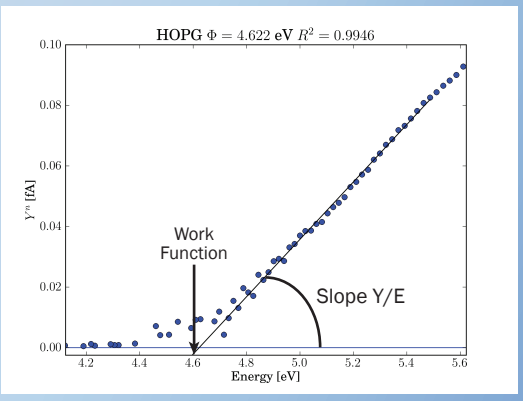
System Overview

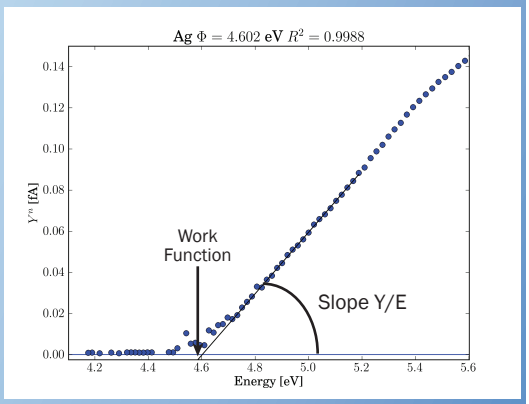
- Non contact and non-destructive analysis of surfaces in air.
- Absolute Work Function / Ionization Potential using Photoelectric effect in Air
- Estimate surface contamination or film thickness

Measurement Principle

When light is incident on a material such as a metal or a semiconductor, the photons may have enough energy to liberate electrons from the surface, a process know as the Photoelectric Effect. Photons having insufficient energy will not liberate electrons, while photons of just enough energy will liberate a few electrons; photons of much more energy than the work function will liberate a lot of electrons.

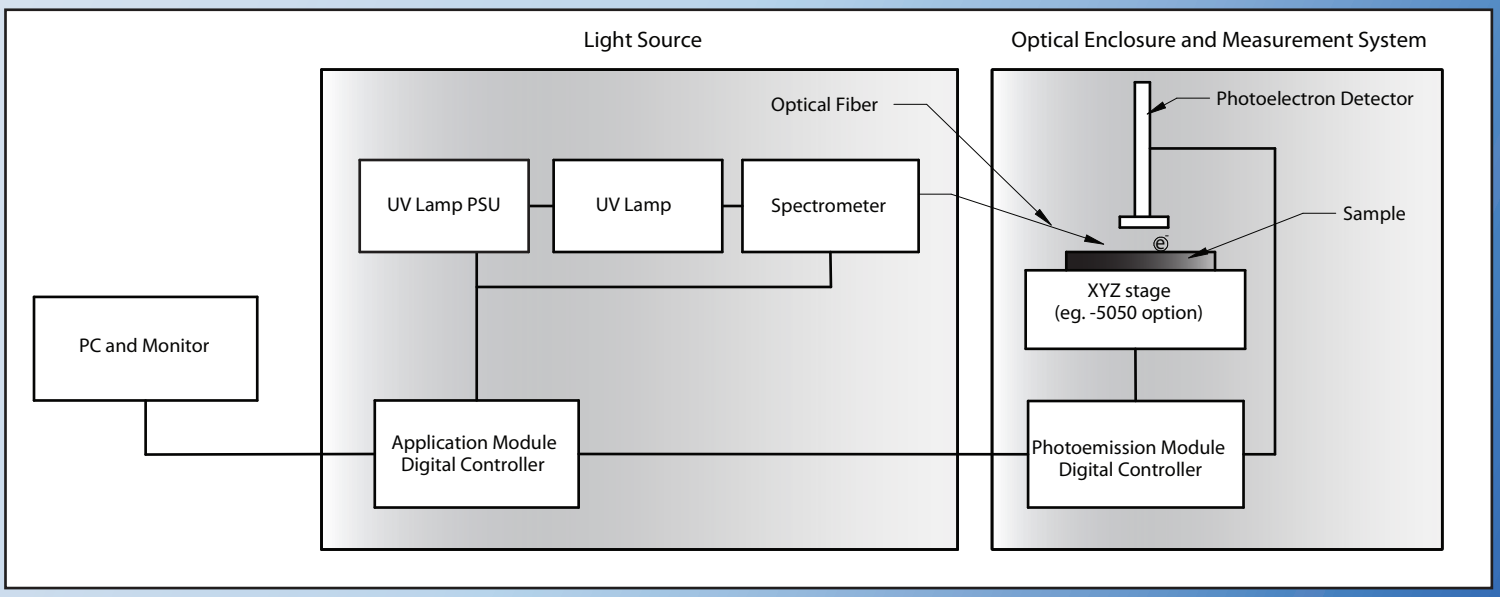


The energy required for electrons to escape the material is termed the photoelectric work function or simply work function. Thus, by varying the energy of the incoming light, the absolute work function can be established if it is possible to detect the ejected photoelectrons from the material being studied.



Based on Fowler's analysis of photoemission [1], the square root* of the detected photoelectron yield is plotted on a graph vs the incident photon energy. Example measurements perfomed using the APS02 are shown on the right. The corresponding work function in air for each material is the intercept on the x-axis, with a measured value for HOPG of 4.65eV, and for Ag of 4.60eV.

* For semiconductors the cube root is usually taken



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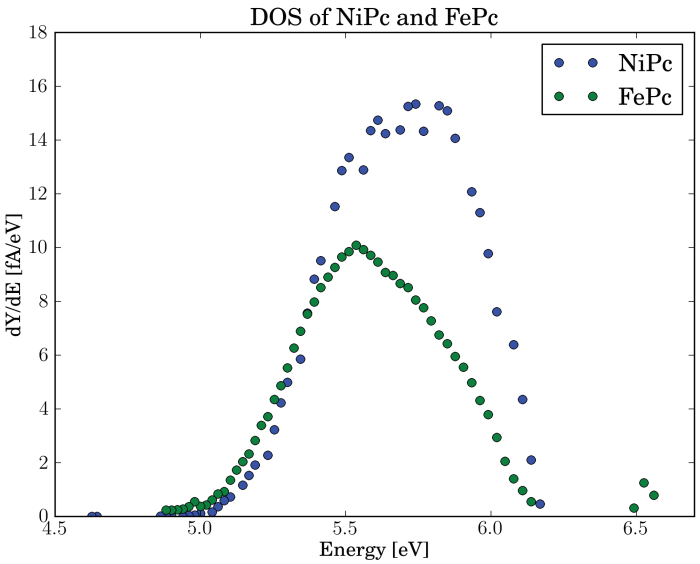
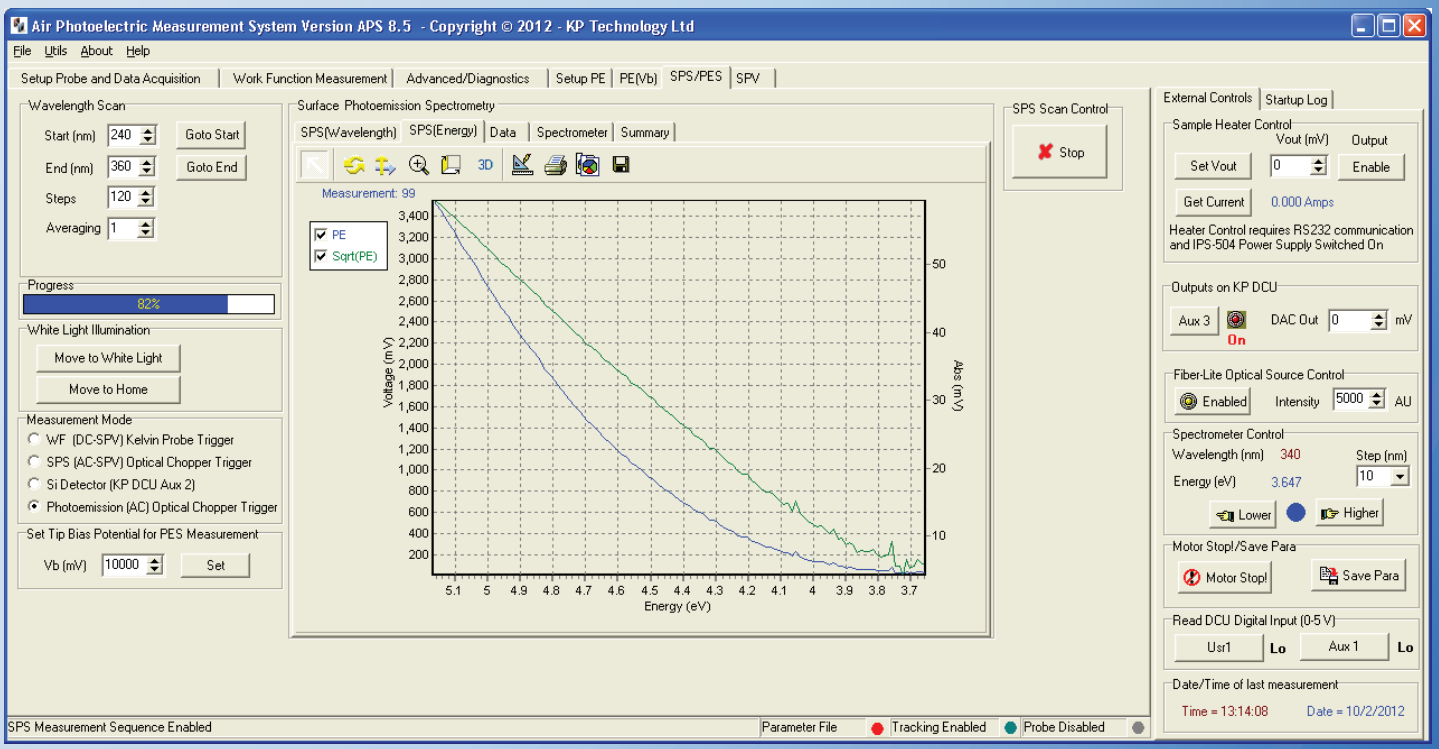
Measurement Example – Density of States (DOS)

The properties of many materials are governed by the Density of States (DOS) near the Fermi Level. The APS02 system is capable of probing the DOS by differentiating the detected photoelectron yields by the incident photon energy. The DOS measurement can thus be compared to molecular orbital calculations for the material under investigation. DOS data collected with the APS02 in air is shown below for the electroluminescent materials Ni- phthalocyanine (Ni-Pc), Co-phthalocyanine (Co-Pc) and Fe-phthalocyanine (FePc). The data is consistent with studies performed using the Open Counter method by Yamashita et al [2] which show a peak at ~6eV and a marked drop in the DOS to zero at ~ 6.2eV.



System Software

The APS02 system software is shown performing a work function scan of a metallic sample. The photoelectron spectrum is measured and the work function and ionization potential is automatically determined by the photoemission threshold (the intercept of the square root of the yield with the x-axis).



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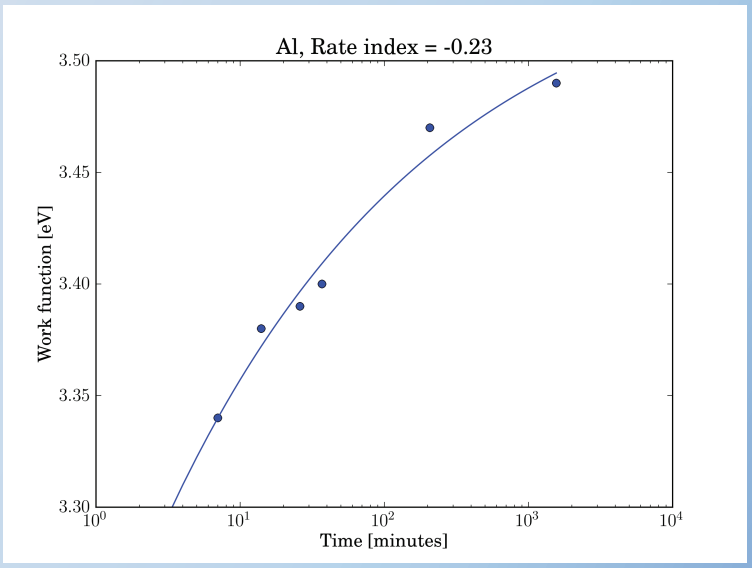
Measurement Example – Work Function changes over time

The surface of aluminium was studied after removal of the surface oxide. The surface oxide forms rapidly on the surface in agreement with measurements performed by Uda et al [3].



References

[1] R. Fowler, Phys Rev 38, 45 (1931)

[2] D. Yamashita et al, J. Surf. Analysis 14, 4 (2008) p433

[3] M. Uda et al, J. Elec. Spec. Rel. Phenomena 88-91 (1998) p.767

KP Technology offers 4 Versions of the Air Photoemission System

- APS02-SP - Single Point Air Photoemission System
- APS02-5050 - 50mm x 50mm Scanning Air Photoemission System
- APS02-200250 - 200mm x 250mm Scanning Air Photoemission System
- APS02-GB - 50mm x 50mm Scanning Air Photoemission System in a Glovebox / Environmental Enclosure

	APS02-SP	APS02-5050	APS02-250200	APS02-GB
Operates in Atmosphere	✓	✓	✓	✓
Optical and Faraday Enclosure	✓	✓	✓	✓
Operates in RH (5%-95%), N_2, Ar				✓
Source Energy Range 3.4 - 6.7eV	✓	✓	✓	✓
50mm Motorised Z-Axis	✓	✓	✓	✓
50mm x 50mm motorised X and Y Axis		✓		✓
250mm x 200mm motorised X and Y Axis			✓	
Camera, Monitor, Enclosure Illumination	✓	✓	✓	✓
Sample-to-Tip Auto-Tracking	✓	✓	✓	✓
2D and 3D Scanning (DM)		✓	✓	✓
Auto-Positioning of Probe			✓	
Automatic Heater and RH Control				✓

Please visit www.kelvinprobe.com/products-APS for further information

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