KP TECHNOLOGY

# AMBIENT-PRESSURE PHOTOEMISSION SPECTROSCOPY SYSTEMS

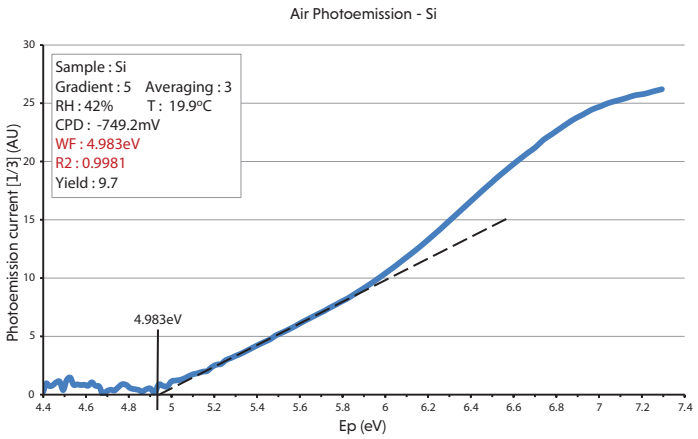
**APS02 • APS03 • APS04**

## SYSTEM DESCRIPTION

The Ambient-pressure Photoemission Spectroscopy (APS) systems are one of KP Technology Ltd's most recent additions to our large surface analysis range.

Domestic and international patents are held for these instruments. APS measures the absolute work function (Φ) of a material by photoemission in ambient conditions, no vacuum is required. The excitation range of APS is 3.4 eV to 7.0 eV, meaning that APS is capable of measuring the absolute work function of metals and the ionisation potential of semiconductors alongside measurement of the surface Fermi level with the Kelvin probe.

If an SPV and SPS source is added to the APS system, the full bands of semiconductors can be measured in one complete desktop system; no other product in the world can do this.



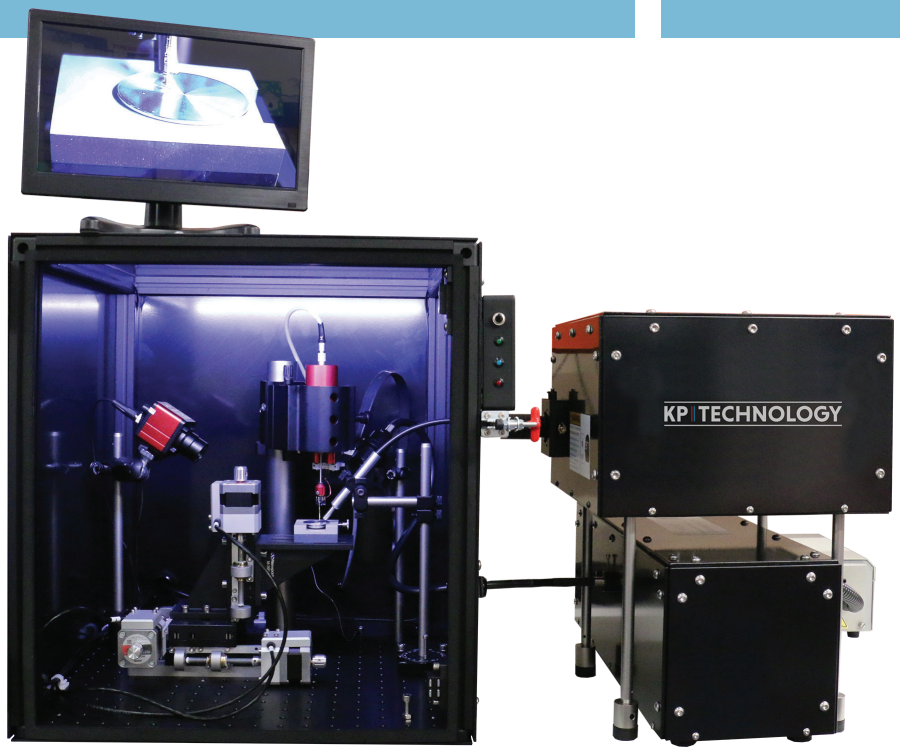

Ambient photoemission measurement of a silicon sample

## FEATURES

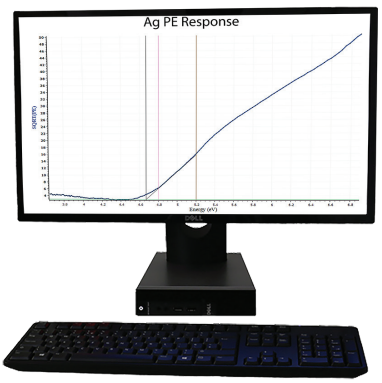
- Work function by photoemission in air
- Density of states measurements
- 3.4 eV to 7.0 eV energy range
- Measurement of all semiconductor bands
- Contact potential difference by Kelvin Probe

## APPLICATIONS

- Organic and non-organic semiconductors
- Metals and metal alloys
- Thin films and surface oxides
- Solar cells and organic photovoltaics
- Corrosion and nanotechnology




Ambient-pressure Photoemission Spectroscopy APS04 system with SKP5050 and surface photovoltage spectrometry



# AMBIENT-PRESSURE PHOTOEMISSION SPECTROSCOPY SYSTEMS

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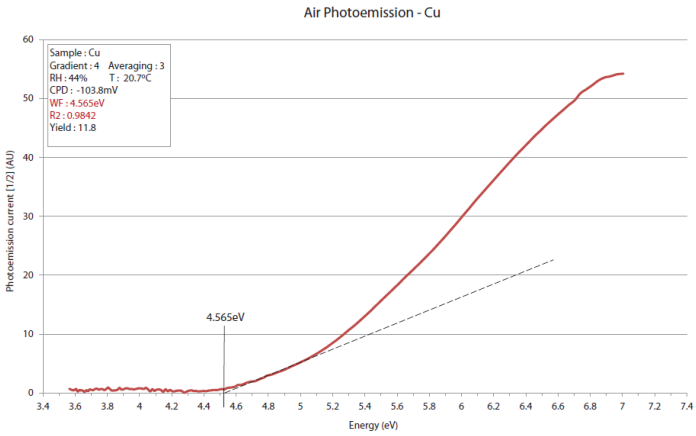
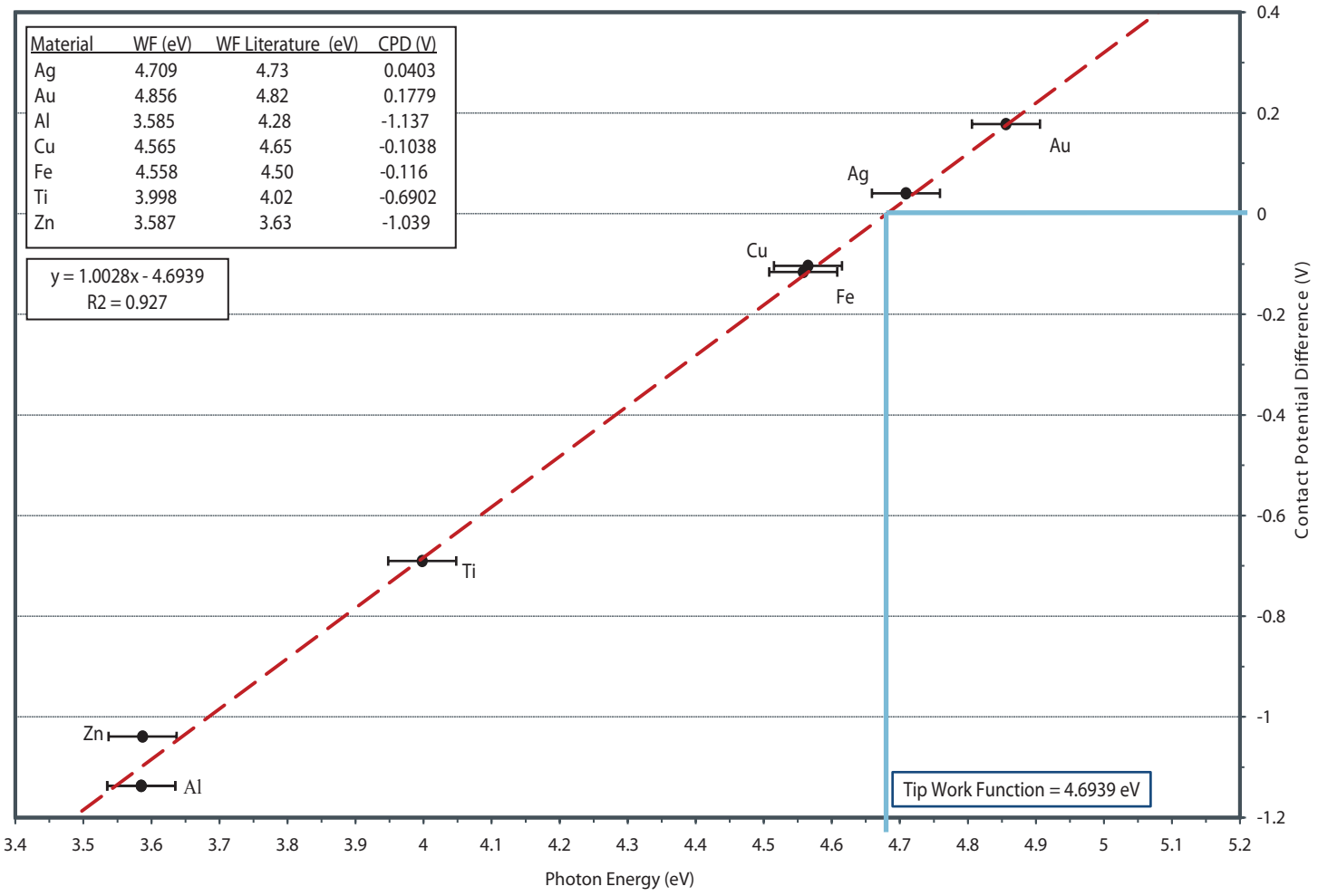
## SYSTEM DESCRIPTION

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 known as the Photoelectric Effect.
The energy required for electrons to escape the material is termed the work function.
By varying the energy of the incoming light, the absolute work function can be established.
Based on Fowler's analysis of photoemission, the square root (cube root for semiconductors) of the photoelectron yield is plotted on a graph versus the incident photon energy (image right).
The work function of the material under analysis is where this straight line extrapolates to zero.




Ambient photoemission curve of copper sample




Ambient-pressure photoemission measurements of a selection of metals

Each metal was measured with the photoemission mode and Kelvin probe mode of an APS02 system.
The contact potential difference (CPD) was measured with the Kelvin probe and the work function was measured by the ambient pressure photoemission mode.
When work function is plotted against CPD, a straight line is formed. A line is drawn at 0 V CPD to the line and when traced down reveals the absolute work function of the tip.

# KP TECHNOLOGY CLIENTS AND PUBLICATIONS USING APS FROM HIGH IMPACT JOURNALS

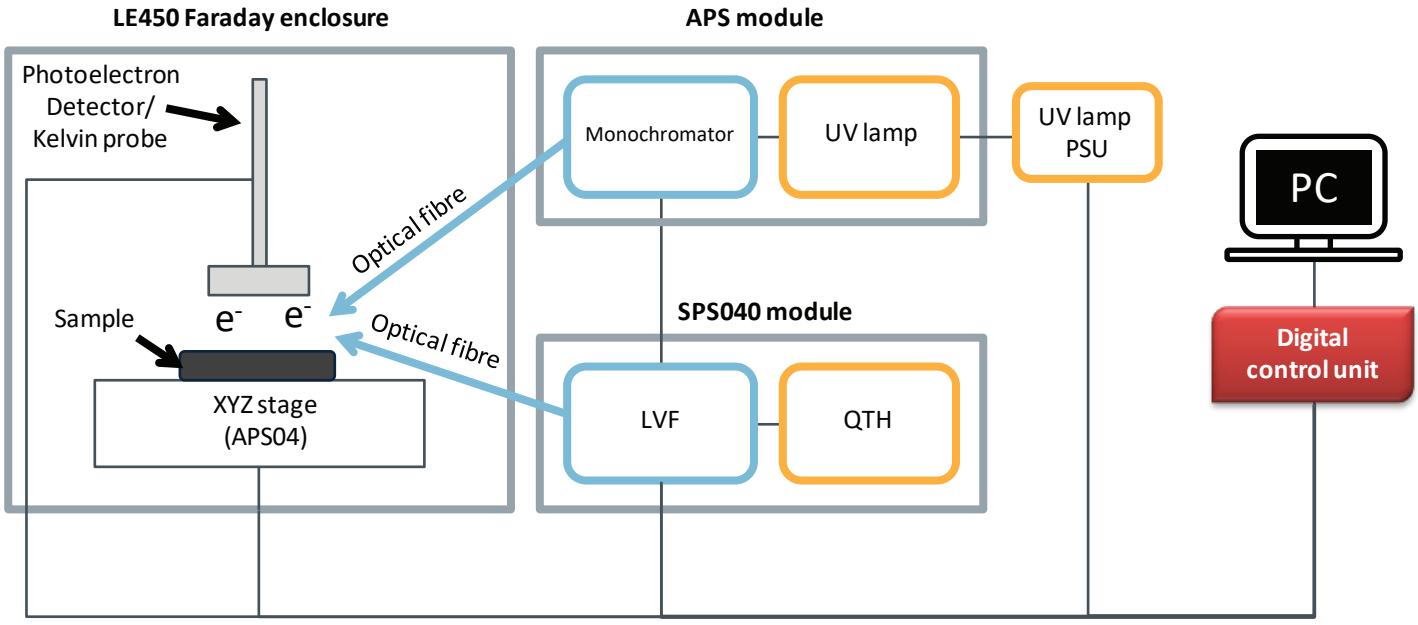
***Selenium-Substituted Non-Fullerene Acceptors: A Route to Superior Operational Stability for Organic Bulk Heterojunction Solar Cells.***
Chiara Labanti, Min Jae Sung, Joel Luke, Sooncheol Kwon, Rhea Kumar, Jisu Hong, Jehan Kim, Artem A. Bakulin, Soon-Ki Kwon, Yun-Hi Kim and Ji-Seon Kim.
**Imperial College London, United Kingdom**
**2021 | APS04**
**ACS Nano**

***Solar Photoelectroreduction of Nitrate Ions on PbI2/CuI Nanocomposite Electrodes.***
Egon Kecsenovity, Saji Thomas Kochuveedu, Jyh-Pin Chou, Diána Lukács, Ádám Gali, Csaba Janáky.
**University of Szeged, Hungary**
**2021 | APS04**
**Solar RRL**

***Demonstration of Energy-Resolved γ-Ray Detection at Room Temperature by the CsPbCl3 Perovskite Semiconductor.***
Yihui He, Constantinos C. Stoumpos, Ido Hadar, Zhongzhen Luo, Kyle M. McCall, Zhifu Liu, Duck Young Chung, Bruce W. Wessels and Mercouri G. Kanatzidis.
**Northwestern University, USA**
**2021 | APS04**
**Journal of the American Chemical Society**

***Formamide iodide: A new cation additive for inhibiting δ-phase formation of formamidinium lead iodide perovskite.***
Itaru Raifuku, Yu-Hsien Chiang, Cheng-Hung Hou, Ming-Hsien Li, Chen-Fu Lin, Pei-Ying Lin, Jing-Jong Shyue and Peter Chen.
**National Cheng Kung University, Taiwan**
**2021 | APS04**
**Materials Advances**

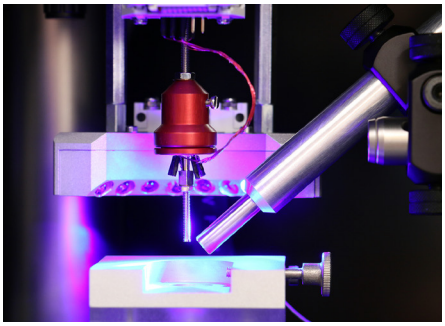
## SYSTEM OVERVIEW



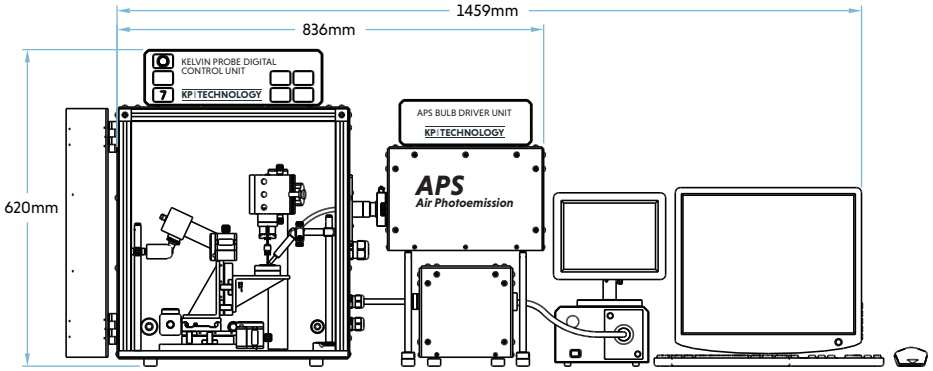

The optical enclosure houses the sample in complete darkness prior to measurement.
The photoelectron detector measures the liberated electrons driven off by the UV light emitted by the monochromator.
The UV bulb is powered by an external PSU and is controlled by software. The UV light is injected into the monochromator and a variable wavelength of light is produced. The energy range of this light is 3.4 eV to 7.0 eV.
The digital controller controls every aspect of the system and is controlled by the dedicated software GUI. The measurement from the photoelectron detector is passed to the digital controller, to the PC and plotted in software, producing the PE curve.

# AMBIENT-PRESSURE PHOTOEMISSION SPECTROSCOPY SYSTEMS
## APS02 • APS03 • APS04

| SYSTEM SPECIFICATIONS | APS02 | APS03 | APS04 |
|---|---|---|---|
| Kelvin probe 3-axis scanning | ✓ | ✓ | ✓ |
| Surface Photovoltage | | ✓ | ✓ |
| Surface Photovoltage Specroscopy | | | ✓ |
| Tip material / diameter | Standard 2 mm Au plated tip | | |
| CPD resolution | 1 - 3 meV | | |
| APS Measurement Resolution | 0.05eV | | |
| Height control (auto) | 25 mm automatic | | |
| Kelvin probe mode and PE mode | CPD and photoemission measurements | | |
| CPD measurement time | CPD measurements in <1 minute | | |
| WF measurement time | PE measurements in <5 minutes | | |
| Optical system | Colour camera with zoom and monitor for positioning | | |
| Oscilloscope | Digital TFT oscilloscope for real time signal | | |
| Test sample | Au/Al and Ag Reference sample | Au/Al, Silicon Solar Cell and Ag Reference samples | |
| Faraday/optical enclosure | LE450 (450 mm x 450 mm) | | |
| Control supplied | PC control with dedicated software | | |
| Patented technology | US:8866505 / GB:2439439 / GB:2495998 / EU:2783205 / JP:6018645 | | |



Photograph of an APS04 system with LED collar




APS04 system with Surface Photovoltage Spectroscopy

**KP Technology has been serving the scientific community since 2000 and has grown to be the leading supplier of Kelvin Probe systems worldwide.**

Founded with the aim of bringing new surface research tools to the market, we offer a spectrum of dedicated Kelvin Probe systems for work function and energy level measurement. Our systems have been specially developed for applications in a variety of environments, ranging from ambient and controlled atmosphere to Ultra-High Vacuum. Recent developments include a patented dual mode Kelvin Probe and Photoemission Spectroscopy system for measurement of the absolute work function of a material by photoemission in air.

The range of Kelvin Probe systems offered, and the accuracy of the work function resolution provided by our unique systems is unsurpassed by any other Kelvin Probe supplier.

A strong research and development team, coupled with decades of experience in materials research and characterisation has supported the rapid growth KP Technology has experienced over the years. We now service hundreds of companies and research institutes worldwide in their materials research and characterisation requirements.

KP Technology systems have been named in hundreds of research papers and continue to feature in peer reviewed client publications year after year.

KP TECHNOLOGY

Contact us for more information, to request a quotation or to discuss how our systems can support your research.

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**www.kelvinprobe.com**

**KP Technology Ltd. is the proud winner of the Queens Award for Enterprise: Innovation 2018**

THE QUEEN'S AWARDS FOR ENTERPRISE 2018