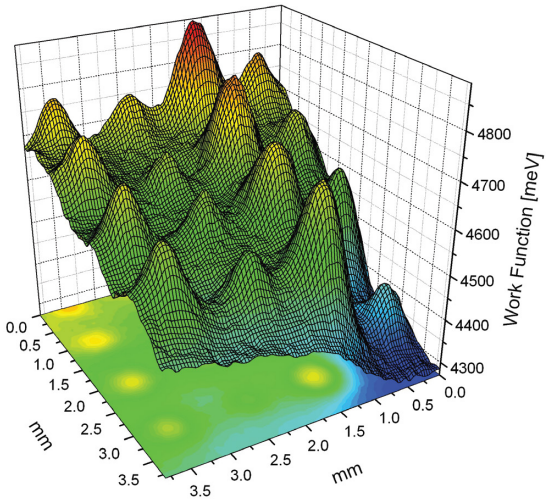
Scanning Kelvin Probe Systems

SKP5050, ASKP100100, ASKP200250, ASKP350350

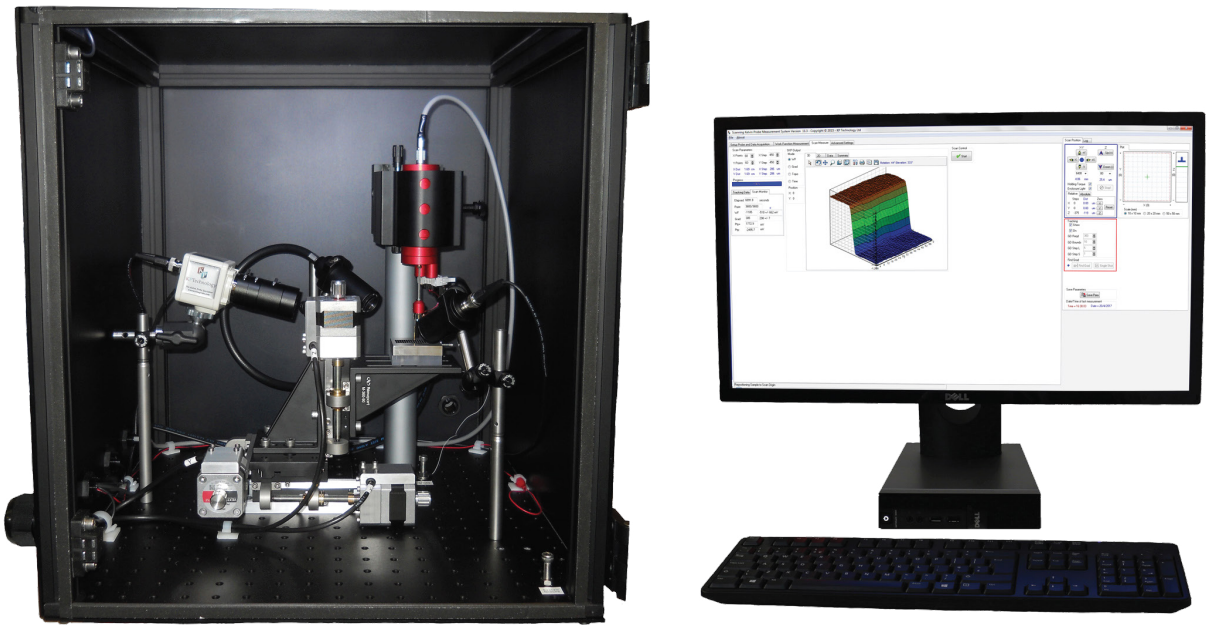
System Description

Our large range of Scanning Kelvin Probes give the user full access to 2D and 3D work function plots of samples ranging in size from 50 mm to 350 mm. With work function resolution of 1-3 meV, and the spatial resolution of the probe tip diameter, the Scanning Kelvin Probe gives reliable, repeatable measurements for work function (Φ), contact potential difference (CPD) and Volta potential (Δψ) measurements.

Effects of corrosion can be measured across a surface with high precision e.g. coating uniformity and performance. A Faraday and optical enclosure shields all of our scanning systems from unwanted fast changing environmental conditions, electromagnetic interference and provides the perfect platform for our Ambient Pressure Photoemission Spectroscopy (APS) and Surface Photovoltage add-on modules.



Silicon substrate modified by a layer of small 'bumps'. Sample is scanned using SKP5050 advanced 2D and 3D techniques



Scanning Kelvin Probe SKP5050 pictured inside standard optical enclosure with PC and software

Features

- Work function measurement by Kelvin probe
- Work function resolution of 1-3 meV
- Scanning area from 50 mm to 350 mm
- Scanning resolution equal to tip diameter
- Automatic height regulation
- Tip diameter 2.00 mm or 0.05 mm (SKP5050)

Applications

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

Scanning Kelvin Probe Systems

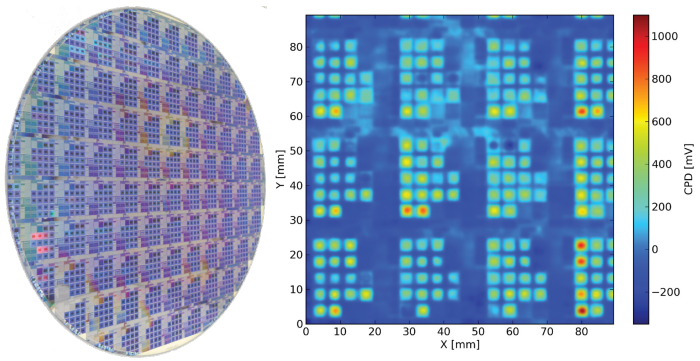
SKP5050, ASKP100100, ASKP200250, ASKP350350

System Specifications

	SKP5050	ASKP100100	ASKP200250	ASKP350350
Tip material / diameter	Standard 2 mm gold tip (0.05 mm available on request)			
Work function resolution	1-3 meV			
Sample scan size	50 x 50 mm	100 x 100 mm	200 x 250 mm	350 x 350 mm
3D sample area	Square	Square	Square	Square & Circular
Height control (auto)	25 mm	50 mm	50 mm	50 mm
Visualisation	3D maps of surface potential			
Optical system	Colour camera with zoom lens and monitor			
Oscilloscope	Digital TFT oscilloscope for real time signal			
Test sample	Gold and aluminium test sample			
Faraday enclosure base (mm)	450 x 450	450 x 450	450 x 450	450 x 600
Control supplied	PC control with dedicated software for full digital control of all parameters			
Detection system	Off-null with parasitic capacity rejection			
Warranty	12 months			

Upgrades and Add-Ons

- Ambient Pressure Photoemission Spectroscopy (APS)
- Surface Photovoltage Spectroscopy (400-1000 nm)
- Surface Photovoltage (QTH or LED)
- Sample heater to 250°C
- Relative humidity control and/or nitrogen environmental chamber
- Tips in gold or stainless steel: 0.05 mm to 2.00 mm



12" silicon wafer measured using the ASKP350350 Scanning Kelvin Probe

The Company

KP Technology Ltd was founded with the aim of bringing to the market new surface research tools. These tools have featured in over 250 peer-reviewed client publications in the last 3 years. KP Technology Ltd also performs a significant amount of material research and training consultancy, mostly based upon the work function (Φ) or surface potential evaluation of client samples. KP Technology Ltd holds international patents on their Ambient Pressure Photoemission Spectroscopy (APS) system for measuring absolute workfunction. Along with a strong research and development division and over 500 systems shipped worldwide, this has placed KP Technology Ltd as the leading supplier of Kelvin probes in the world.

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Single-Point Kelvin Probe System

KP020

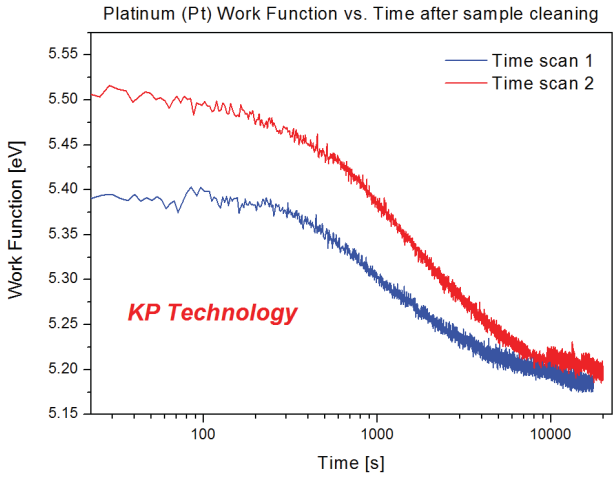
System Description

Our single-point Kelvin probe (KP020) system is the introductory system to the KP Technology Ltd range. The off-null signal detection method allows very high quality measurements of the work function (Φ), otherwise known as the Volta potential (Δψ), and Fermi level of materials.

The economical system enables users to quickly record non-scanning data and the dedicated software allows full digital control of all parameters to match the exact requirements of the sample under investigation. The recorded data is easily exportable to analysis software.

For rapid events, the KP020 can record work function at a rate of over 300 work function measurements per minute, or alternatively, the system will track slow work function evolution over a number of days.

There is an in-built height regulation feature to control the tip to sample spacing during measurements which gives rise to stable, reliable and repeatable data.



Platinum work function over time after cleaning

Single-point Kelvin probe KP020 pictured with optical/Faraday enclosure and PC

Features

- Work function measurement by Kelvin probe
- Work function resolution of 1-3 meV
- Modular system for upgrades and add-ons
- Economical, entry system
- USB version plug-and-play
- Off-null signal detection system

Applications

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

Single-Point Kelvin Probe System

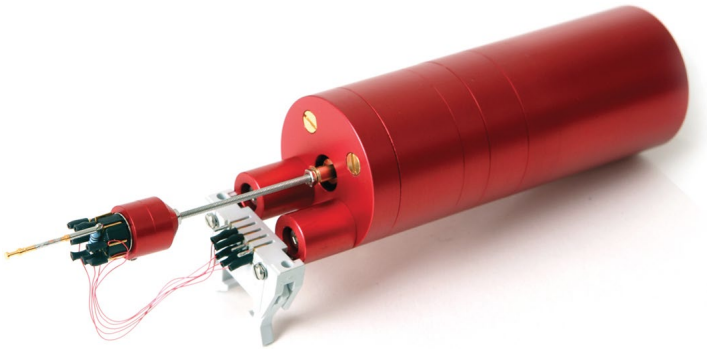
KP020

System Specifications

	KP020
Tip material/diameter	Standard 2 mm gold tip (other materials/sizes available on request)
Work function resolution	1-3 meV
Probe translation	25 mm manual translator
Visualisation	Single-point work function / contact potential difference measurement
Oscilloscope	Digital TFT oscilloscope for real time signal
Test sample	Gold/aluminium sample
Control supplied	PC control with dedicated software for full digital control of all parameters
Height regulation	Through DC probe adjustments
Detection system	Off-null with parasitic capacity rejection
Enclosure	450 mm x 450 mm optical/Faraday enclosure included
Optical system	Colour camera with zoom lens and monitor
Warranty	12 months

Upgrades and Add-Ons

- Scanning Kelvin Probe system
- Relative humidity control and nitrogen environmental chamber
- Ambient Pressure Photoemission Spectroscopy
- Sample heater to 250°C
- Surface Photovoltage Spectroscopy (400-1000nm)
- Surface Photovoltage (QTH or LED)



The KP Technology Ltd Kelvin probe

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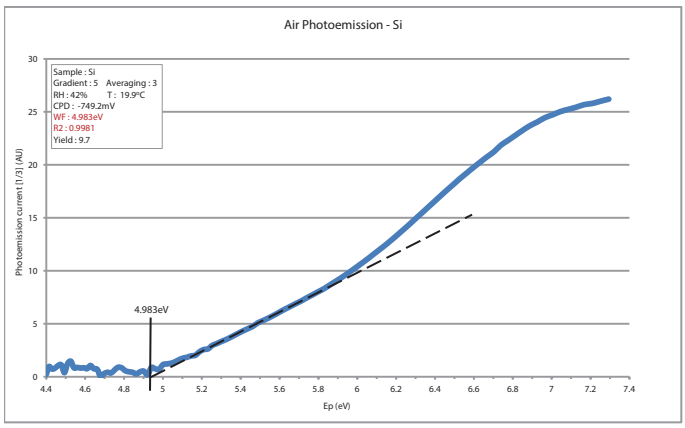
Ambient Pressure Photoemission Spectroscopy Systems

APS01, APS02, APS03, APS04

System Description

The Ambient Pressure Photoemission Spectroscopy (APS) systems are KP Technology Ltd's newest addition to our large surface analysis range and international patents are held for these instruments. The APS systems measure the absolute work function (Φ) or Volta potential (Δψ) of a material by photoemission in air, no vacuum is required. With an excitation range of 3.4 eV to over 7.0 eV, the APS systems are 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.

With the addition of an SPV and SPS source, the full bands of semiconductors can be measured in one system; no other product can do this.



Photoemission in air measurement of a silicon sample

Ambient Pressure Photoemission Spectroscopy APS04 system - scanning Kelvin probe with ambient pressure photoemission spectrometry and surface photovoltage spectrometry

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 Systems

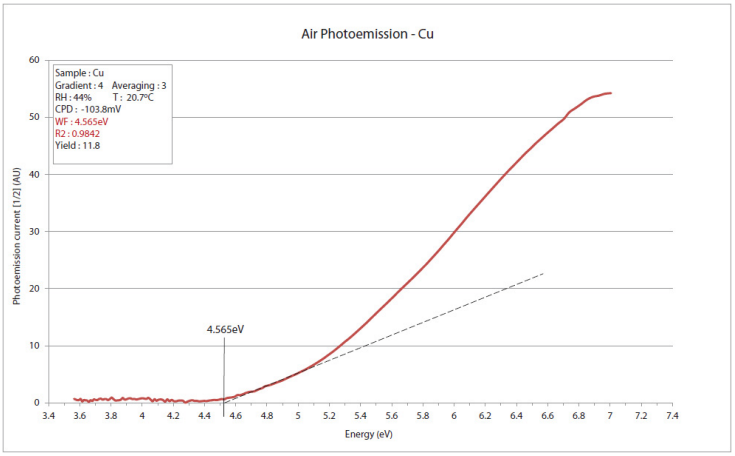
APS01, APS02, APS03, APS04

Measurement Principle

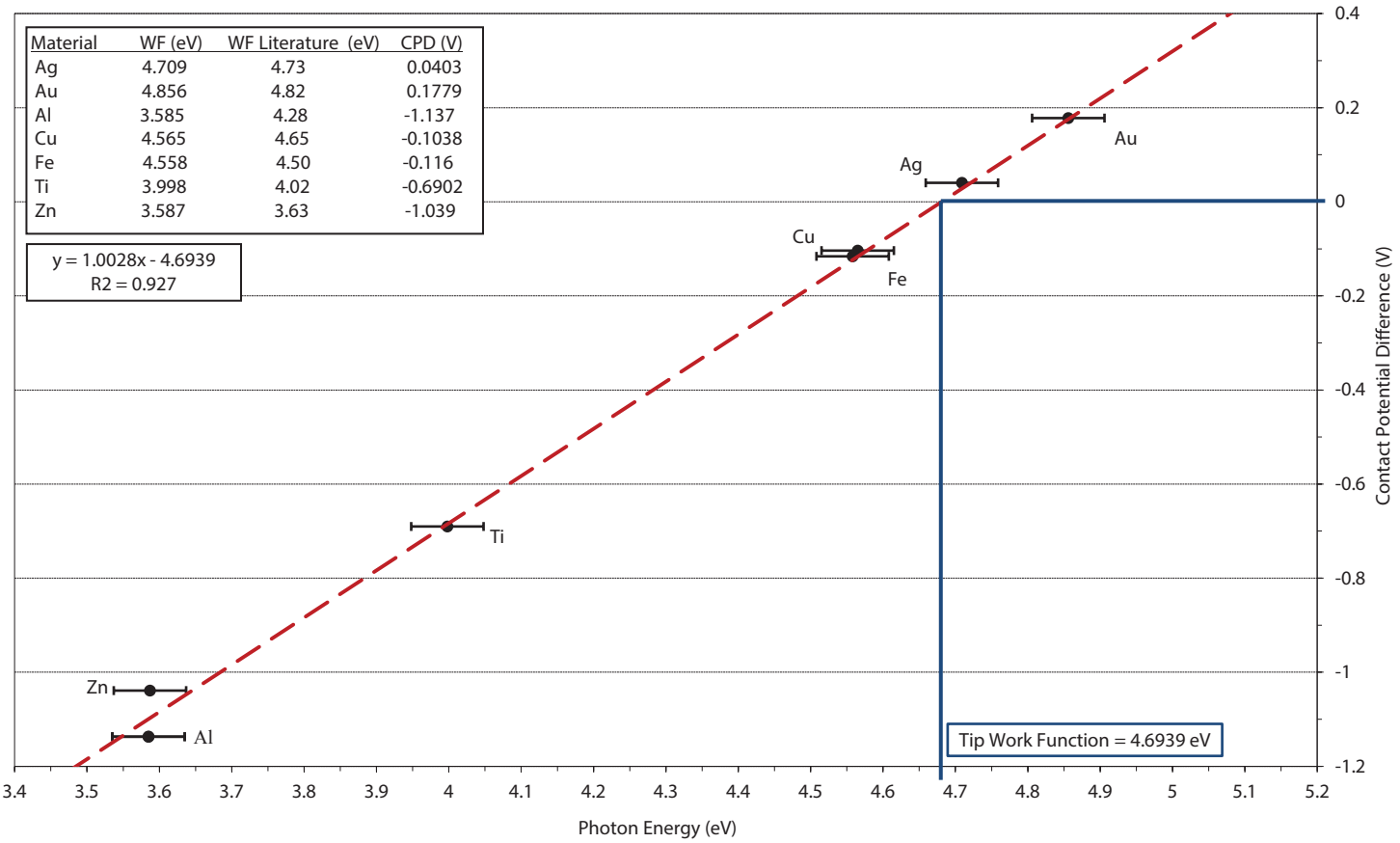
When light is incident on a material such as a metal or a semiconductor, the photons may have enough energy to liberate electrons from the surface, a process known as the Photoelectric Effect.

The energy required for electrons to escape the material is termed the work function or volta potential. 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.



Air photoemission curve of copper sample



Ambient pressure photoemission measurements of a selection of metals.

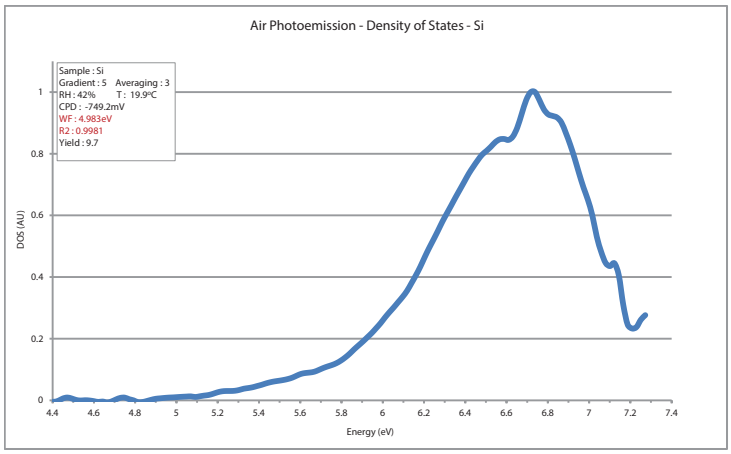
Each metal was measured with the photoemission mode and Kelvin probe mode of an APS02 system. The contact potential difference (CPD) was measured with the Kelvin probe and the work function was measured by the ambient pressure photoemission mode. When work function is plotted against CPD, a straight 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.

Ambient Pressure Photoemission Spectroscopy Systems

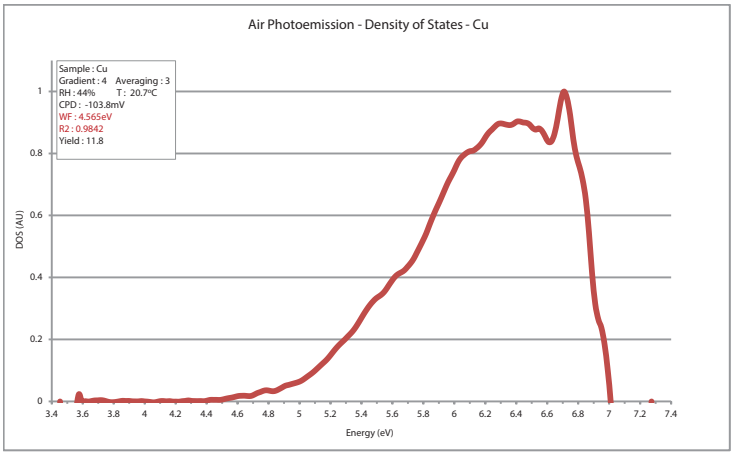
APS01, APS02, APS03, APS04

Density of States

The properties of many materials are governed by the Density of States (DOS) near the Fermi level. The Ambient Pressure Photoemission system is capable of probing the DOS by differentiating the detected photoelectron yield with respect to 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 APS in air is shown to the right for copper. The data for all measured samples is consistent with literature.

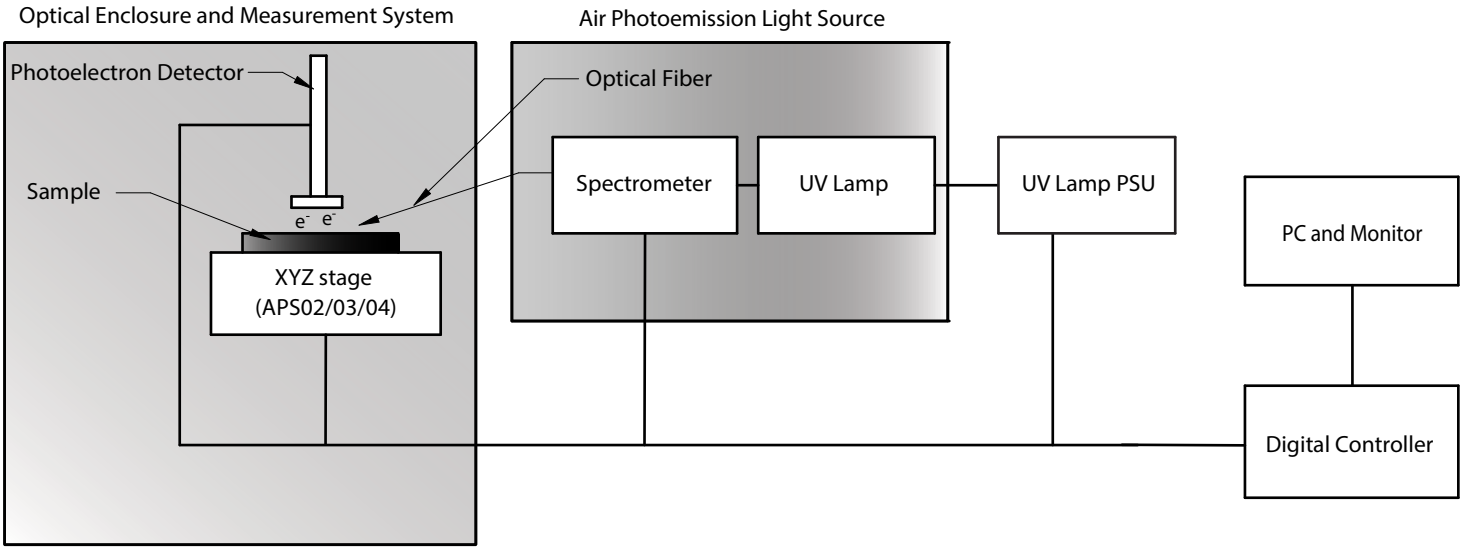


Silicon sample density of states



Copper sample density of states

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 spectrometer.

The UV bulb is powered by an external PSU and is controlled by software. The UV light is injected into the spectrometer and a variable wavelength of light is produced. The energy range of this light is 3.4 eV to 7.0 eV.

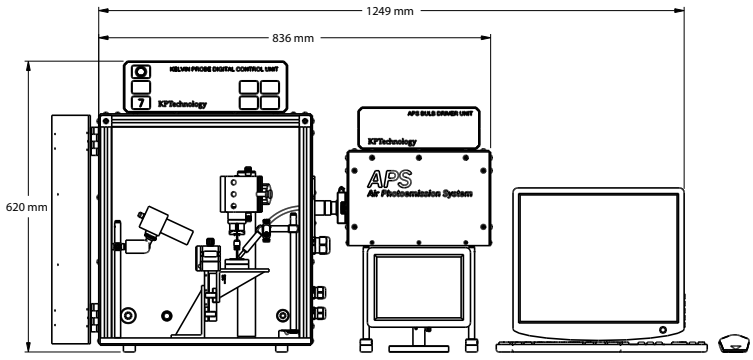
The digital controller controls every aspect of the system and is controlled by the dedicated software GUI. The measurement from the photoelectron detector is passed to the digital controller, to the PC and plotted in software, producing the PE curve.

Ambient Pressure Photoemission Spectroscopy Systems

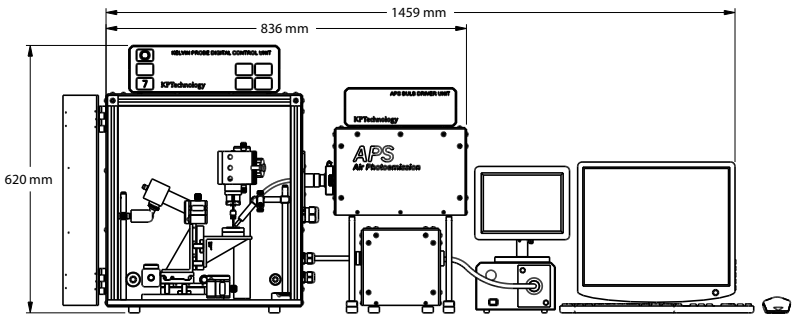
APS01, APS02, APS03, APS04

System Specifications

	APS01	APS02	APS03	APS04
Kelvin probe 3-axis scanning		✓	✓	✓
Surface Photovoltage			✓	✓
Surface Photovoltage Spectroscopy				✓
Tip material / diameter	2 mm gold tip			
CPD resolution	1-3 meV			
Height control (auto)	25 mm automatic			
Kelvin probe mode and PE mode	CPD and photoemission measurements			
CPD measurement time	CPD measurements in <1 min			
PE resolution	Full photoemission measurement			
WF measurement time	PE measurement in <5 mins			
DOS measurements	Full access to DOS information			
Optical system	Colour camera with zoom lens and monitor for positioning			
Oscilloscope	Digital TFT oscilloscope for real time signal			
Test sample	Gold, aluminium and silver test samples			
Faraday enclosure base	450 x 450 mm			
Control supplied	PC control with dedicated software			
Patented technology	US: 8866505, GB: 2439439, GB: 2495998, EU: 2783205, JP: 6018645			



APS02 system with scanning capability



APS04 system with Surface Photovoltage Spectroscopy

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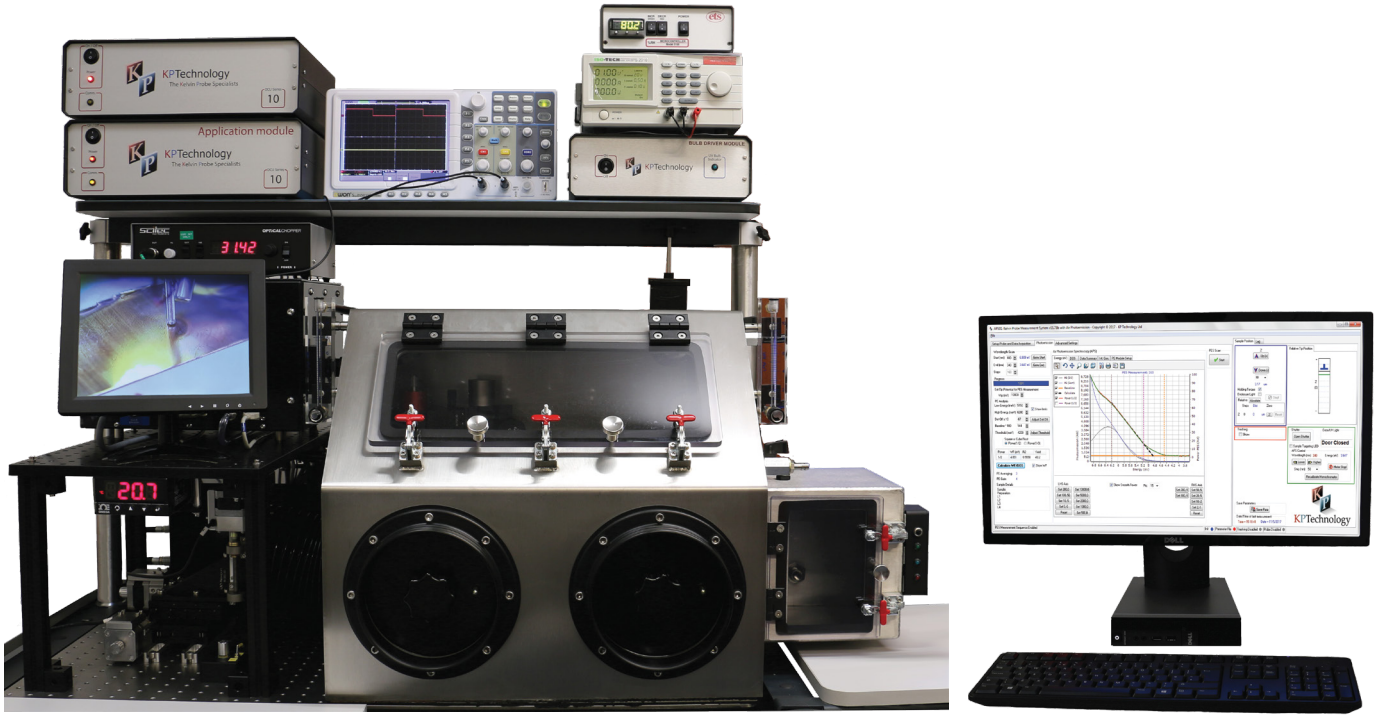
Ambient Pressure Photoemission System with Nitrogen Environment

APS04-N2-RH

System Description

The Ambient Pressure Photoemission Spectroscopy with Nitrogen Environment system (APS04-N2-RH) allows the measurement of material energy levels under nitrogen or ambient conditions. Absolute work function (Φ) can be measured with an accuracy of 0.05 eV. The relative humidity in this system can be automatically controlled from 20% to 85% via the user-friendly software. As well as this, the APS04-N2-RH comes with the KP Technology Scanning Kelvin Probe platform, perfect for plotting the changes in properties over the sample surface.

The APS04-N2-RH incorporates a tuneable deep ultra-violet (UV) source outputting 3.4-7.0 eV, for absolute work function and highest occupied molecular orbital (HOMO) measurements, a surface photovoltage spectroscopy (SPS) module outputting 400 - 1000 nm for V_{oc} and E_g measurements, together with a 50 x 50 mm scanning area for planar relative work function measurements (Fermi level). This system allows absolute work function determination in the presence of a nitrogen atmosphere. Our dedicated software allows the user full control of the energy scan ranges, tip potential, signal gain and averaging. Cube or square root fitting of the emission data over user-selectable photon energy, normalised light intensity and baseline correction.



APS04-N2-RH system with ambient pressure photoemission spectroscopy, nitrogen environment and scanning capabilities

Features

- Work function by photoemission in air/N_2
- Work function resolution of ≤ 3 meV
- Automatic control of relative humidity
- Atmospheric control to < 1% oxygen
- 3.4 eV to 7.0 eV energy range

Applications

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

Ambient Pressure Photoemission System with Nitrogen Environment

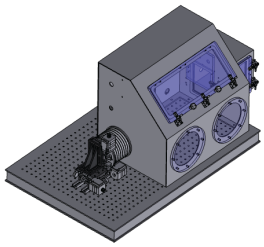
APS04-N2-RH

System Specifications

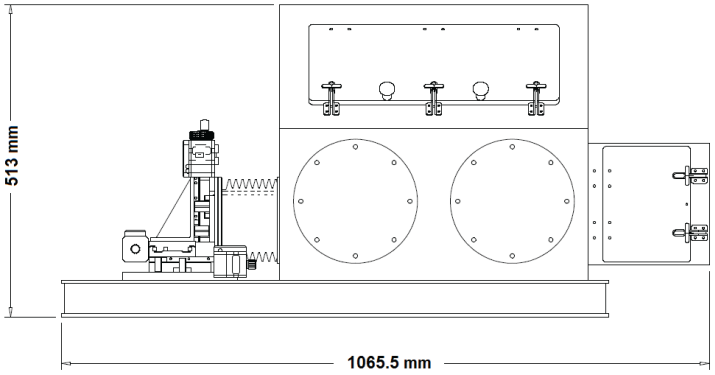
	APS04-N2-RH
Tip material/diameter	2 mm stainless steel
Absolute work function resolution (Φ)	≤ 0.05 eV
Contact potential difference resolution (ΔΦ)	≤ 0.001 eV
Sample scanning	50 x 50 mm
Atmospheric control	Nitrogen and RH control
Relative humidity range	20-85%
Height control	25 mm automatic
Kelvin probe mode and PE mode	CPD and PE measurements
WF measurement time	PE measurements in < 5 minutes
Optical system	Colour camera with zoom lens for monitoring and positioning
Oscilloscope	Digital TFT oscilloscope for real time signal
Test sample	Gold, aluminium, silver and silicon solar cell test samples
Breadboard footprint	900 x 600 mm
Control supplied	PC control with dedicated software
Detection system	Off-null with parasitic capacity rejection
Warranty	12 months

Upgrades and Add-ons

- Surface Photovoltage (QTH or LED)
- Surface Photovoltage Spectroscopy (400-1000 nm)
- Sample Heating to 115˚C



Isometric view of the glove box section of the APS04-N2-RH system



Dimensions of glove box section of APS04-N2-RH system

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Environmental Kelvin Probe Systems

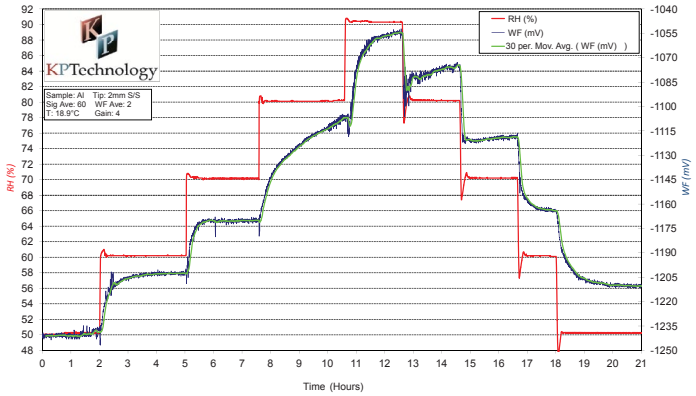
RHC010, RHC020, RHC030, RHC040

System Description

The Relative Humidity Kelvin Probe (RHC) systems are the ideal solution for monitoring samples in a controlled atmosphere for work function (Φ), otherwise known as Volta potential (Δψ), determination. The RHC systems have the ability to automatically control the relative humidity within the chamber from 20% to 80% using the easily programmable software.

As well as RH control, the RHC020 and RHC040 Kelvin probe systems come with the KP Technology Ltd Scanning Kelvin Probe platform, perfect for plotting the effect of corrosion over the surface of a sample and providing more insight into corrosion protection and resistance.

The RHC030 and RHC040 come with the added benefit of nitrogen atmosphere control with the ability to go down to <1% oxygen within the system.



Effect of relative humidity on aluminium sample over time

Relative humidity system model: RHC040 with 3-axis scanning capabilities

Features

- Work function measurement by Kelvin probe
- Work function resolution of 1-3 meV
- Automatic control of relative humidity
- Atmospheric control to <1% oxygen
- Modular system for upgrades and add-ons

Applications

- Corrosion e.g protection and resisitance
- Metals and metal alloys
- Thin films and surface oxides
- Organic and non-organic semiconductors
- Solar cells and organic photovoltaics

Environmental Kelvin Probe Systems

RHC010, RHC020, RHC030, RHC040

System Specifications

	RHC010	RHC020	RHC030	RHC040
Tip material/diameter	2 mm stainless steel tip			
Work function resolution	1-3 meV			
Sample scanning	Single-Point	50 mm x 50 mm	Single-Point	50 mm x 50 mm
Relative humidity control	Automatic: 20% to 80%			
Atmospheric control	RH Only	RH Only	Oxygen to <1%	Oxygen to <1%
Optical system	Front window		Colour camera	
Oscilloscope	Digital TFT oscilloscope for real time signal			
Test sample	Gold and aluminium test sample			
Breadboard footprint	900 x 600 mm			
Control supplied	PC control with dedicated software			
Detection system	Off-null with parasitic capacity rejection			
Warranty	12 months			

Upgrades and Add-Ons

- Ambient Pressure Photoemission Spectroscopy (APS)
- Surface Photovoltage (QTH or LED)
- Surface Photovoltage Spectroscopy (400-1000nm)
- Upgrade to Scanning Kelvin Probe System
- Sample Heating to 115˚C

Relative humidity system model: RHC020 with 3-axis scanning

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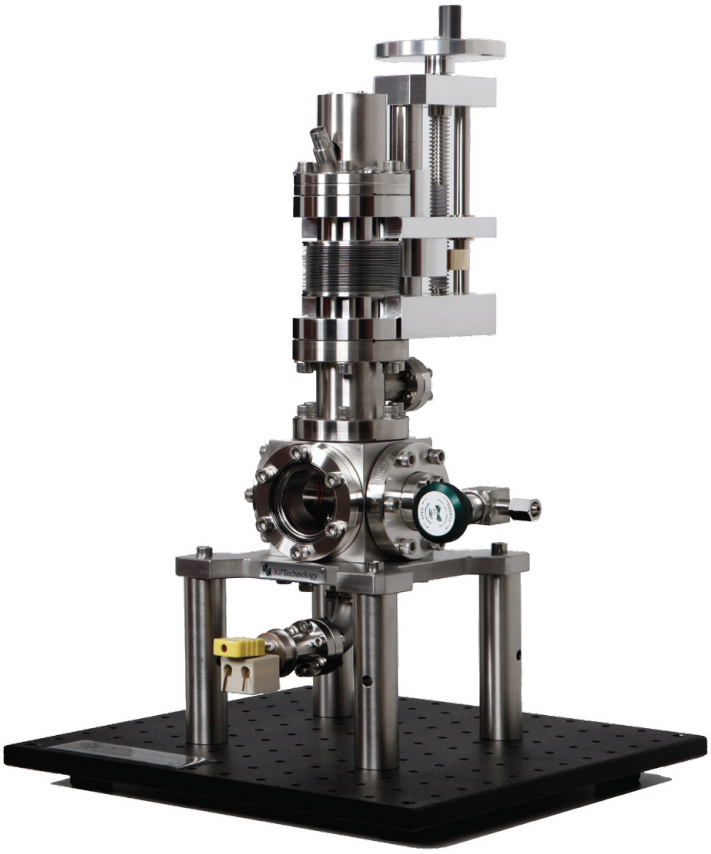
UHV Kelvin Probe Systems

UHVKP Corner Cube featuring UHVKP020

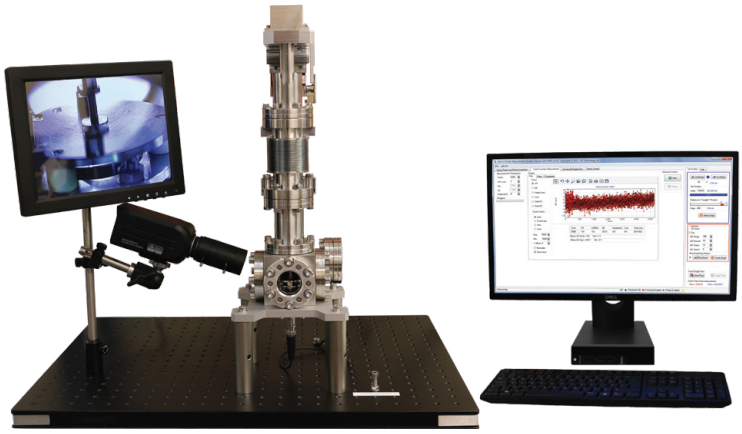
System Description

Our range of Ultra-high Vacuum Kelvin Probes gives the user the user full access to work function (Φ) or Volta potential (Δψ) and contact potential difference (CPD) measurements under vacuum. Each system comes with a high quality manual or motorized translator that enables reliable and accurate tip-to-sample positioning, and the unrivalled tracking system holds the tip separation constant at all times during the measurement. Even under these conditions, the work function resolution is 1-3 meV.
The dedicated software allows full digital control of all parameters to match the exact requirements of the sample under investigation. The recorded data is easily exportable to analysis software.

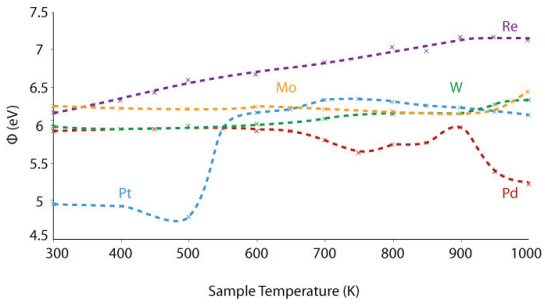
The UHV Kelvin probe can be mounted to the user's existing chamber or KP Technology Ltd offers an elegant UHVKP cell system (UHVKP corner cube) that can be used for ambient, UHV or gaseous measurements. This cell is completely modular and a host of additional extras can be added-on.



UHVKP corner cube system, mounted on breadboard. Cell with heater stage, gas inlet and Kelvin probe mounted vertically.



Example of our UHVKP corner cube system with camera and monitor highlighting the sample position.



Work Function of Metals versus Temperature under Vacuum I.D.Baikie et al. J. Vac. Sci. Technol. A 19.4, Aug 2001

Features

- Work function resolution of 1-3 meV
- Camera and monitor provided
- Gaseous or ambient measuring
- Modular system for upgrades and add-ons
- Automatic height regulation
- SPV, SPS and APS options available

Applications

- Organic and non-organic semiconductors
- Metals and metal alloys
- Thin films and surface oxides
- Solar cells and organic photovoltaics
- Corrosion e.g. protection and resistance

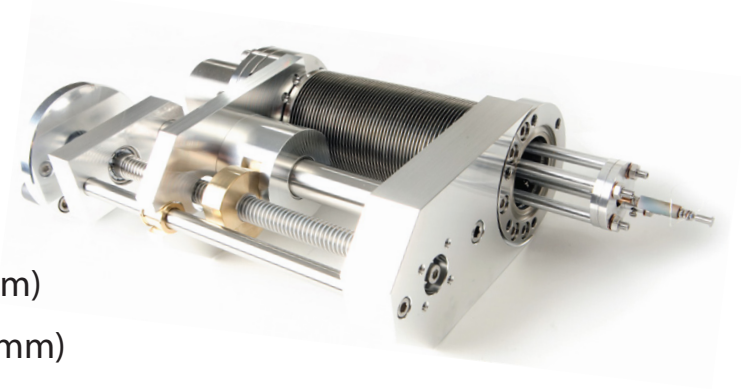
UHV Kelvin Probe Systems

UHVKP Corner Cube featuring UHVKP020

System Specifications	UHVKP020	UHVKP Corner Cube
Tip material/diameter	4 mm / 10 mm stainless steel tip (other diameters available)	
Work function resolution	1-3 meV	
Standard translator	50 mm manual translator	
Translator sizes possible	50 mm or 100 mm manual or motorised translators	
Height control (auto)	Approximately 1-5 mm by DC offset (unless motorised)	
Visualisation	Single-point work function / contact potential difference scans	
Oscilloscope	Digital TFT oscilloscope for real time signal	
Test sample	Available on request	
Control supplied	USB control with dedicated software	PC control with dedicated software
Detection system	Off-null with parasitic capacity rejection	
Mounting geometry	Normal to sample surface	
Mounting port	DN40 / CF70 (2.75 inch) OD	
Vacuum compatibility	2×10^{-11} mBar	
Flange to sample distance	User defined	
UHV cell	Not included	2.75" 6 port cell
Warranty	12 months	

Upgrades and Add-Ons

- Ambient Pressure Photoemission Spectroscopy
- Surface Photovoltage (QTH or LED)
- Surface Photovoltage Spectroscopy (400-1000 nm)
- Motorized or manual translators (50 mm to 100 mm)
- Heater stage and/or sample translation



Controlled gas Kelvin probe head with manual translator

The Company

KP Technology Ltd was founded with the aim of bringing to the market new surface research tools. These tools have featured in over 250 peer-reviewed client publications in the last 3 years. KP Technology Ltd also performs a significant amount of material research and training consultancy, mostly based upon the work function (Φ) or surface potential evaluation of client samples. KP Technology Ltd holds international patents on their Ambient Pressure Photoemission Spectroscopy (APS) system for measuring absolute workfunction. Along with a strong research and development division and over 500 systems shipped worldwide, this has placed KP Technology Ltd as the leading supplier of Kelvin probes in the world.

Contact

For quotation requests, further information or to discuss any research or particular measurements, please feel free to contact us:

Email: sales@kelvinprobe.com
Tel: +44 1955 602 777

Or visit our websites
www.kelvinprobe.com

KP Technology Ltd is the proud winner of the Queens Award for Enterprise: International Trade 2013

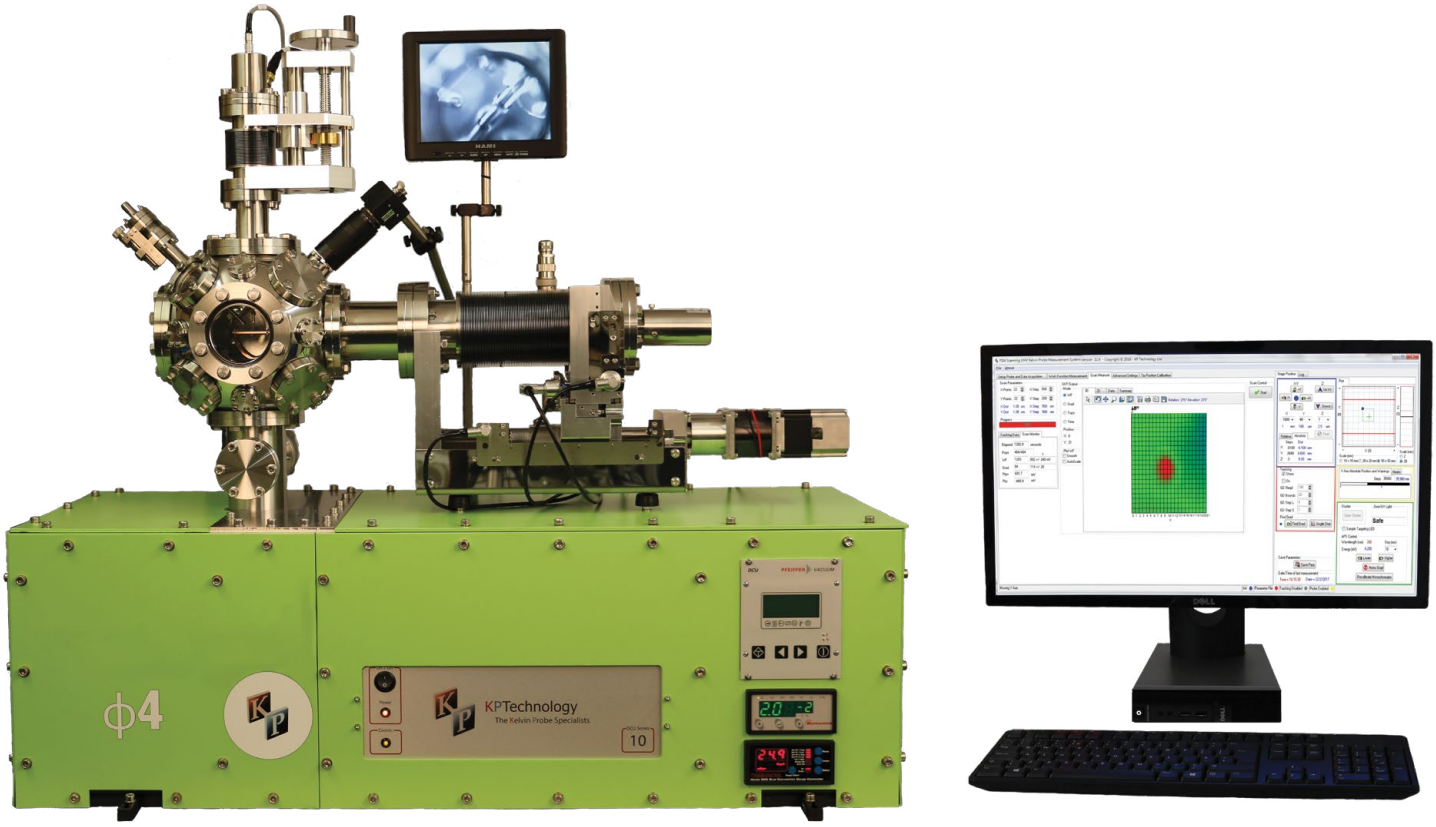
UHV Kelvin Probe Systems

Φ4

System Description

Our Φ4 Ultra-high Vacuum Scanning Kelvin Probe system gives the user full access to work function (Φ) or Volta potential (Δψ) measurements under vacuum with the ability to alter the temperature from 77 K to 860 K. The Kelvin probe measurement has resolution of 1-3 meV for a 2 mm tip on a conducting sample. The sample is mounted on a plate that is located on a motorized (x, y, z) translator attached to a stainless steel vacuum chamber. Φ4 also comes with a photoemission spectroscopy system with a tunable source (3.4 - 7.0 eV). The deep ultra-violet (DUV) light spot measures approximately 3 x 4 mm. Absolute work function measurements can be obtained with this system in the range of 4.0 - 6.5 eV with an accuracy of 0.05 - 0.1 eV.

The system can be upgraded with Surface Photovoltage Spectroscopy through utilising other ports in the system chamber. Liquid nitrogen is used as the method of cooling the sample and heating is achieved by controllable direct current . Nitrogen gas is used to displace the oxygen to facilitate the use of the photoemission system source. An optical breadboard is used to support the chamber and standard power is required for operation.



Φ4 Ultra-high Vacuum Kelvin Probe system with ambient pressure photoemission and surface photovoltage spectroscopy, heating, cooling and scanning capabilities

Features

- Work function measurement by Kelvin probe
- Work function resolution of 1-3 meV
- UHV, gas or ambient measuring
- Absolute work function measurements
- Heating and cooling from 77 K - 860 K
- Options of SPV or SPS

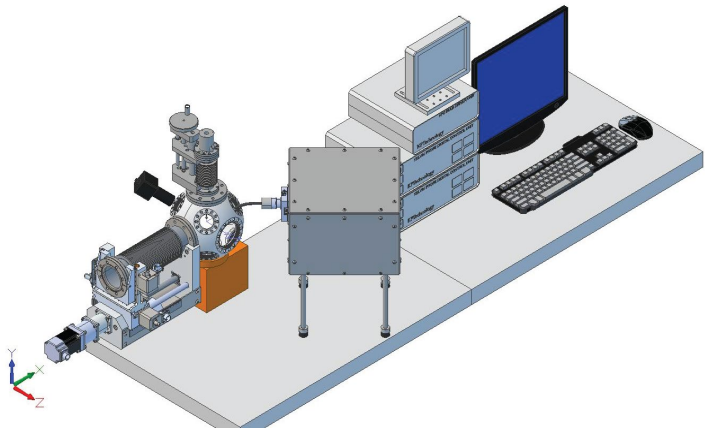
Applications

- Organic and non-organic semiconductors
- Metals/metal oxides/metal alloys
- Thin films
- Solar cells and organic photovoltaics
- Corrosion
- Diamond electronics

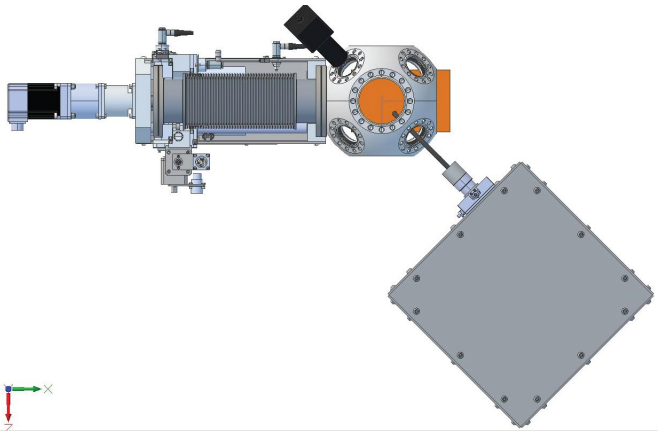
UHV Kelvin Probe Systems

Φ4

System Specifications	Φ4
Tip material/diameter	2 mm / 4mm / 10mm stainless steel tip
Work function resolution	1-3 meV
Manual translation	100 mm manual translator
Scan control	Automatic, via user interface - 20 x 20 mm
Sample stage	UHV compatible 3-axis motorised stage
Visualisation	3D maps of surface potential and sample topography
Oscilloscope	Digital TFT oscilloscope for real time signal
Pump	Turbo-molecular pump backed by rotary pump
Energy range (APS/SPS)	3.4 - 7.0 eV / 1.24 - 3.10 eV
Detection system	Off-null with parasitic capacity rejection
Mounting geometry	Normal to sample surface
Mounting port	DN40 / CF70 (2.75 inch) OD
Vacuum compatibility	$1x10^{-9}$ mBar
Flange to sample distance	User defined
UHV cell	DN63 spherical chamber (Kimball Physics)
Warranty	12 months



Technical drawing showing full layout of 4 system including light source,camera, control units and PC. Turbo-molecular pump not visible but attaches to base of system



Plan view showing motorized sample stage, spherical chamber and light source at 45°

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www.airphotoemission.com

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Surface Photovoltage Modules

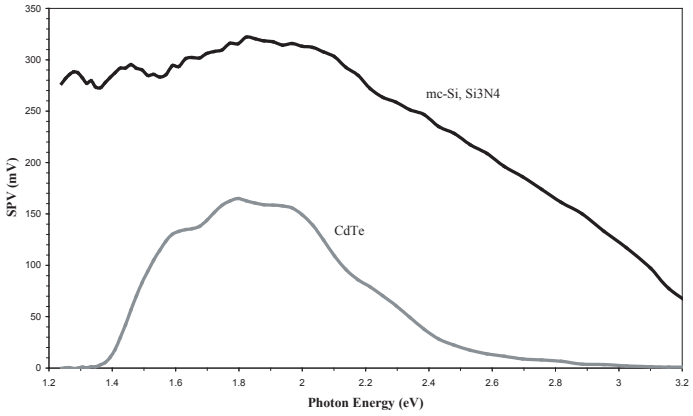
SPS030, SPS040

System Description

The surface photovoltage spectroscopy modules are the perfect all-in-one solution for in-depth studies of light sensitive materials such as organic semiconductors, solar cells or light sensitive dyes.

The modules offer a comprehensive range of measurement modes including DC and AC surface photovoltage studies utilising the built-in optical chopper.

Total digital control of all parameters including light intensity and wavelength (400-700 nm or 400-1000 nm) gives the opportunity to investigate and characterise the surface photovoltage and surface photovoltage spectroscopy properties of samples.



SPS response of mc-Si, Si_3N_4 and CdTe samples

Surface Photovoltage Spectroscopy SPS030 pictured with silicon solar cell sample

Features

- SPS030 - 400 to 700 nm range
- SPS040 - 400 to 1000 nm range
- Intense white light QTH source
- DC and AC measurement modes
- Compatible with all Kelvin probe systems

Applications

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

Surface Photovoltage Modules

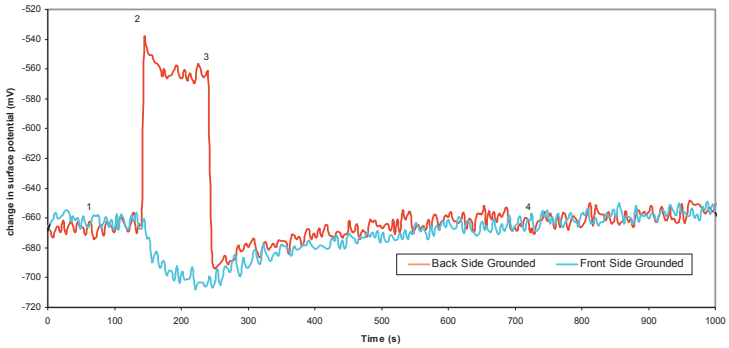
SPV020

System Description

The SPV020 module is the ideal upgrade to any of our Kelvin probe systems, for investigating light sensitive materials such as solar cells, light sensitive dyes and semiconductors.

Vary the light intensity of the 150 W DC regulated Quartz Tungsten Halogen (QTH) bulb to achieve open circuit potential or investigate the quality of your latest roll-to-roll silicon solar cells.

SPV020 is an extremely intense Quartz Tungsten Halogen light source that has a variable light intensity from software control.



FSE and BSE coated, defective, measured with SPV020 QTH light pulse

Quartz Tungsten Halogen SPV020 source and SPV010 LED source with electronics control box

Features

- SPV020 - QTH variable light source
- Intense light sources
- Automatic software control
- Variable intensity SPV measurement
- Compatible with all Kelvin probe systems

Applications

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