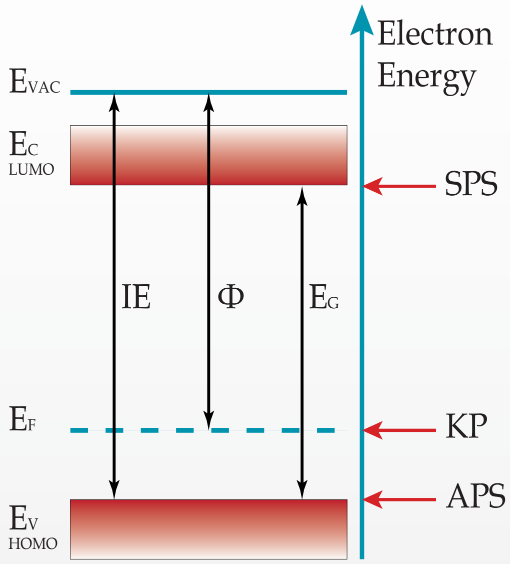
KPTechnology

Award-winning instrumentation for work function and energy level determination - E_F, E_V, E_G



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Introducing our latest innovation: APS04-N2-RH

Allowing measurement of material energy levels under nitrogen, controllable relative humidity or ambient conditions

Our latest APS04-N2-RH system incorporates a tuneable UV source from 3.4-7.0 eV, for **absolute work function** and highest occupied molecular orbital (**HOMO**) measurements, a surface photovoltage spectroscopy (**SPS**) module from 400 - 1000 nm for $\mathbf{V_{oc}}$ and $\mathbf{E_g}$ measurements, together with a 50 x 50 mm scanning area for relative work function measurements (**Fermi level**). The APS04-N2-RH allows absolute work function determination in the presence of a nitrogen blanket and/or 20-85% relative humidity. Our dedicated software allows the user full control of the energy scan range, tip potential, signal gain, signal integration time and averaging. Cube or square root fitting of the emission data over user selectable photon energy, normalised light intensity, baseline correction, LDOS vs. photon energy is also facilitated.

Client testimonials - APS04 system

"We are impressed with the performance of the custom built APS04 system from KP Technology. This equipment provides an accessible method to measure important energy levels in layers and complete devices. I am happy with all aspects of the technical support provided by company director Prof. Baikie and his staff."

Professor Arie Zaban
Vice President for Research and Development
Bar-Ilan University

"We find KP Technology's Ambient Pressure Photoemission System/APS04 extremely useful for determining the energy levels of OLED and solar cell materials."

Professor Ifor Samuel
Dean of Research
University of St Andrews

Recent client publications

KP Technology systems feature in 2 peer-reviewed client publications every week. Please visit our website for the full database of over 400 publications all using our equipment, and search for your application to see what product could suit your research: http://www.kelvinprobe.com/research.php

[1] An Investigation of the Energy Levels within a Common Perovskite Solar Cell Device and a Comparison of DC/AC Surface Photovoltage Spectroscopy Kelvin Probe Measurements of Different MAPBI3 Perovskite Solar Cell Device Structures, Susanna E. Challinger, Iain D. Baikie, Jonathon R. Harwell, Graham A. Turnbull and Ifor D.W. Samuel; MRS Advances, DOI: https:/doi.org/10.1557/adv.2017.72 (2017).

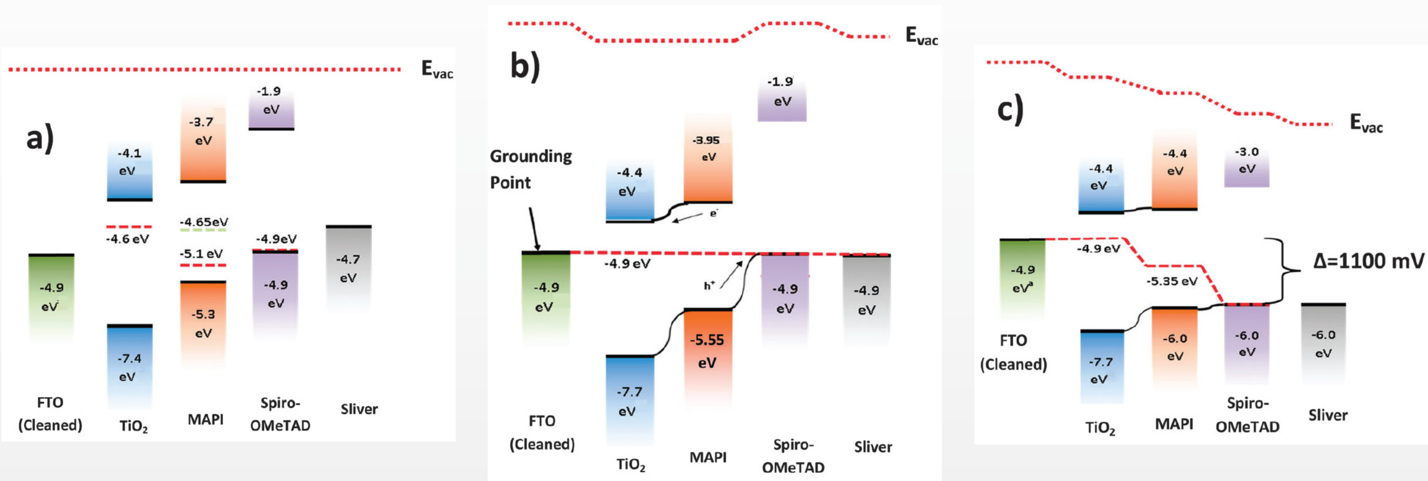
[2] Polyacetylene-based polyelectrolyte as a universal interfacial layer for efficient inverted polymer solar cells, Sungho Nam, Jooyeok Seo, Myeonghun Song, Hwajeong Kim, Moonhor Ree, Yeong-Soon Gal, Donal D.C. Bradley, Youngkyoo Kim; Organic Electronics, DOI: https://doi.org/10.1016/j.orgel.2017.05.012 (2017).

[3] Probing the energy levels of perovskite solar cells via Kelvin probe and UV ambient pressure photoemission spectroscopy, J. R. Harwell, T. K. Baikie, I. D. Baikie, J. L. Payne, C. Ni, J. T. S. Irvine, G. A. Turnbull and I. D. W. Samuel; Phys. Chem. Chem. Phys. 18 (29) 19738-19745 (2016).

[4] One-step synthesis of crystalline Mn2O3 thin film by ultrasonic spray pyrolysis, Adam Ginsburg, David A. Keller, Hannah-Noa Barad, Kevin Rietwyk, Yaniv Bouhadana, Assaf Anderson, Arie Zaban; Thin Solid Films, DOI: https://doi.org/10.1016/j.tsf.2016.06.050 (2016).

[5] Flexible light-emitting electrochemical cells with single-walled carbon nanotube anodes, Laura Martínez-Sarti, Antonio Pertegás, María Monrabal-Capilla, Evgenia Gilshteyn, Ilkka Varjos, Esko I. Kauppinen, Albert G. Nasibulin, Michele Sessolo and Henk J. Bolink Organic Electronics 30, 36-39 (2016).

Perovskite solar cell study



A summary of the energy levels of the materials in isolation from each other. Red dashed lines show the Fermi levels measured in isolation, while the green dashed line shows the Fermi level for $CH_3NH_3PbI_3$ (abbreviated to MAPI) when on a TiO_2 substrate. (b) The solar cell at open circuit in dark conditions-the vacuum level has shifted for each layer so that the Fermi levels are aligned. There is a potential gradient for electrons to flow to the TiO_2 and holes to the spiro-OMeTAD. (c) The cell under illumination – the vacuum levels shift until equilibrium is reached the band offset between the layers is flattened, removing the potential gradient for electrons and holes. The result is a Fermi level shift equal to the maximum open circuit voltage of the cell. These results were measured with a KP Technology APS04 system. [3]

KP Technology systems: Materials database v2.1/17

Material	HOMO/ E_V (eV)	E_F (eV)	Reference*
Ag	4.59-4.60	4.69-4.72	[1-3]
Ag nano-network		5.06	[4]
Al	3.58-3.65	3.36	[1, 2]
Au	4.8	4.83-5.06	[1, 2, 5]
AZO / ITO		4.4	[6]
C16IDT-BT	5.15		[7]
C8-BTBT	5.04		[7]
C8-BTBT:C16IDT-BT 0-5% C60F48	5.1	4.3-5.0	[7]
Carbon Single Walled Nanotubes (SWCNTs)	4.69		[8]
Cu	4.45	4.5	[2]
CuO thin film (annealed in vacuum 30 mins)		4.80-4.88	[10]
CuO	4.8	4.6-4.68	[10, 11]
CuSCN	5.35		[12]
Fe	4.4	4.41	[2]
FeS		5.74	[13]
FTO		4.9	[14]
Graphene	4.9	4.2-5.3	[11, 16, 17]
Graphene Doped with VOx		5.65	[17]
Graphene Oxide / Ag nano-network (0-80 µmol NaBH4)		4.65-5.12	[4]
Graphene Oxide Reduced Nanosheets (rGO)		4.74-5.00	[16, 18]
HOPG	4.79	4.61	[2]
ITO (with and without O2 or Argon Plasma)		4.24 - 5.14	[4-6, 21-25]
MAPBI3		4.30-4.32	[26-28]
MAPBI3 (Dilute tBP Treatment)		4.93	[28]
MAPBI3 (on TiO2, FTO)	5.3	4.7-5.1	[14]
MAPBI3 (pyridine treated)		5.21	[27]
Mn2O3	5.8	5.12	[29]
MoO3 / ITO		5.3	[22]
MoS2 (RF plasma 30/50W, without plasma)		5.06 - 5.4	[30]
Ni	4.2	4.18	[2]
PBDTTPD	5.15		[12]
PbS-EDT 1.12-1.38 eV (6 layer, 1 ligand)		4.84-4.87	[31]
PbS-TBAI 1.38 eV (6 layer, 1 ligand)		4.79	[31]
PEDOT:PSS	5.00	5.0-5.25	[12, 22, 32-34]
Phen-NaDPO (15mm/s) / AZO or ZnO / ITO		3.83-3.92	[6]
Phen-NaDPO (5-25mm/s) / ITO		4.01-4.51	[6]
Pt		5.65	[13]
PTFE / ITO		5.15	[22]
Sb2O3/Ag/Sb2O3 (SAS structure)		5.1	[35]
Si (native-oxide 22Ωcm-1, n-type)	5.15-5.17	4.31-4.33	[1, 11]
Sn3N4	5.9	4.7	[36]
SnO2		4.53-5.45	[3, 15, 18, 23]
Spiro-OMeTAD (on FTO, MAPBI3)	4.9	4.9	[14]
SWCNTs / PEDOT:PSS	4.85		[8]
Ti	4.07	3.94	[2]
TiO2 (on FTO)		4.6	[14]
TiO2 Mesoporous (Black) Nanosheets (M(B)TNs)		5.37-5.42	[37]
TiO2 Nanoparticle Films		4.43	[38]
TiO2 Nanoplates (Hydrogenated)/N-doped (N(H)TA)		5.17-5.26	[39]
TiO2 Nanotubular Array (+ D Peptide Coating)		4.55-4.63	[40]
Vanadium Oxide (solution processed, s-VOx)		5.3	[41]
Zn	3.52	3.49	[2]
ZnMgO		4.5	[42]

* See overleaf for full reference list

KP Technology systems:
Materials database v2.1/17 references

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