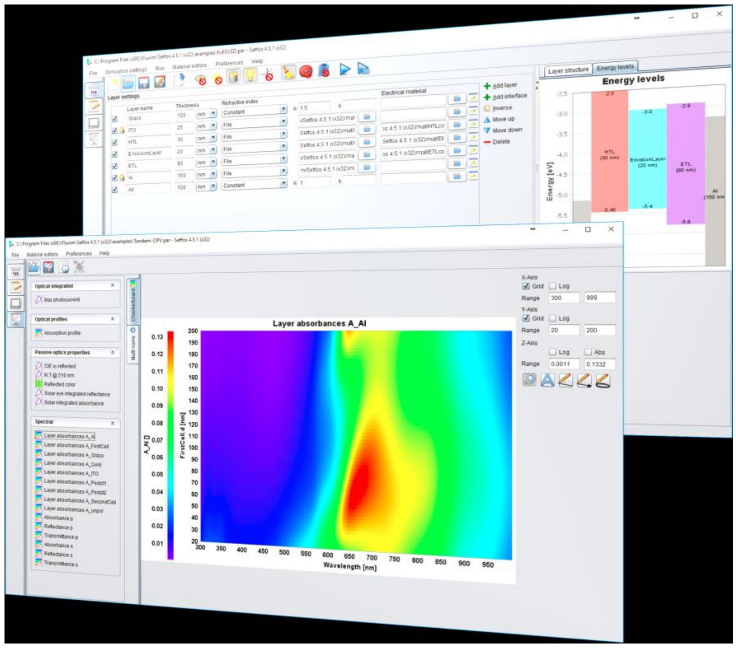
FLUXiM

https://www.fluxim.com

202001

Setfos

世界上最先进的OLED/OPV/PSC模拟软件，被广泛的应用在全世界的面板制造商和新型太阳能电池研究单位,并获得各界的认可！



Paios

多功能有机光电量测系统,整合稳态、瞬态以及交流阻抗多种量测技术,是OLED/OPV/PSC研究人员最佳的量测工具！

- Charge Extraction
- Photo-CELIV
- Capacitance-Voltage
- IMPS / IMVS
- Impedance Spectroscopy
- MELS
- Current-Voltage-Luminance
- Emission Spectrum
- Transient Electroluminescence
- Transient Photocurrent
- Transient Photovoltage
- User-Defined Signals

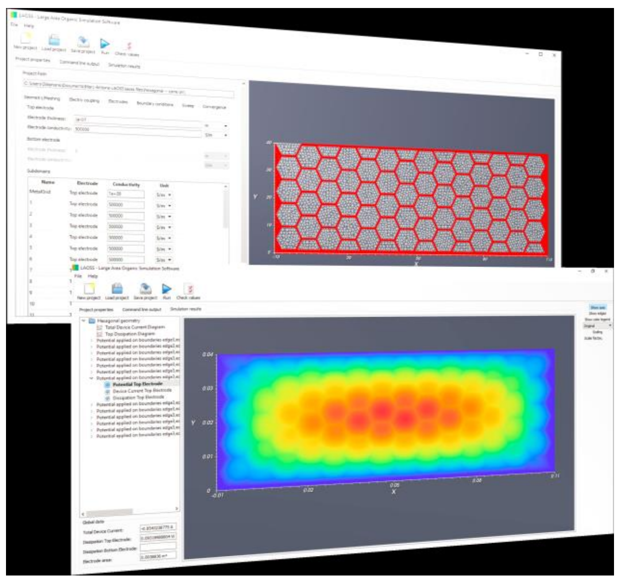
LAOSS

用于大面积OLED/OPV/PSC器件的模拟软件

1、Electrical Module 电模块

2、Thermal Module 热模块

3、Optical Module 光模块



Phelos

OLED专用量测设备，可量测获得

1、不同角度下的发光光谱和颜色

2、OLED器件IVL特性, EQE, lm/W, Cd/A

3、结合Setfos软件提取有机材料分子方向性和分子分布情况

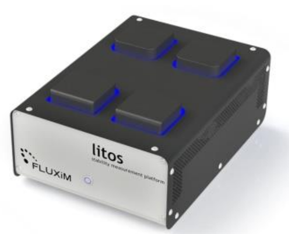
4、有机材料的PL与器件的EL

Litos

太阳能电池和OLED

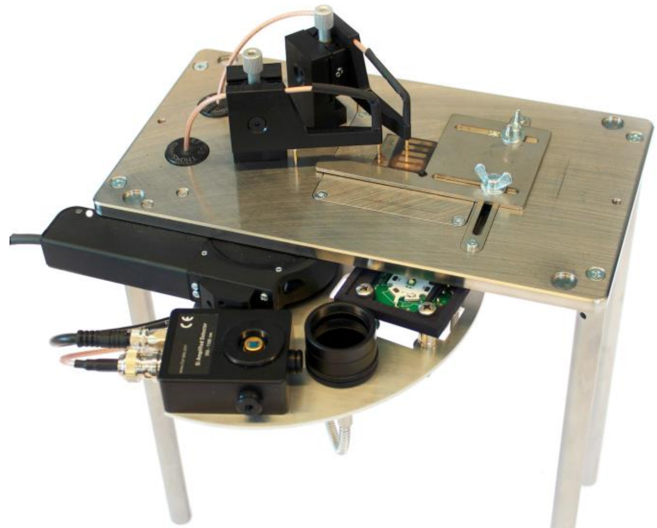
稳定性寿命测量系统

并符合ISOS全部标准



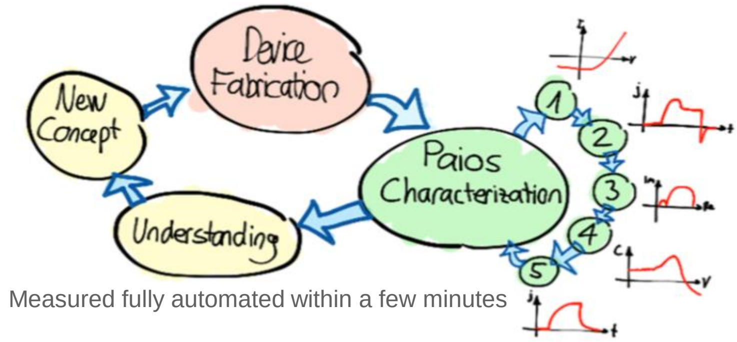
Paios

Paios自动量测台及各项功能



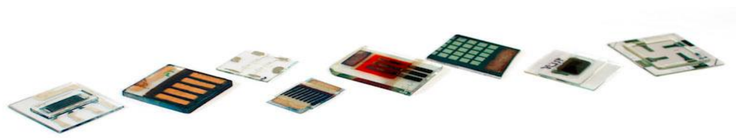
Paios自动测量台：
可以根据测试项目自动旋转

Paios Research Cycle



系统规格：
采样率：60MS/S　　　　时间解析度：16ns
测试电压：±10V（标准规格），±60V（选配）
测试频率：10mHz~10MHz　　最小可解析电流：<100pA
量测分辨率：12Bit　　　　量测时间：100ms

适用器件：
钙钛矿/有机/量子点等混合式太阳能电池
染料敏化电池
OLED，LEC，单载子器件，金氧半器件

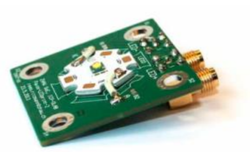


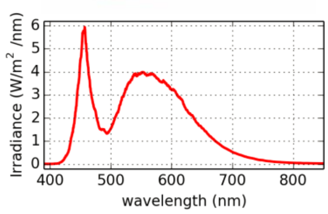
The automated measurement table **automatically switches** between measurement instruments and light-sources. The default configuration is equipped with:

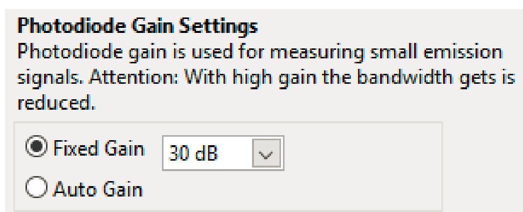
- LED light source
- Photodetector
- Spectrometer
- Empty space for existing sun-simulator

LED光源：
LED上升时间：100ns
LED光照面积：1.7cm²
LED驱动电流：100mA
LED颜色：白光

光探测器：
增益：0dB-70dB手动可调
探测面积：13mm²
探测光谱范围：350nm-1000nm
自动增益（**选配**）：通过软件控制







For Solar Cell Research

A **sun-simulator can be placed below the** measurement table. When Paios moves away the instruments, the cell is illuminated by the sunsimulator and the power conversion efficiency is determined. Measure transient electroluminescence, the EL spectrum and all classical experiments with an LED. Everything automated. Everything with one click.

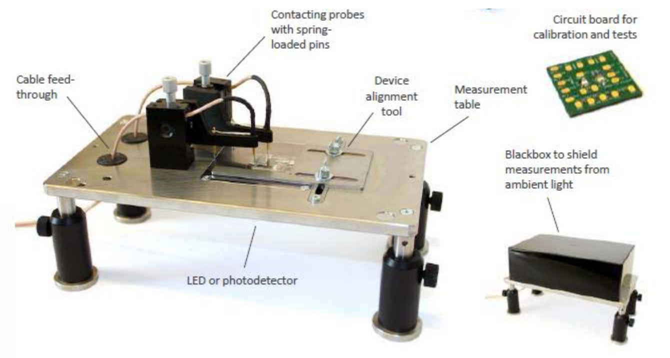
光谱仪（选配模块）：
光谱范围：360nm-1100nm　　积分时间：1ms-10min
可以获得OLED参数：luminance, radiance, EQE, lm/W, CRI, CIE coordinates

For OLED Research

Measure the OLED spectrum and transient electroluminescence without changing manually the measurement instrument. Using a blue or UV LED Paios can also measure photo-responses of OLEDs.

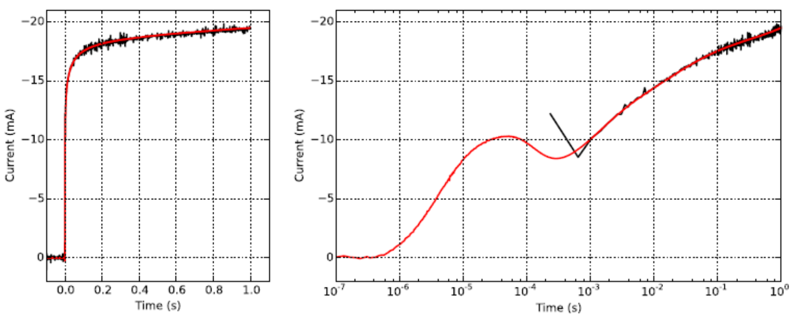
Paios

Paios软,硬件特殊功能



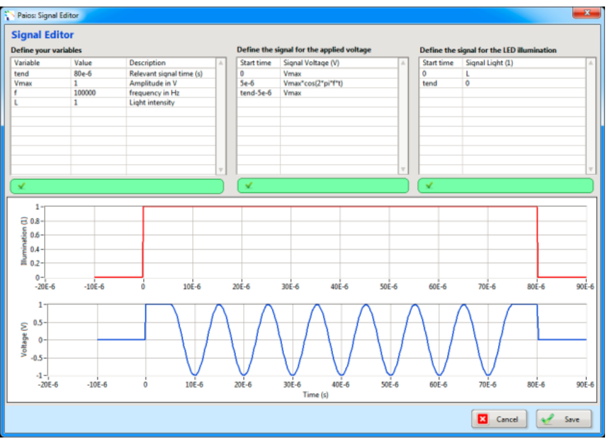
高集成度的硬件设计，测量台以及探测探针可以灵活控制便于用户测量不同大小的样品以及不同电极设计的样品

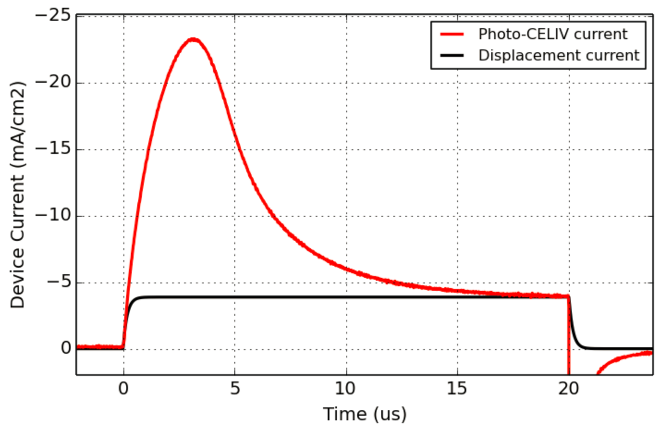
Flexible Time-Resolution



Transient photocurrent of a perovskite solar cell with linear time scale (left) and logarithmic time scale (right).

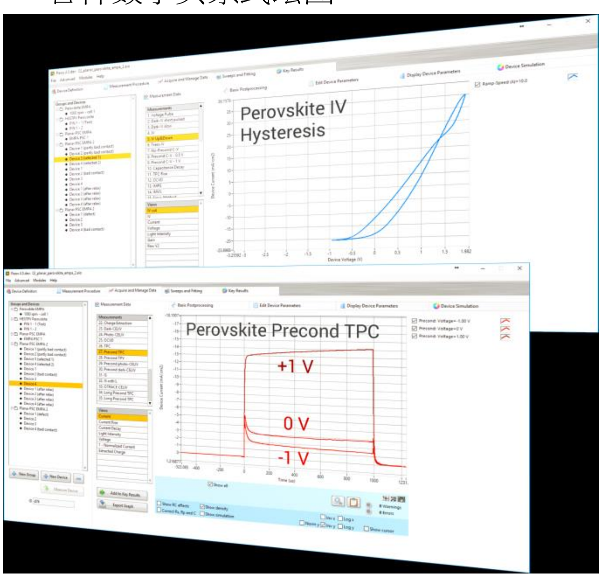
灵活的时间选择，用户可以利用**Paios**提供8个数量级时间跨度，测试钙钛矿电池TPC信号

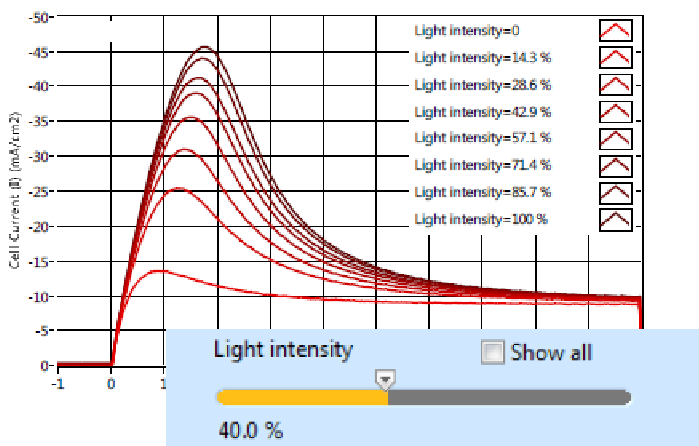




除了常用的测试信号用户可以通过公式自己制定任意波形测试电压，光强信号。用户可以对量测结果进行log，ln，exp，sin，x^2，1/x，$1/x^2$，√x，1/ √x，1-x，$1-x^2$各种数学关系式绘图

由于薄膜器件普遍存在RC效应，对于新型瞬态量测技术一般产生明显的干扰，**Paios**具备提取Rs串阻，Cgeo几何电容程序，进一步计算位移电流经过RC效应的修正而获得正确的电流。





可以随时对器件进行预处理，钙钛矿电池在**Paios**预先偏压条件下呈现更稳定，重现度高的量测结果，另外IV曲线也随本身内部条件可能呈现迟滞现象，所以需要预处理才能量测想要的信号。

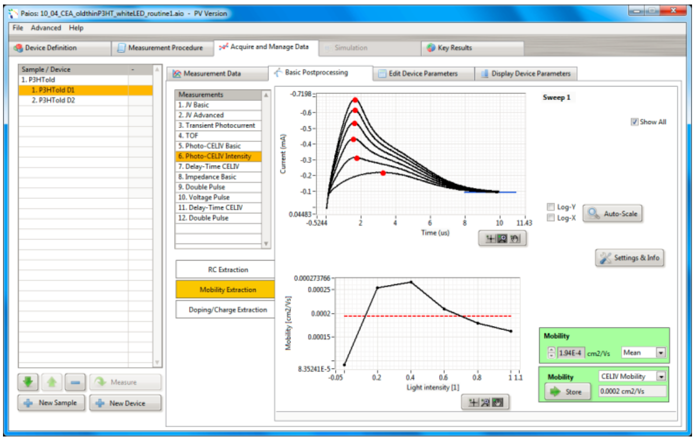
Paios可以进行参数扫描量测，一次性量测得到不同参数下的量测结果；

Paios不仅是Steady state稳态，Transient瞬态，AC交流信号等多合一自动化功能超强量测仪器，更具备测试资料管理，结果比较，输出高品质eps，png，ms-word，PDF等格式可以用于出版的结果资料

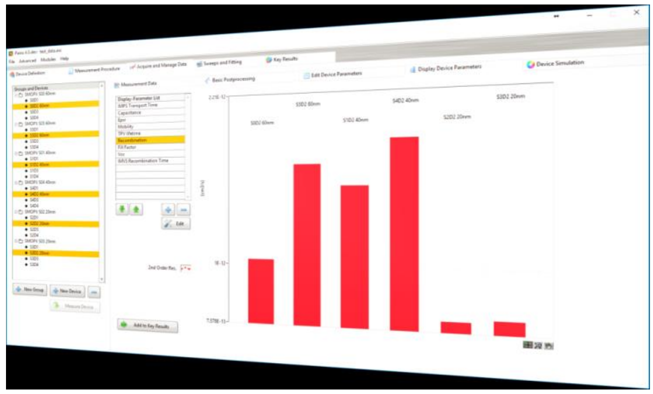
Paios

Paios强大的数据后处理拟合功能

Charge Carrier Mobility from CELIV

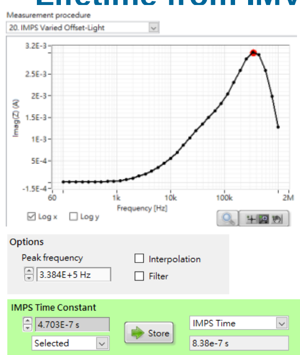


Extract the charge carrier mobility from **CELIV** experiments. The user can choose between several formulas to evaluate the mobility.



不同器件在不同量测技术下的量测结果可以在Paios软件内直接比较

Transport-Time from IMPS
Lifetime from IMVS



The peak frequency of the imaginary part of the IMPS signal is related to the IMPS time constant (τ_{sc}). It is an effective value of the combined processes of charge collection and charge recombination at short circuit:

$$\tau_{sc} = \frac{1}{2 * \pi * f_{max}} \Rightarrow \frac{1}{\tau_{sc}} = \frac{1}{\tau_{rec}} + \frac{1}{\tau_{cc}}$$

The peak frequency of the imaginary part of the IMVS signal is related to the IMVS time constant (τ_{oc}). As IMVS is performed at open circuit conditions the time constant is the recombination time constant:

$$\tau_{oc} = \frac{1}{2 * \pi * f_{min}} = \tau_{rec}$$

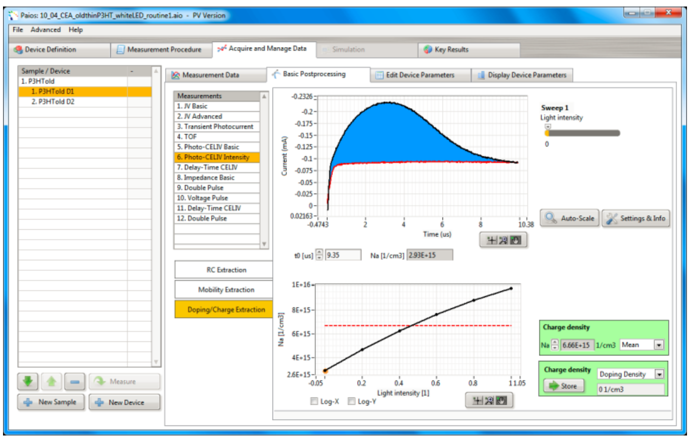
The peak can be extracted more accurately by interpolating between the data points, it is also possible to use a smoothing filter.

The IMPS and IMVS time constant are further related by the charge collection efficiency, which is automatically calculated as a device parameter:

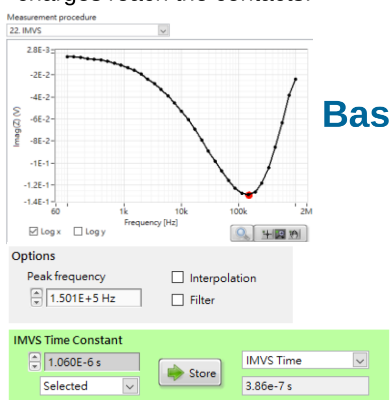
$$\eta_{cc} = \frac{J_{sc}}{J_{inj}} = \frac{J_{sc}}{J_{sc} + J_{rec}} = \frac{1/\tau_{cc}}{1/\tau_{cc} + 1/\tau oc} = 1 - \frac{\tau_{sc}}{\tau_{oc}}$$

Easily determine the transport time from IMPS that describes how fast charges reach the contacts.

Doping Density from CELIV

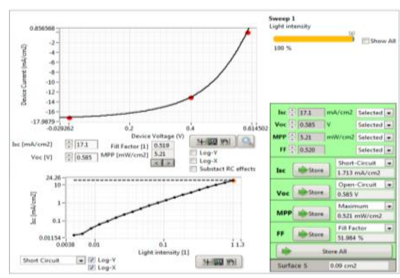


The dark-CELIV current overshoot (shown in blue) is integrated to obtain the doping density.



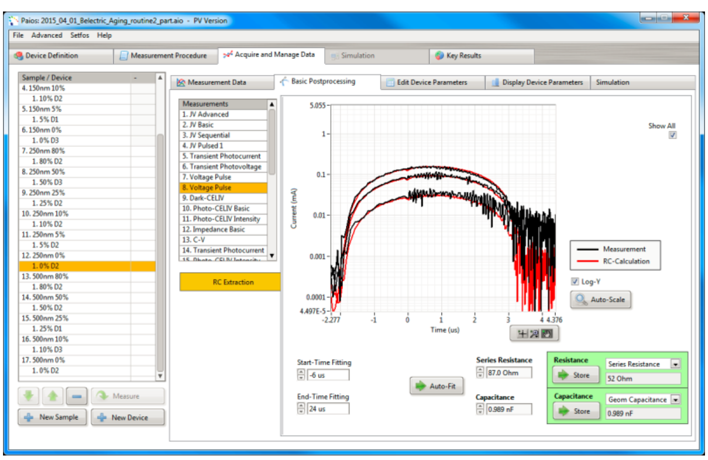
From IMVS the charge carrier lifetime is determined.

Basic Solar Cell Parameters



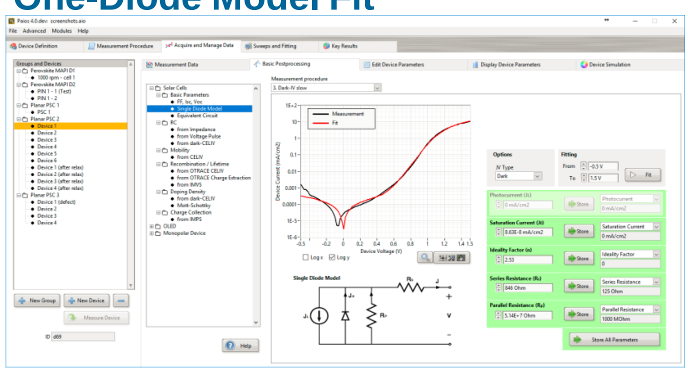
Extracts short-circuit current, the open-circuit voltage, the fill factor and the maximum power point of a solar cell

Series Resistance and Permittivity from Voltage-Pulse



Determine the permittivity/capacitance and the series resistance from **a small voltage pulse** in reverse

One-Diode Model Fit

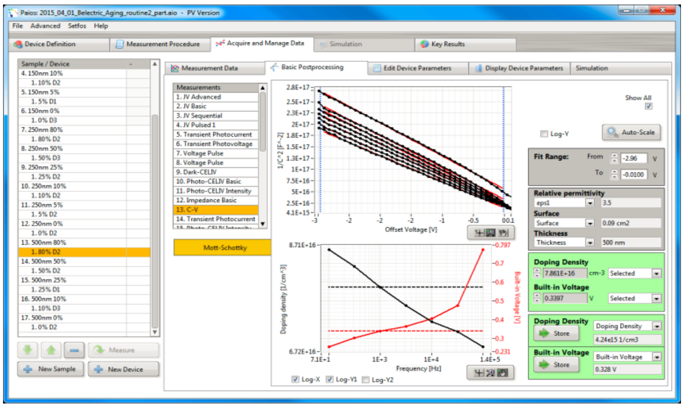


Extract the parameters of the one-diode model for solar cells: ideality factor, dark saturation current, series resistance and parallel resistance.

Paios

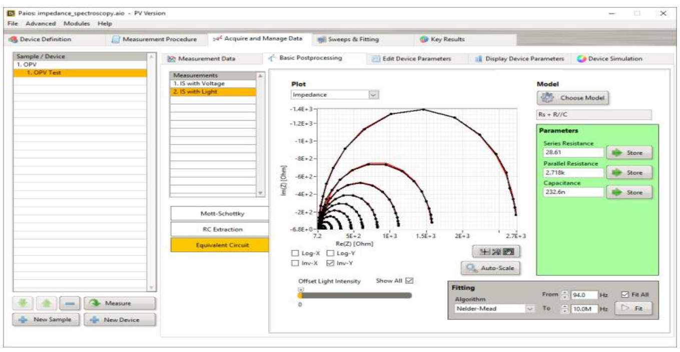
Paios强大的数据后处理拟合功能

Mott-Schottky Doping Density from CV



With a Mott-Schottky analysis the doping density of a semiconductor can be extracted from CV measurements (provided the device is thick enough).

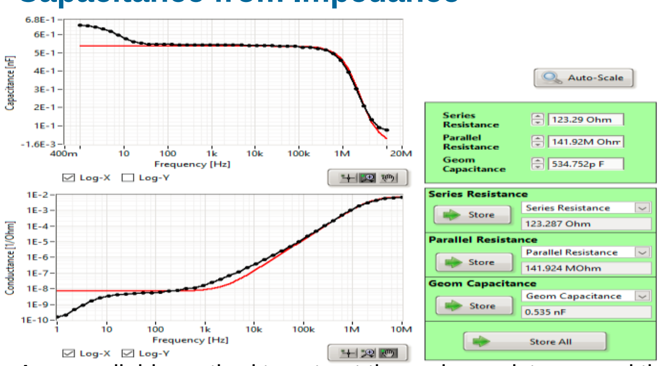
Equivalent Circuit Fitting



The most popular way to analyze impedance spectroscopy data is equivalent circuit fitting. **Paios** has integrated a routine for such fits.

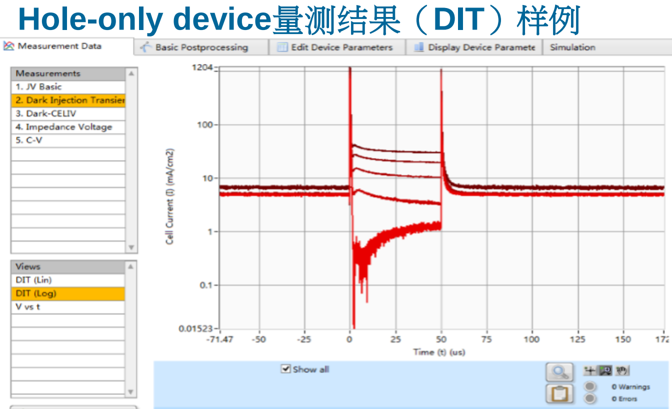
User-defined or pre-defined circuits are available.

Series Resistance and Geometric Capacitance from Impedance

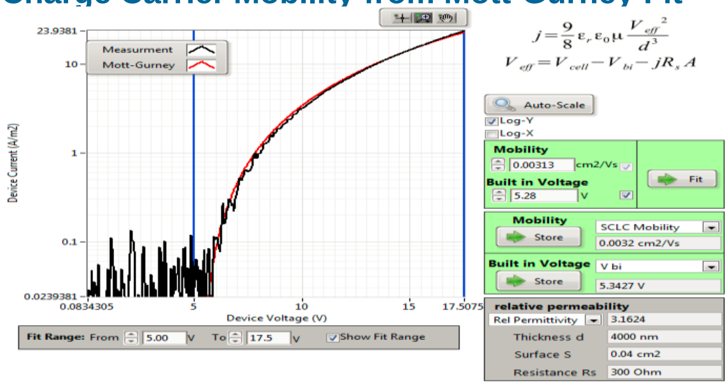


A very reliable method to extract the series resistance and the geometric capacitance from impedance spectroscopy data

Hole-only device量测结果（DIT）样例

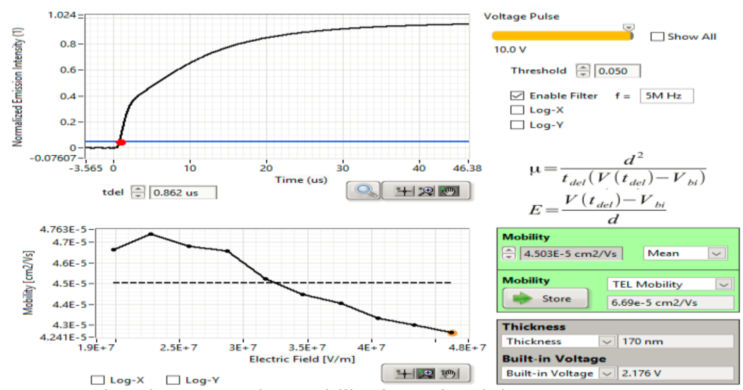


Charge Carrier Mobility from Mott-Gurney Fit



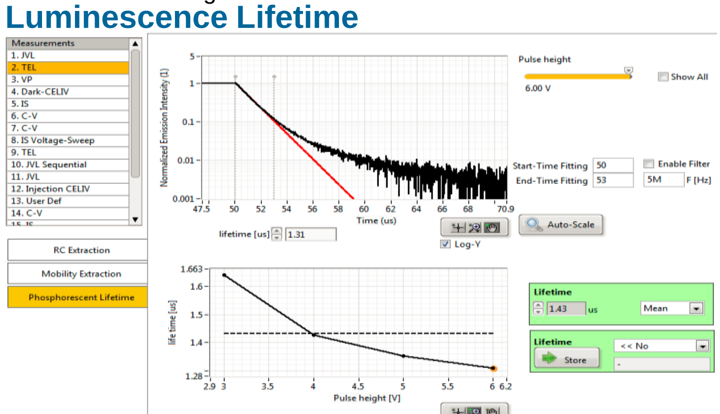
In monopolar devices the charge carrier mobility can be extracted from an IV-curve using a SCLC-fit.

Mobility from Transient Electroluminescence



Extracts the charge carrier mobility from the delay time between voltage and EL turn-on.

Luminescence Lifetime

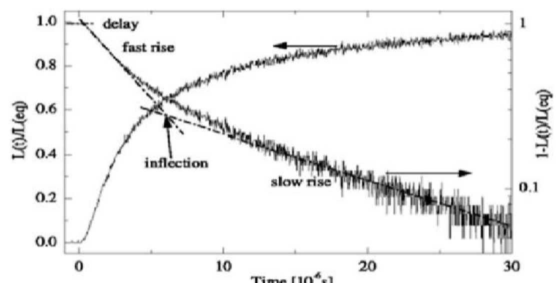


From the electroluminescence decay after voltage turn-off the luminescence lifetime of the emitter can be extracted.

TEL曲线进一步分析

Sensing electron transport in a blue-emitting copolymer by transient electroluminescence

Sebastian Bange, Andriy Kuksov, and Dieter Nehera Physik weicher Materie, Universität Potsdam, Am Neuen Palais 10, 14469 Potsdam, Germany



swiss made

Paios

SPI--Setfos与 Paios结合：唯一的参数提取，扫描优化拟合功能

Numerical simulation helps to understand your measurement results.Therefore we integrated our simulation software **Setfos** seamlessly into the **Paios** software

- Perform simulations of all **Paios** experiments
- Simulate **OLEDs** and **solar cells**
- Compare simulation and measurement directly in the **Paios** software
- Use our **global fitting** routine to extract device and material parameters
- Easy-to-use software interface

SPI：基于强大数据库及坚实模型，Setfos已经成为有机光电OLED产业以及OPV有机太阳电池研究领域专用软件，Fluxim公司将Setfos 与Paios Integration（SPI）更是极有效辅助了许多传统测试技术无法达成的功能，如器件优化验证，老化机理了解掌握，等效电路拟合，参数提取R_s，R_p，C_{geo}，掺杂浓度，各种载子迁移率提取技术SCLC/TPC/CELIV/TEL/DIT，载子寿命IMPS/IMVS/TPV，复合系数，电池各种电性参数Isc/Voc/FF/Pm，电荷提取CE，二极管模型理想因子，暗电流，介电常数等.

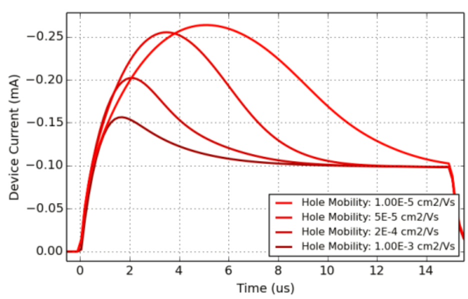
Parameter Extraction

Use the **Setfos-Paios Integration** to **extract** device and material parameters**:**

- electron and hole mobilities
- recombination coefficients
- charge injection barriers
- built-in voltage
- doping densities
- trap depth
- trap density
- permanent dipole moments
- series resistance
- parallel resistance
- electrical permittivity
- ....

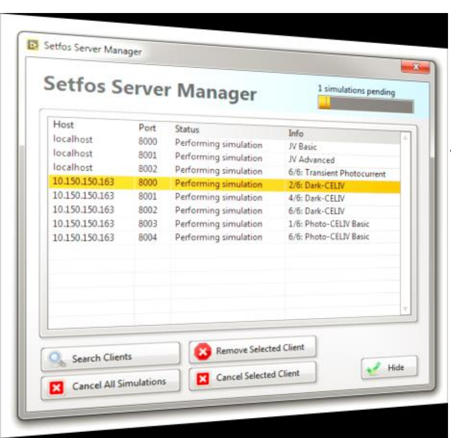
How Does a Material Parameter Influence an Experiment?

Use drift-diffusion simulation to analyze the influence of certain material parameters on an experiment. Easily **sweep** a simulation parameter to understand its influence.



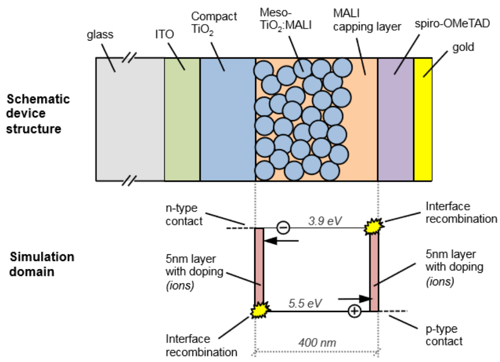
Simulation of a photo-CELIV experiment with varied hole mobility.

Distributed Computing

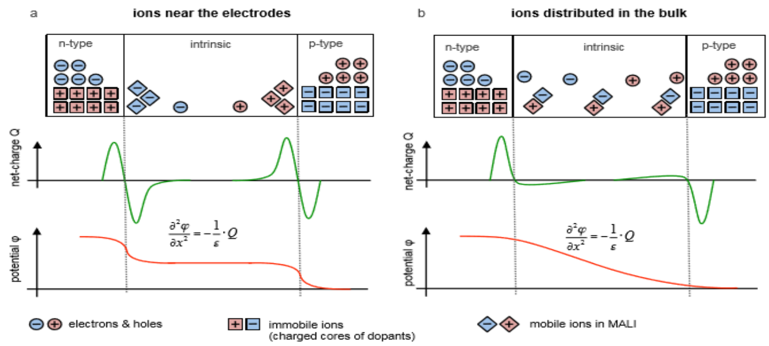


With **the Setfos-Paios Integration** calculations can be distributed on different computers over the network.
Save time by running simulations in parallel on different computers

Setfos Paios Integration分析鈣鈦矿离子移动效应



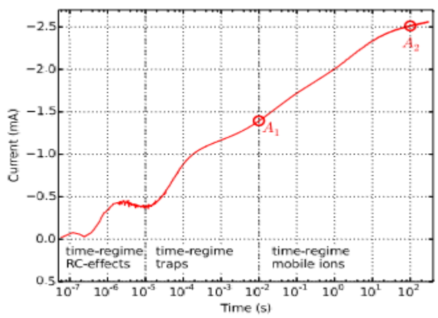
Device structure and simulation domain. The perovskite layer MALI and the mesoporous TiO2 is simulated as one effective medium with one electron and one hole transport level.



Schematic illustration of the effect of mobile ions on the potential. a) Ions are close to the interfaces and screen the electric field inside the bulk. The band is therefore flat. This is the state in the dark. b) Ions are distributed in the bulk and compensate each other. The potential drops over the whole intrinsic region leading to efficient charge extraction.

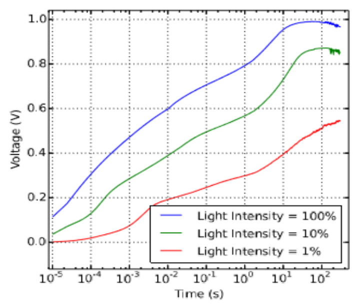
Paios Filexible time resolution 8 orders scale

Transient Photocurrent (TPC)



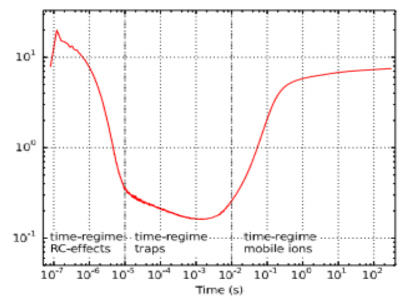
transient photocurrent (TPC) measurement of a perovskite solar cell. The LED light is turned on at t = 0 with an intensity of approximately one sun. The applied voltage is V(t) = 0V. A1 and A2 mark two states of the solar cell

Transient Photo-voltage (TPV)



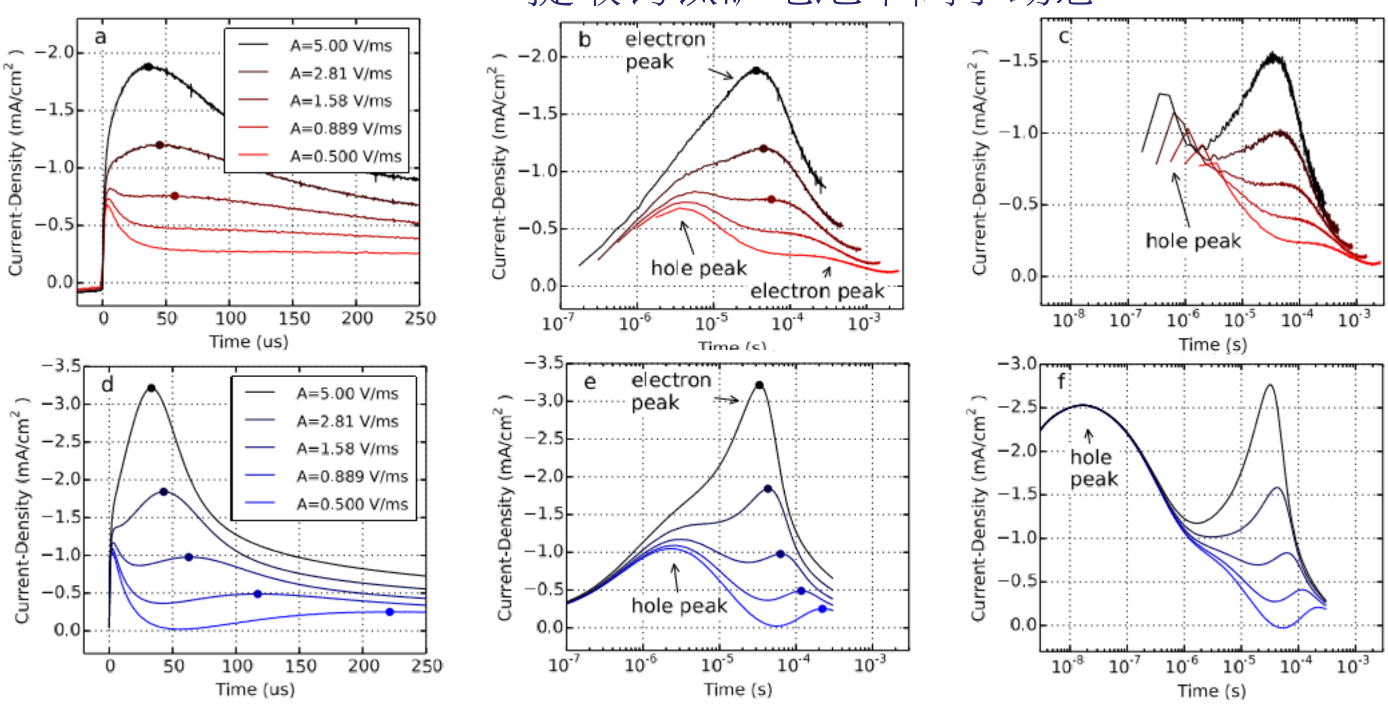
transient photo-voltage (TPV) rise for three different light intensities.

Current+Response As voltage pulse



Current response to a voltage step in the dark with V = 2V. The first regime is governed by RC effects, the second by space charge effects due to imbalanced charge mobilities and traps. The third regime is governed by mobile ions.

Photo-CELIV提取钙钛矿电池中离子动态



Measured photo-CELIV currents with 5 different ramp rates A in linear (a), in logarithmic time scale (b) and with correction of RC effects (c). The circle marks the second current peak. Setfos drift-diffusion simulations in (d), (e) and (f) respectively.

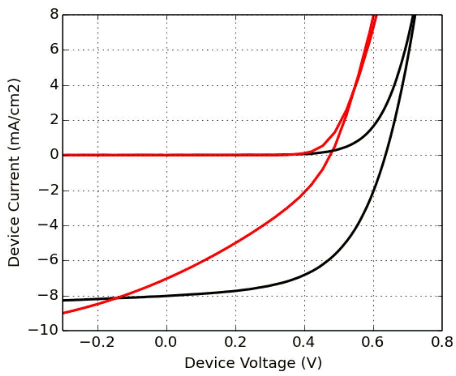
Paios

SPI--Setfos与Paios结合：唯一的参数提取，扫描优化拟合功能

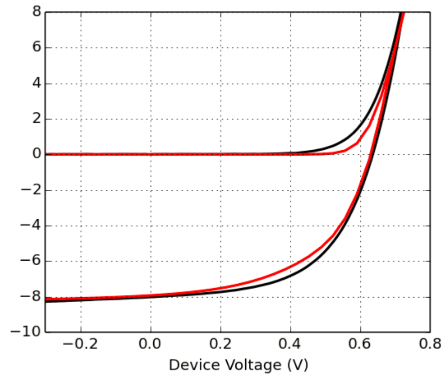
What is Fitting?

Fitting is a process where simulation parameters are adapted such to bring measurement and simulation result in agreement.

Fitting is used to extract parameters from experimental results.



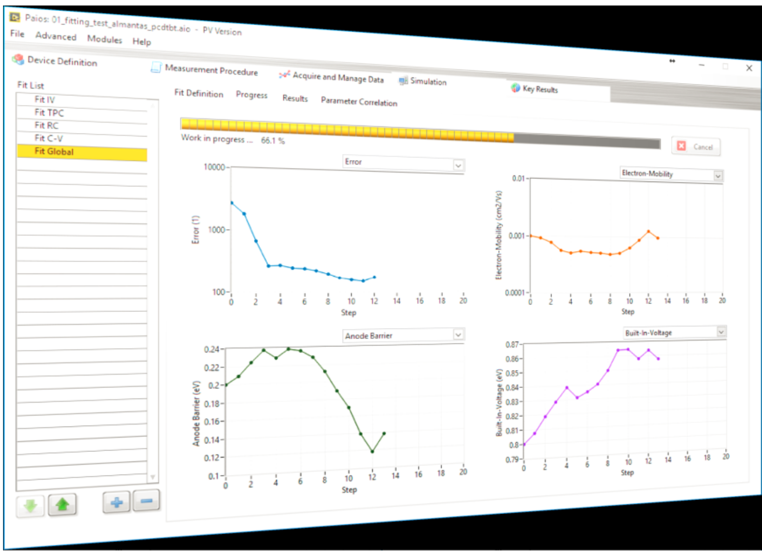
IV-curve simulation (illuminated and dark) with initial parameter-set.



IV-curve simulation (illuminated and dark) after fitting.

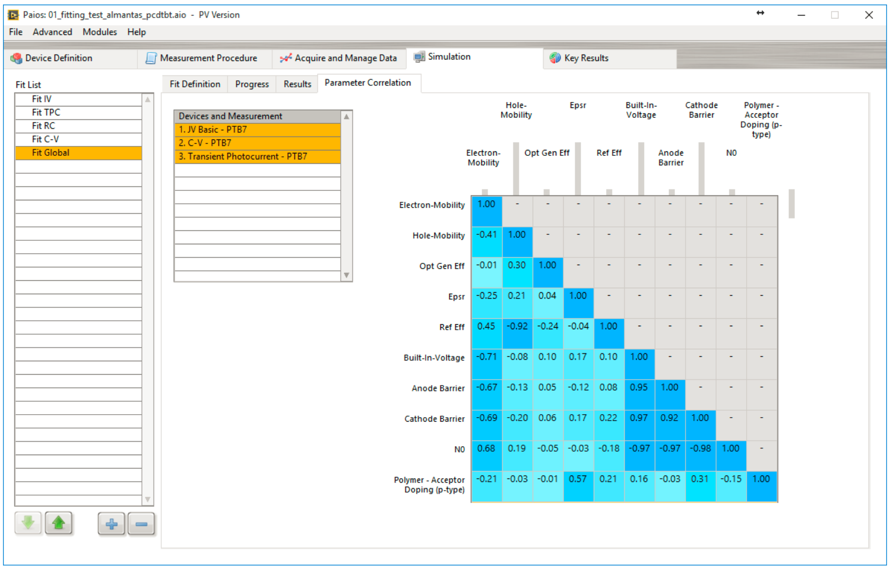
Global Fitting of Experimental Results

If more than one experiment type is fitted simultaneously, this is called global fitting. The **Paios** software optimizes parameters in order to fit several experiments.
The user defines the targets (what to fit) and the parameters to optimize. The software does the rest.
Use global fitting to extract device and material parameters reliably and with **increased accuracy.**



What is Parameter Correlation?

Global fitting功能使得**Paios**可以实现对多于一个参数的同时拟合**fitting**，然后自动计算给出这些参数之间的相关性**Parameter Correlation**
并以矩阵的方式呈现给使用者。
通过相关矩阵使用者可以判断提取出来的参数是否可靠！
当两个参数相关性很强时意味着他们对模拟结果有着相同的影响效果此种情况下提取出来的参数就不是唯一的,可靠性不高！

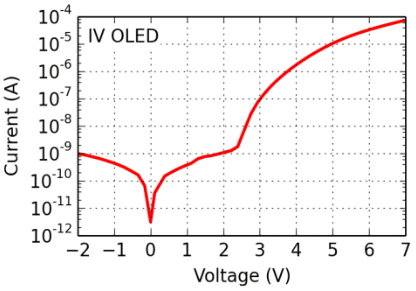


Additional Measurement Features:
DLTS-Deep Level Transient Spectroscopy
OCVD-Open Circuit Voltage Decay
OTRACE-Open Circuit Corrected Charge Carrier Extraction
DCM-Displacement Current Measurement

Paios

Paios与众不同的量测技术

IV – Current-Voltage Characteristics



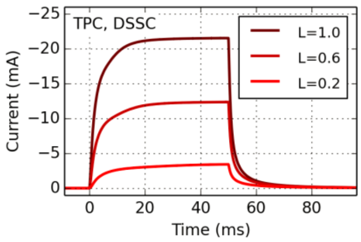
I-V特性曲线是OLED器件或者OPV器件最常见的量测技术. OLED器件除了I-V特性量测之外也会量测发光也即是 I-V-L曲线

Available Post-processing Routines

- Extracting the emission onset voltage of an OLED
- Extracting the mobility of a monopolar device from Mott-Gurney analysis (SCLC)
- Extracting the parameters of the one-diode model
- Extracting FF, Isc, Voc and MPP of a solar cell

- Voltage range -10 V to +10 V
- Current resolution < 100 pA
- For solar cells and OLEDs

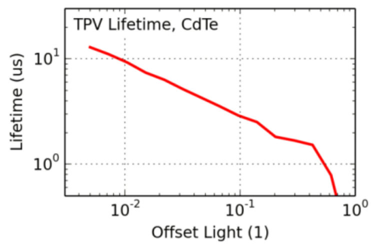
TPC – Transient Photocurrent



TPC量测技术量测瞬态光电流，主要用于量测有机太阳能电池. 通过TPC上升曲线和下降曲线可以得到载流子移动率Mobility，以及研究器件的trapping动态等.

- Pulse length: 1 μs to 1000 s
- Offset voltage -10 V to +10 V
- For solar cells

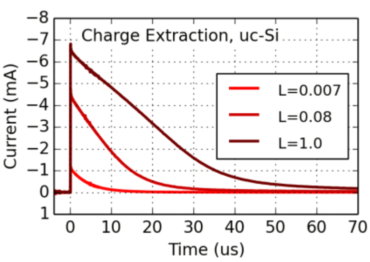
TPV – Transient Photo-voltage



与TPC量测技术类似，也是量测器件在光脉冲下的相应，主要用于量测有机太阳能电池. 次量测技术中有机太阳能电池处于开路状态。通过**TPV**下降曲线可以得到载流子lifetime

- Automatic calculation of the charge carrier lifetime
- For solar cells

CE – Charge Extraction



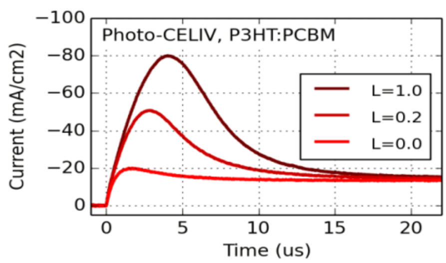
CE量测技术主要用于量测有机太阳能电池，量测时电池先处于开路状态并进行光脉冲照射，当光脉冲关闭时同时将电池片切换至短路状态进行提取电荷，此技术用来获取器件内的电荷载子浓度

- For solar cells

Available Post-processing Routines

- Extracting the recombination coefficient from charge extraction with varied delay time similar as in OTRACE.

CELIV – Charge Carrier Extraction with Linearly Increasing Voltage



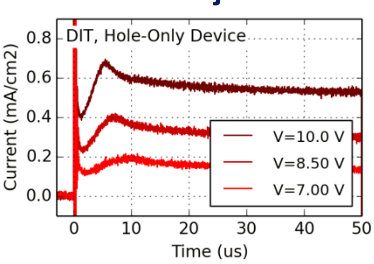
- For solar cells, MIS and OLEDs

CELIV技术是比较有名的提取载子移动率，复合系数，掺杂浓度等参数的技术。CELIV在有机太阳能电池量测上很有名气，但是它也可以量测钙钛矿电池以及OLED器件。给器件施加反向的斜率上升电压，可以提取器件内的载子，获取的电流-时间曲线的峰值位置与载流子移动率有关，用来计算载流子移动率

Available Post-processing Routines

- Extracting the charge carrier mobility
- Extracting the doping density from dark-CELIV measurements
- Extracting the geometrical capacitance and the series resistance from dark-CELIV
- Extracting the recombination coefficient of solar cells from OTRACE CELIV

DIT – Dark Injection Transients



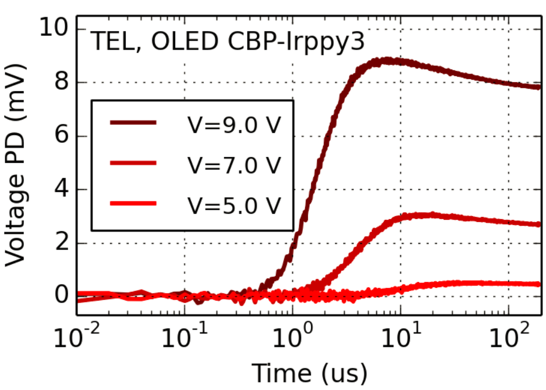
DIT量测技术主要用于量测单载子器件并获取载子的移动率，量测时给器件加一个短的电压脉冲量测器件的瞬态响应电流，通过响应电流峰值位置的时间来计算得到载子移动率

- For mono-polar devices, solar cells and OLEDs

Available Post-processing Routines

- Extracting the series resistance and geometric capacitance

TEL – Transient Electroluminescence



TEL量测技术主要用来量测OLED器件并获取载流子移动率以及磷光寿命等，量测时也是给器件加一个短脉冲电压量测瞬态EL信号，通过EL信号时间跟施加电压信号时间之间的delay time可以计算出载子移动率。分析EL信号的衰减曲线可以得到磷光寿命

- For OLEDs and highly efficient solar cells

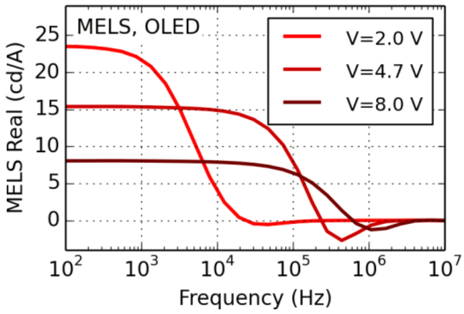
Available Post-processing Routines

- Extracting the average charge
- Extracting the PL lifetime carrier mobility

Paios

Paios与众不同的量测技术

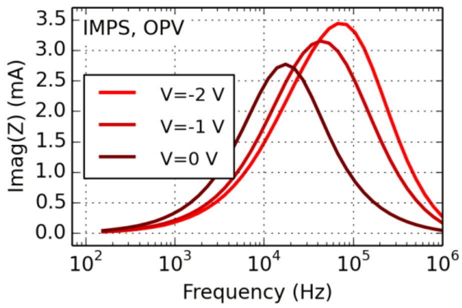
MELS – Modulated Electroluminescence Spectroscopy



同IS量测技术类似给器件施加的直流偏置电压上叠加一个小信号交流电压信号，但是量测的信号是不同频率下EL信号的相位和振幅。**MELS**用来研究OLED器件内电荷的传输情况

- Frequency range:10 mHz to 10 MHz
- Offset voltage -10 V to +10 V
- For OLEDs

IMPS – Intensity Modulated Photocurrent Spectroscopy



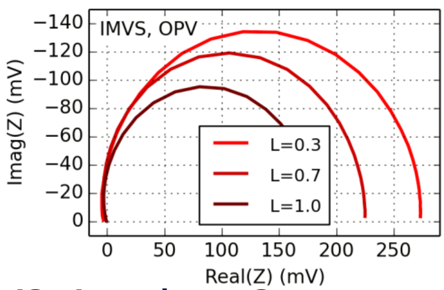
IMPS用来研究有机太阳电池内电荷的传输，太阳能电池处于短路状态时被恒定光强度光信号照射，恒定强度光信号照射时同时叠加一个小的调变光信号，量测不同频率下短路电流的振幅跟相位

- Frequency range:10 mHz to 1 MHz
- Offset voltage -10 V to +10 V
- For solar cells

Available Post-processing Routines

- Extracting the charge transport from the IMPS peak

IMVS – Intensity Modulated Photovoltage Spectroscopy



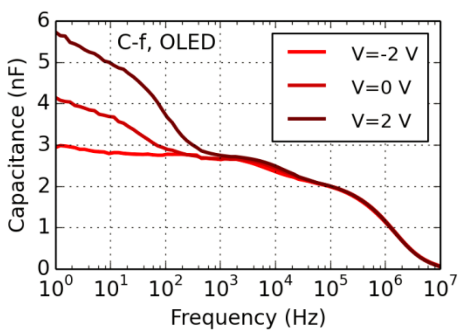
IMVS量测技术与IMPS技术类似，不同点在于电池片处于开路状态，主要用来提取电池片内部电荷的寿命。

- Frequency range:10 mHz to 1 MHz
- For solar cells

Available Post-processing Routines

- Extracting the recombination time from the IMVS peak

IS - Impedance Spectroscopy

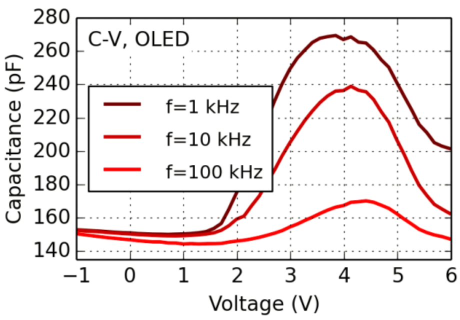


IS量测技术是一种广泛应用的量测技术，既可以量测OPV也可以量测OLED研究这些器件的电荷动态特性。
给器件施加的直流偏置电压上叠加一个小信号交流电压信号，量测不同频率下电流信号的相位跟振幅进而得到器件的复阻抗谱。

Available Post-processing Routines

- Frequency range:10 mHz to 10 MHz
- Impedances up to GΩ
- Offset voltage -10 V to +10 V
- For solar cells and OLEDs
- Fitting with Equivalent-Circuits
- Extracting series resistance,parallel resistance and the geometric capacitance

CV - Capacitance-Voltage



CV量测技术是量测器件的阻抗时让频率固定，直流偏置电压做扫描进而得到器件的C-V曲线。
C-V曲线可以得到器件的内建电场，以及注入能障等信息。

- Offset voltage -10 V to +10 V
- For solar cells and OLEDs

Available Post-processing Routines

- Extracting the doping density by Mott-Schottky analysis

Paios

Paios各种应用的选项模块

Low Temperature Module 液氮制冷

- Paios所有量测实验都可以在低温条件下进行
- 自动温度控制以及获取数据
- 液氮冷却系统
- 测量腔体内有氮气保护器件老化并防止冷凝
- 光照光源是LED，光探测器量测亮度
- 可以评估器件的热稳定性通过阶梯升高温度

Temperature range: **-150˚C to +200˚C**
Dewar size: 2 L
Filled dewar lasts for: 4 h
Maximum temperature ramp: 30 K/min

Multiplexing Module

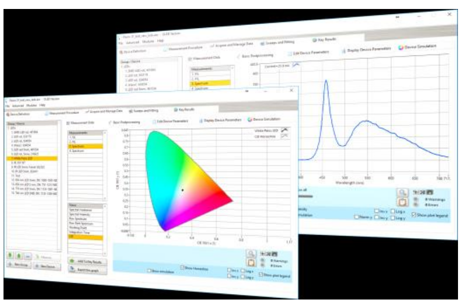
- 一次性同时量测4个器件
- 与定制夹具搭配使用

Peltier Cooling Unit (水冷/气冷）

改变半导体器件的温度对于研究物理学总是很有意义。 然而，使用低温恒温器相当耗时且乏味。 因此，我们开发了一种基于Peltier元件的微型低温恒温器，可实现快速电冷却。

•温度范围: -50˚C(-20) to +80˚C
•Peltier冷却（无需液氮）

Spectrometer Module



•量测OLED器件发光光谱
•光谱仪经过校准的
•自动对暗光谱进行修正
•可以跟自动测量台整合

Spectral range: 360 – 1100 nm
Integration time: 1 ms to 10 min
Post-processing quantities: luminance, radiance, EQE, lm/W,
CRI, CIE coordinates

Voltage Extension Module (SMU Module)

- SMU模块可以使施加器件电压高达±60V

Voltage range: ±60 V
Min measurable current: 1 pA
Frequency range impedance: 10 mHz to 1 kHz
Sampling Frequency: 100 kS/s

Nanosecond Pulser Module

Short (20 ns – 20 us) light pulses and bias light
Can be used for TPC, TPV and CELIV experiments
Only available with Automated Measurement Table

Glovebox Feed-Through

•Paios可以放在手套箱里使用
•根据客户需求定制线缆连接器

Automated Measurement Table

•自动测量台可以自动在光探测器，LED光源，光谱仪之间进行切换
•对于有机太阳电池可以将Sun simulator放在测量台底部搭配使用，并且自动切换
•对于OLED可以量测OLED的EL和光谱，不必手动切换光探测器和光谱仪，所有都是自动进行

Paios

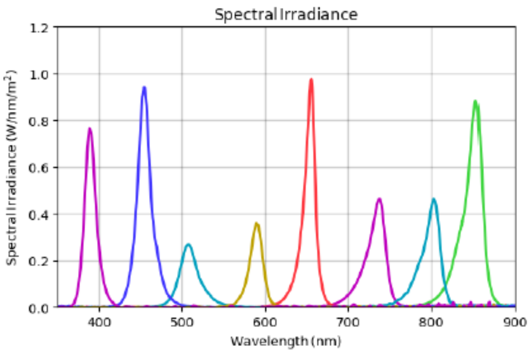
swiss made

Paios各种应用的选配模块

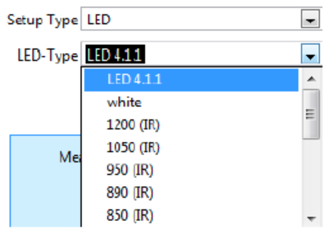
Multi-LED Extension Module

Additional 15 LEDs, allowing for EQE measurements at various wavelengths

Only available with Automated Measurement Table and for Solar Cell version

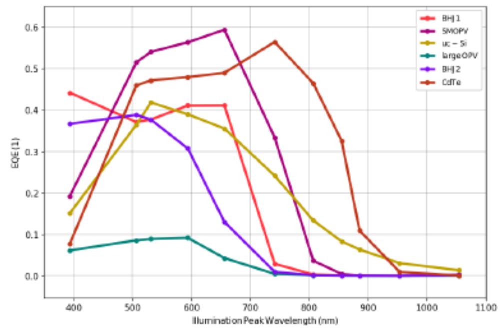


(a)



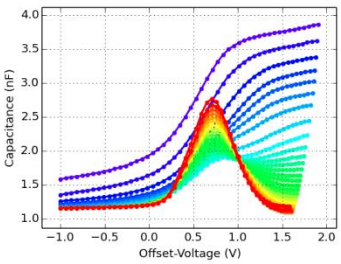
(b)

Figure 5.17: (a) Selected spectra of LEDs used in the ***Multi-LED Module***. (b) Setup Type selector for experiment settings.

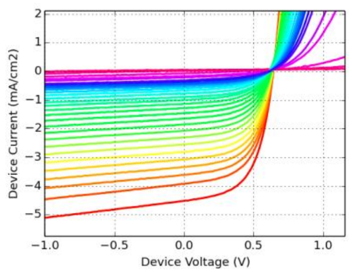


(a) Exampe for an EQE measurement of different solar cells.

Stress-Test Module

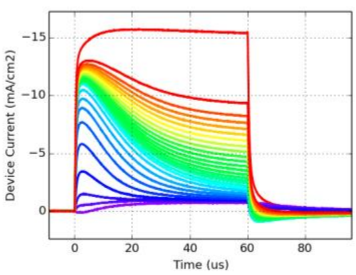


Capacitance-Voltage curves of an organic solar cell at different degradation stages.



Current-voltage characteristics of an organic solar cell at different degradation states.

- 监控器件的老化
- 给器件施加恒定电流，电压，或者光照信号进行老化实验
- 全自动化老化实验操作以及数据量测
- 可以获取高一致性数据
- 探寻并理解器件老化原因



Transient photocurrents of an organic solar cell at different degradation stages

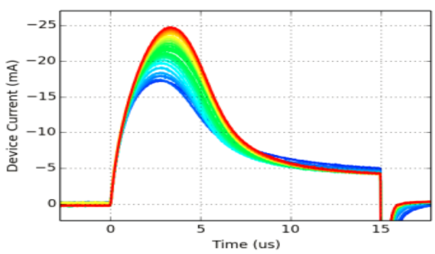
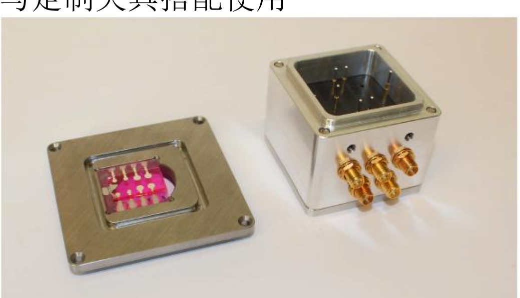


Photo-CELIV measurements of an organic solar cell at different degradation stages.

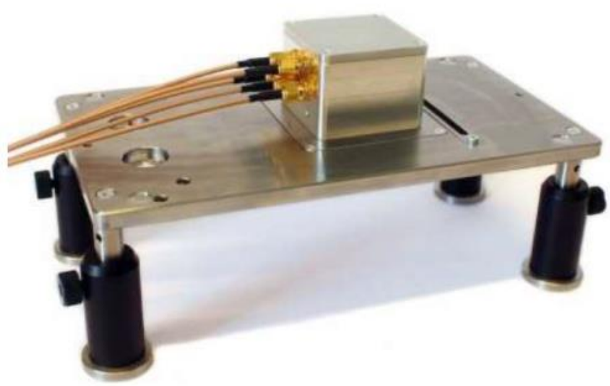
Multiplexing Module(4 devices)

- 一次性同时量测4个器件
- 与定制夹具搭配使用



Customized Sample Holder

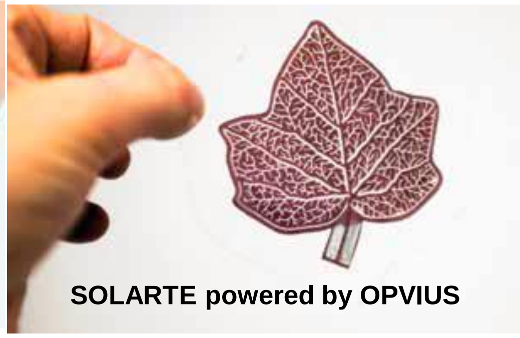
- 根据客户需求进行定制
- 可以最多连接4个器件
- 也可以与自动测量台搭配使用
- 当需要在手套箱里工作时非常有用



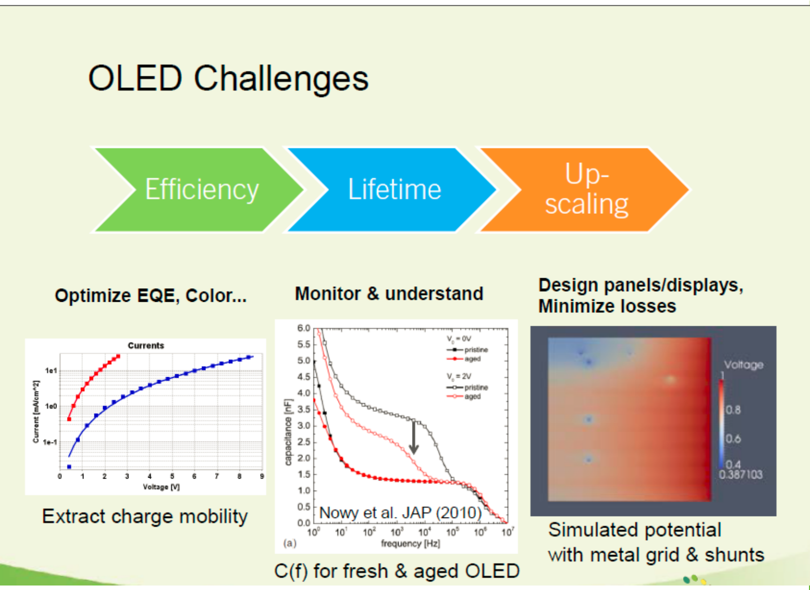
Setfos

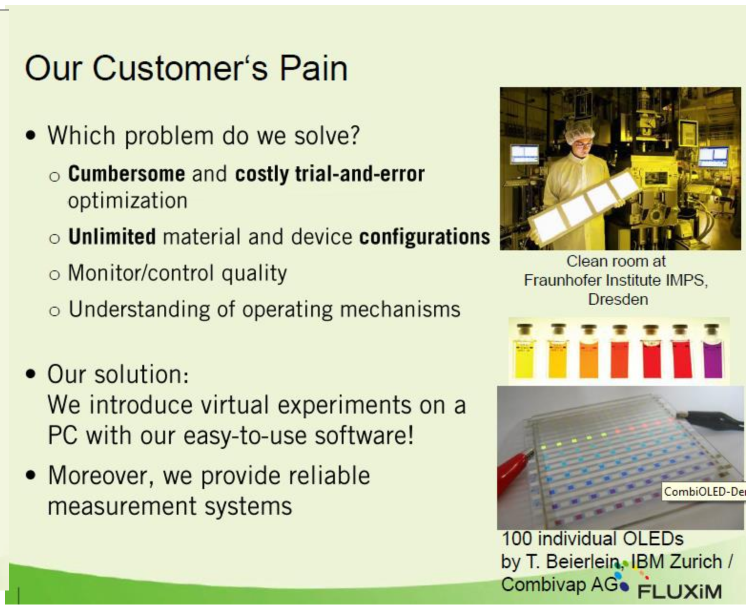
OLED Displays

OLED Lighting



Next Generation Photovoltaics



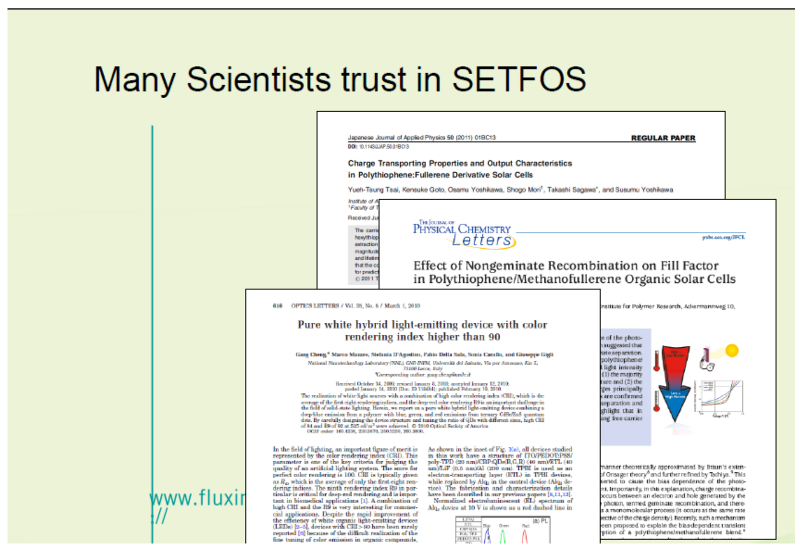


OLED/OPV/PSC的挑战：

1）效率的提升
2）器件寿命需要提高
3）大尺寸

客户的痛以及我们解决哪些问题：

1）避免了繁杂的和昂贵的的反复试验优化
2）提供无限量的材料和器件配置实验
3）便于质量监控和控制
4）提供更深层次了解器件的运行机制的途径



Setfos在业界得到广泛的好评，并且很多科学家都相信Setfos的模拟结果并在发表文献中积极引用Setfos！

Setfos

swiss made

Setfos是业界最先进的仿真软件，目前有4个模块

PVs　　OLEDs

Absorption
- Coherent/incoherent layers
- Absorption profiles
- Layer specific absorption

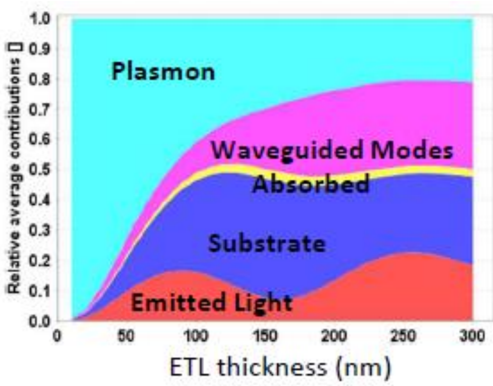
Drift-diffusion
- Electronic charges
- Excitons
- Ionic charges
- Traps, SRH recombination
- DC, AC, transient solvers
- Hopping interfaces (tandem devices)
- Polar layers

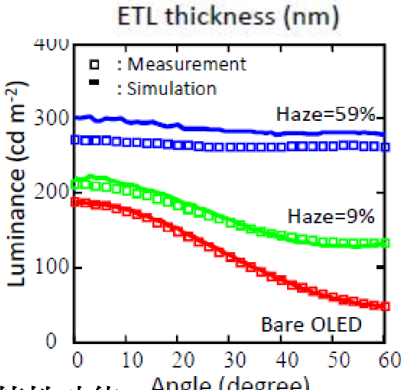
Advanced Optics
- Scattering (ray, Fourier) interfaces and particles (Mie)
- Birefringence
- Quantum dot down conversion

Emission
- Coherent/incoherent layers
- Spectral emission
- Mode analysis
- Quenching

Emission

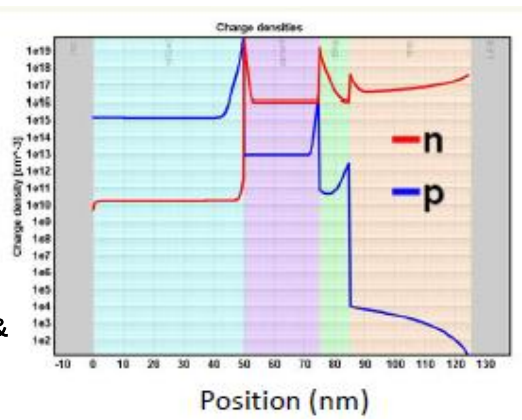
- Dipole emission
- Full spectrum, CIE coordinates
- Thin film, color filter & substrate optics
- Mode analysis





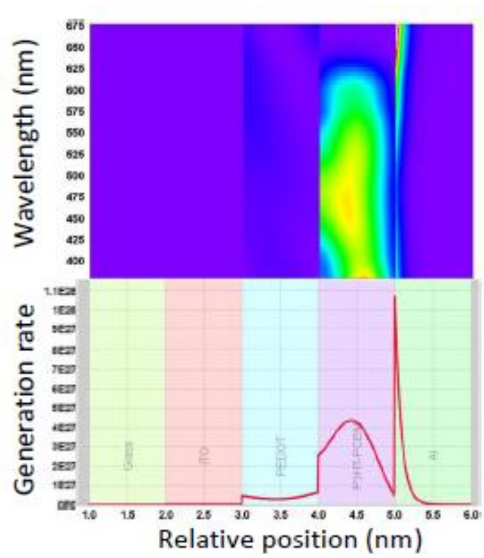
Drift-Diffusion

- Charge transport & recombination
- Exciton physics: decay, diffusion, interaction,TADF, transfer, saturation
- Advanced transport models: traps, doping, EGDM
- Multi-layer steady-state, transient & AC modeling



Absorption

- Charge generation profile
- Layer specific absorption & optimization
- Short-circuit current and current matching in tandem solar cells



Advanced Optics

- Efficiency improvement by scattering
- Internal & external structures
- Joint device & structure optimization
- Birefringent materials
- Mixed quantum dots & scatter particles

额外特性功能

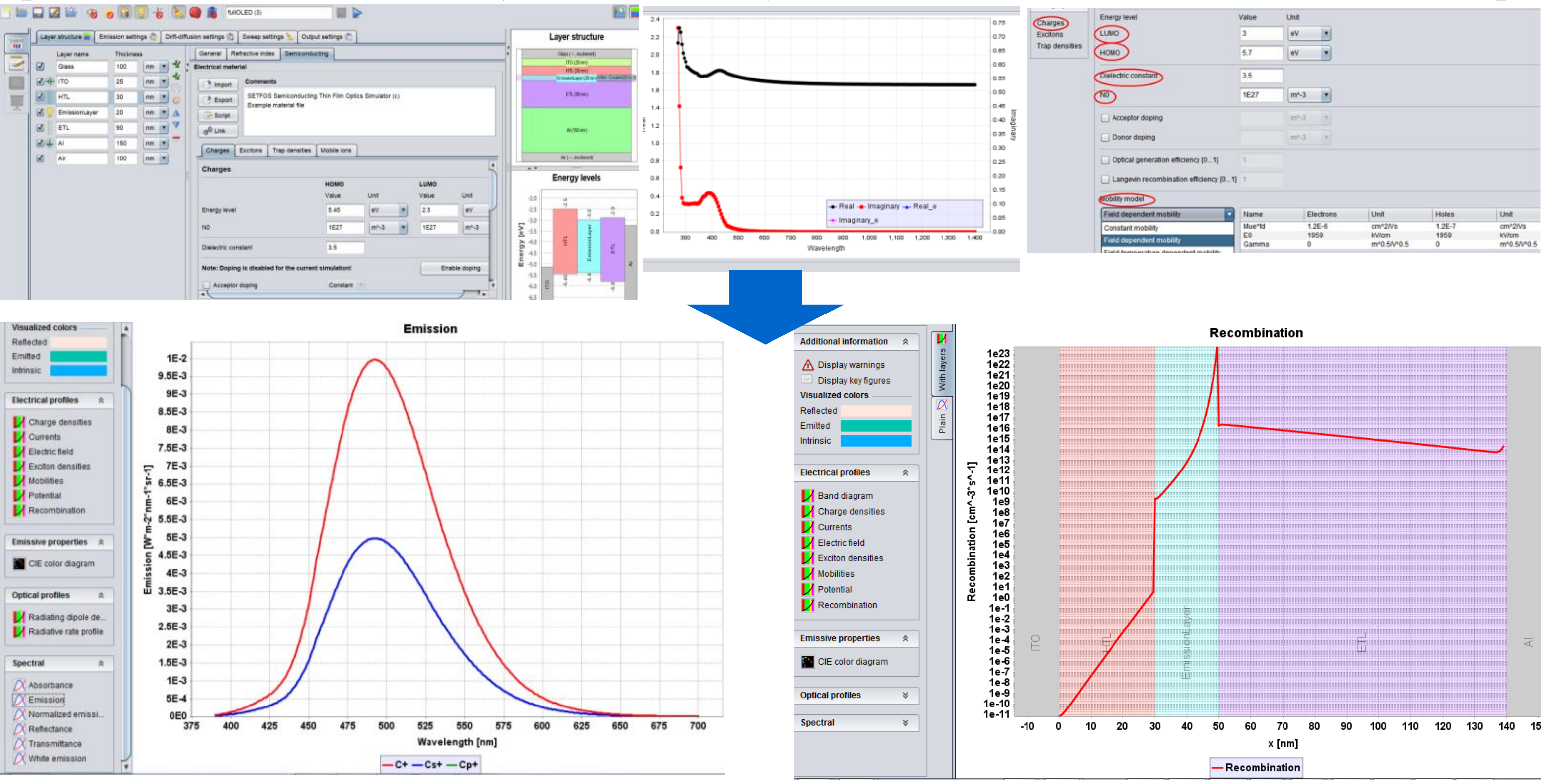
Use the **optimization** toolbox to improve your device or to find physical parameters.

Sweep material parameters to analyze their influence on the device performance

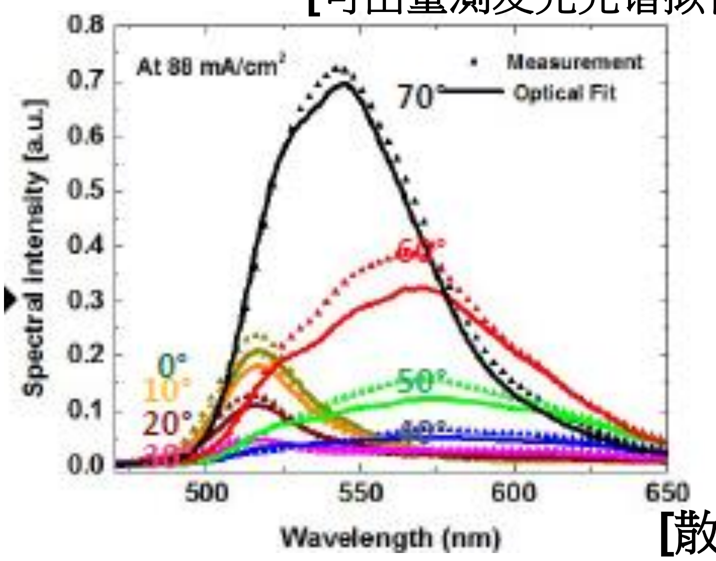
Fit emission spectra to reconstruct the dipole distribution and optionally extract the intrinsic luminescence spectrum of the emissive material

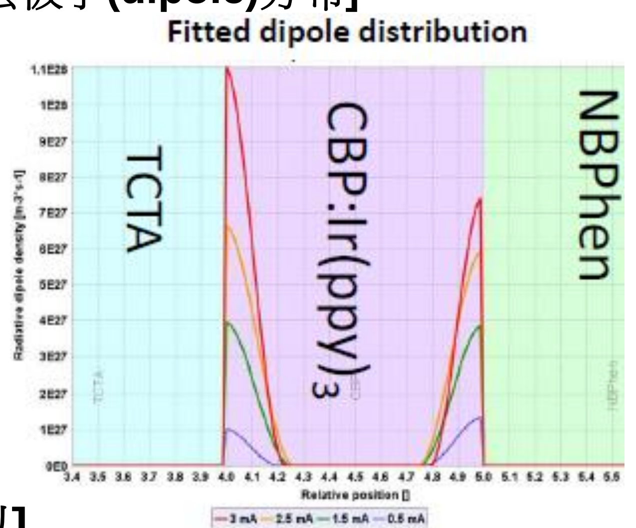
Setfos

[设定器件结构依材料参数,模拟电性出光,有参数可进行无限制材料器件配置实验]

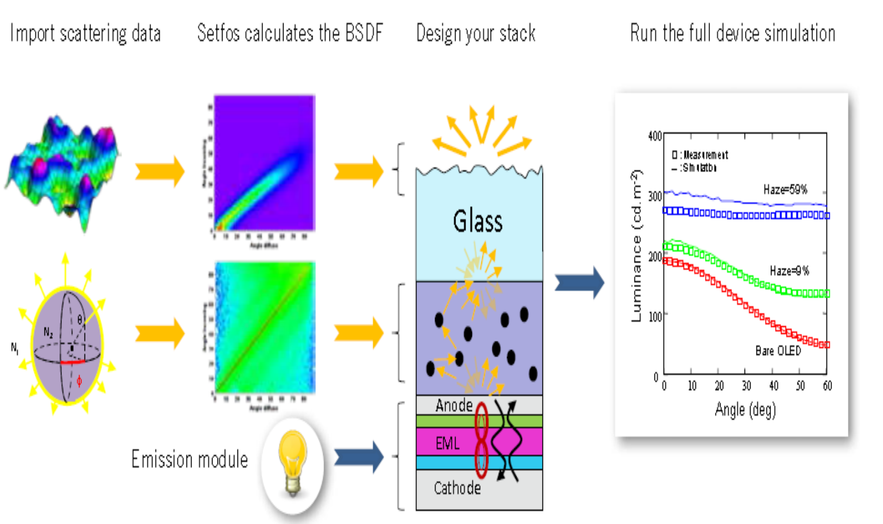


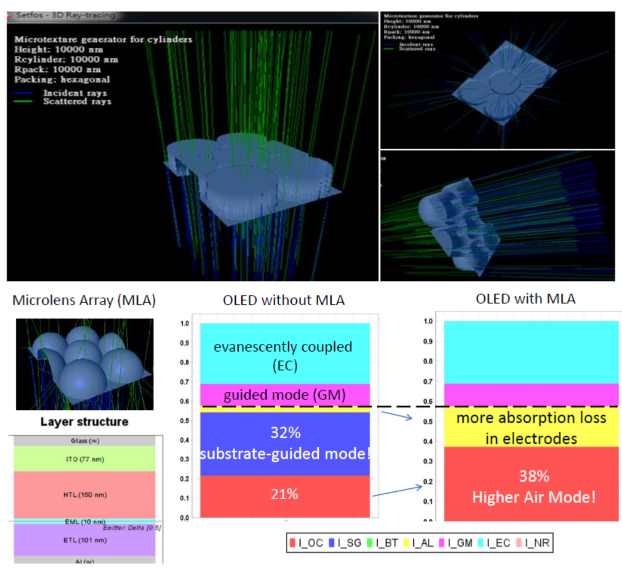
[可由量测发光光谱拟合发光层极子(dipole)分布]





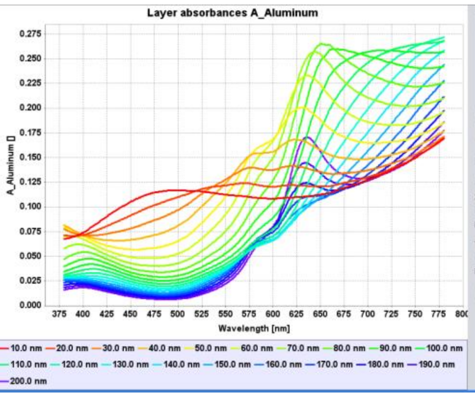
[散射模拟]

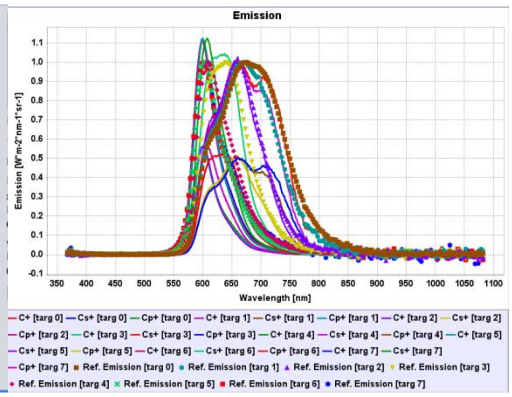


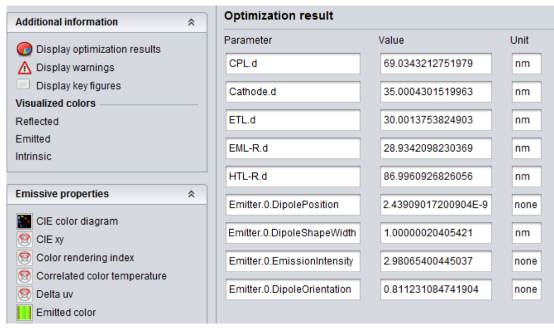


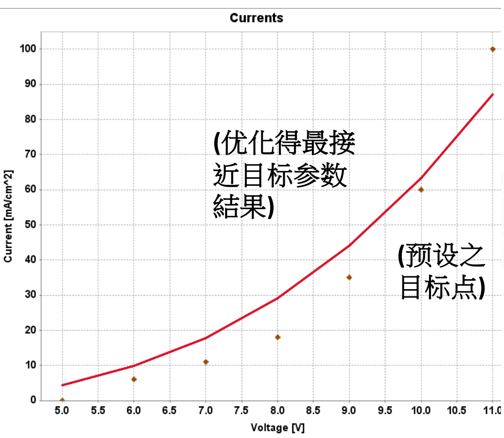
Setfos

[扫描优化等功能模拟变化趋势与优化参数,避免了繁杂昂贵的反复实验]

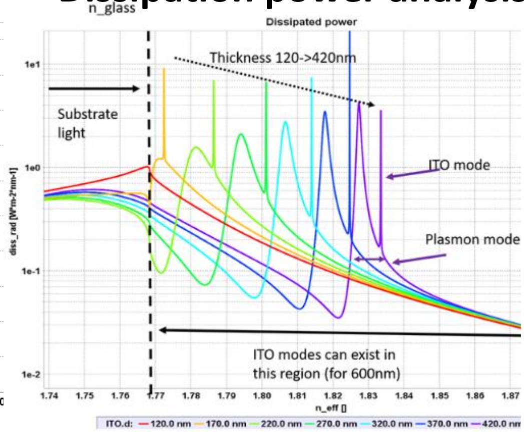




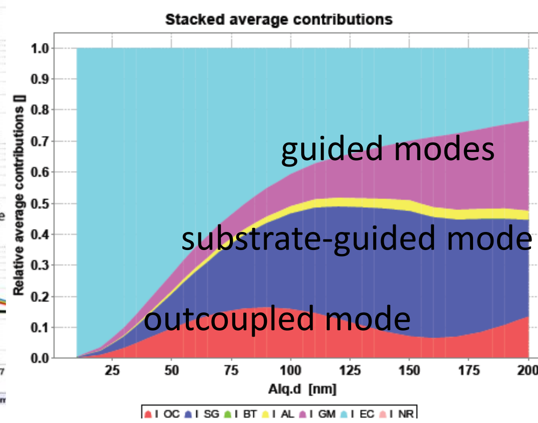




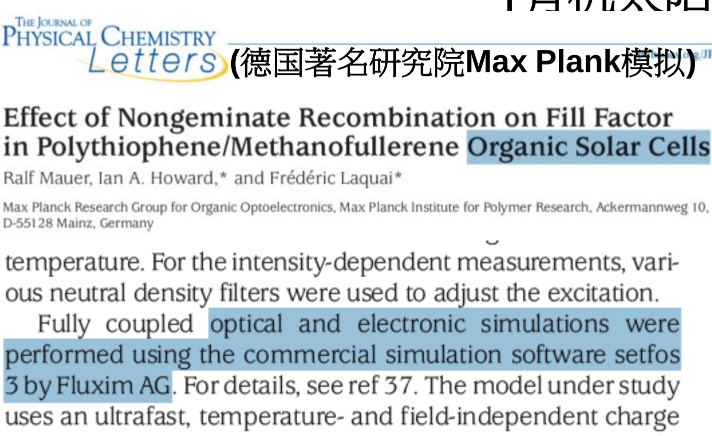
Dissipation power analysis



Mode analysis



[有机太阳能电池模拟]


The Journal of Physical Chemistry Letters (德国著名研究院Max Plank模拟)

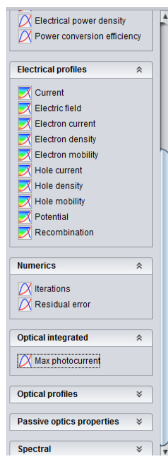
Effect of Nongeminate Recombination on Fill Factor in Polythiophene/Methanofullerene Organic Solar Cells

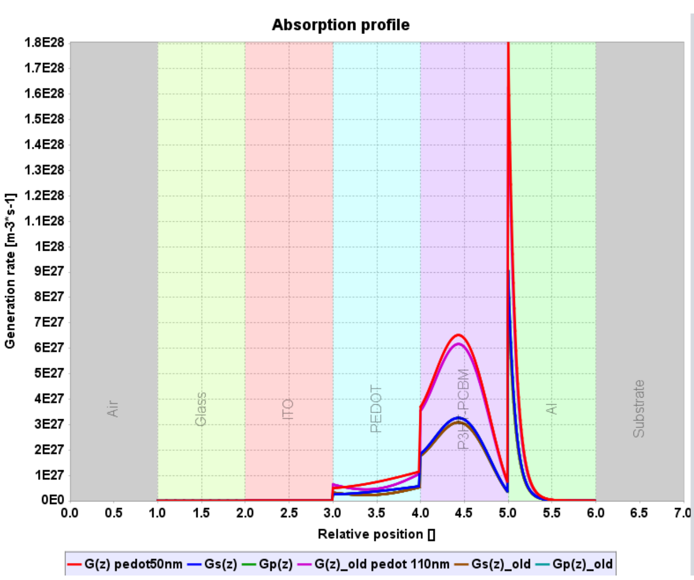
Ralf Mauer, Ian A. Howard,* and Frédéric Laquai*

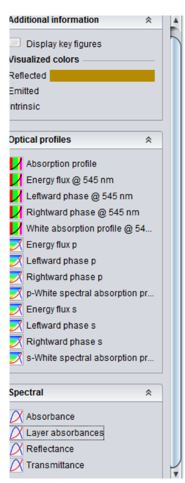
Max Planck Research Group for Organic Optoelectronics, Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany

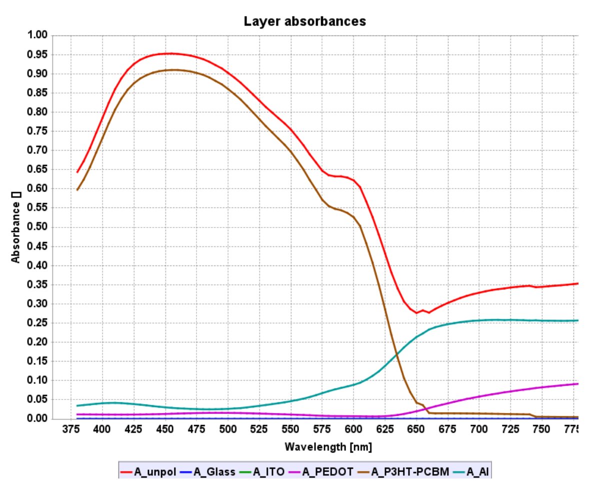
temperature. For the intensity-dependent measurements, various neutral density filters were used to adjust the excitation.

Fully coupled optical and electronic simulations were performed using the commercial simulation software setfos 3 by Fluxim AG. For details, see ref 37. The model under study uses an ultrafast, temperature- and field-independent charge







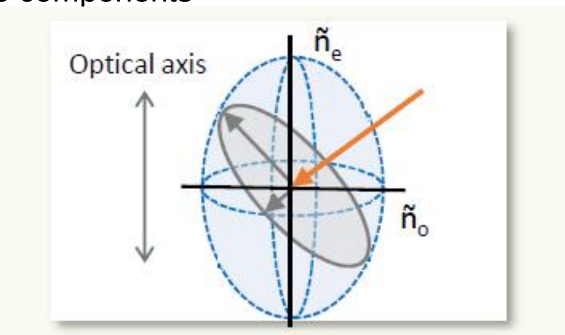


Setfos

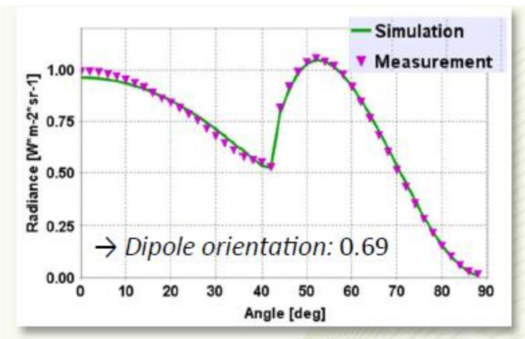
New Highlights of Setfos

Birefringent materials

• Simulate devices with layers employing a refractive index with ordinary ño and extraordinary ñe components

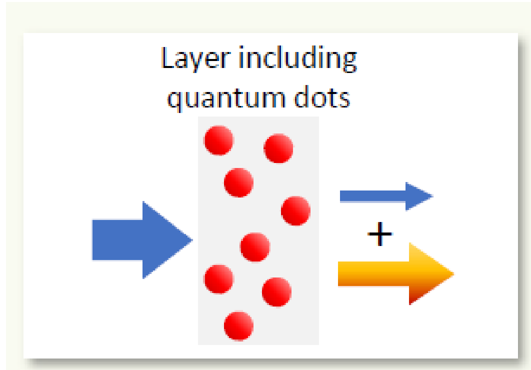


Determine the emitter orientation in a birefringent emitting layer

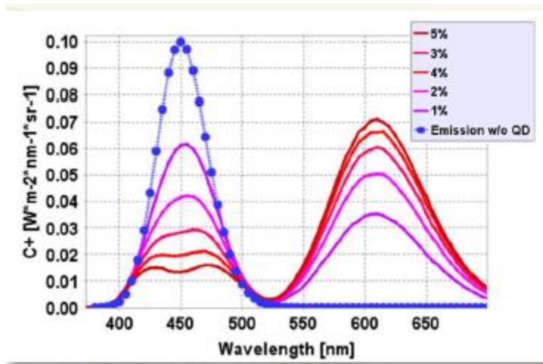


Quantum dots

• Include quantum dot down conversion in your optical simulation

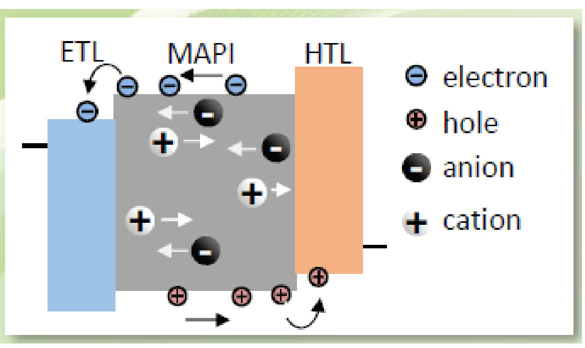


Analyze the effect of incorporating quantum dots in a color conversion film

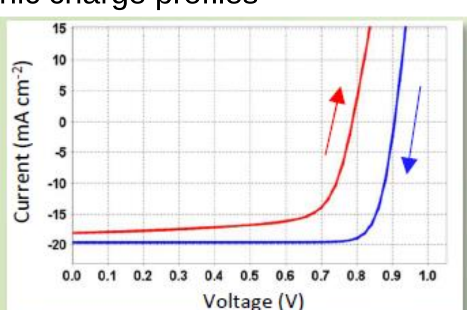


Mobile ionic charges

• Introduce mobile ions to simulate perovskite solar cells and light-emitting electrochemical cells

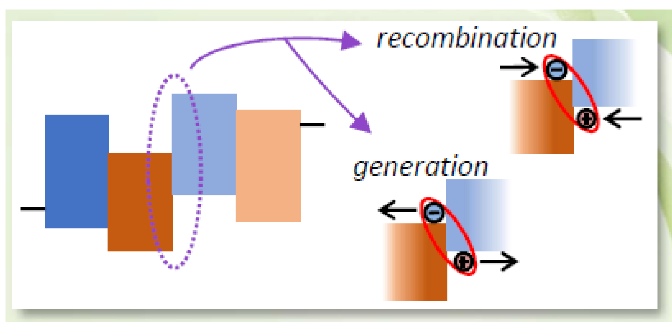


• Fully coupled steady-state and transient modeling
• Understand device operation from electronic & ionic charge profiles

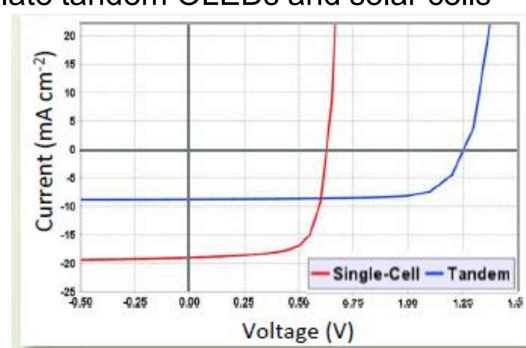


Interface recombination

• Charge recombination and generation at organic/organic interfaces
• Advanced injection layer modeling



• Simulate tandem OLEDs and solar cells



Setfos for OLED 散射层与散射接口及其出光增强与调整

Setfos散射文獻:實際與模擬 是否有setfos散射模擬文獻說明器件和散射模擬比較與精度

(http://www.fluxim.com/references-1/)

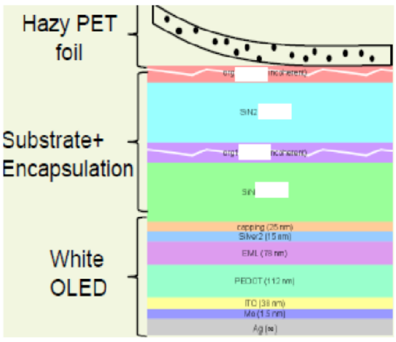
Simulations, measurements and optimization of OLEDs with scatter layer

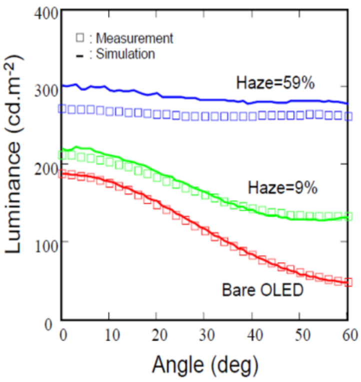
Stéphane Altazin*, Clément Reynaud*, Ursula M. Mayer*, Thomas Lanz**, Kevin Lapagna**, Reto Knaack**, Lieven Penninck*, Christoph Kirsch**, Kurt P. Pernstich**, Stephan Harkema***, Dorothee Hermes***, Beat Ruhstaller*

*Fluxim AG, Winterthur, Switzerland

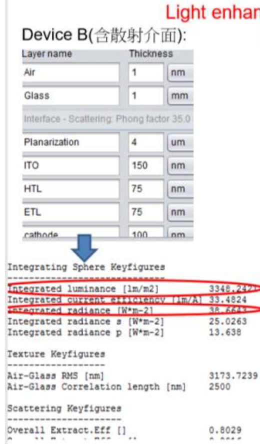
**Zurich University of Applied Sciences, Institute of Computational Physics, Winterthur, Switzerland

***Holst Centre, Eindhoven, The Netherlands





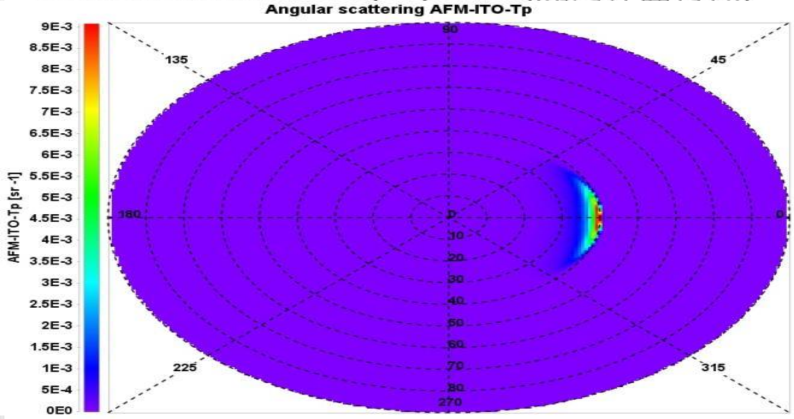
Light enhancement(第一incoherent層到散射後出光增益)另法



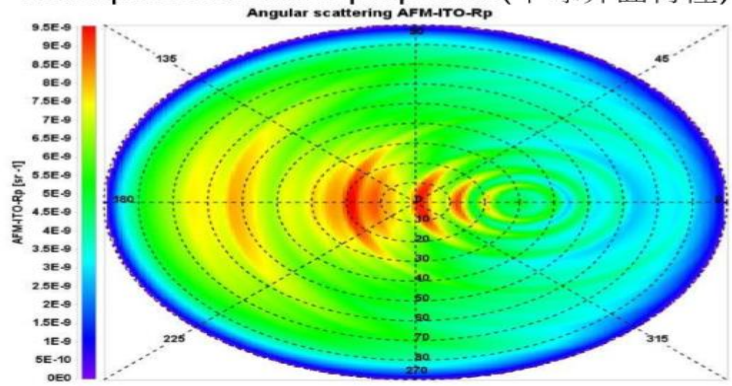
比較散射及非散射(掃描角度)模擬之 integrated radiance ,luminance值, 如果出光頻譜不改變太多 ,應代表了改善EQE

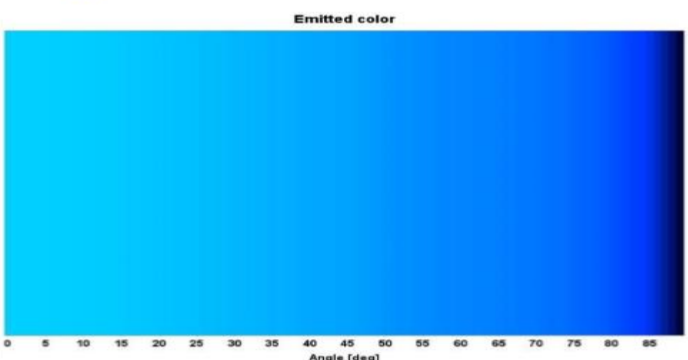
- Ioc counts the number of extracted photons , radiance counts the power
- luminance counts the emitted candelas.
- Therefore if you have a variation of the emitted spectrum versus your swept parameter, these 3 values may not vary exactly the same way.

Goniometric interface properties(測角介面特性)



hemisphere interface properties(半球介面特性)

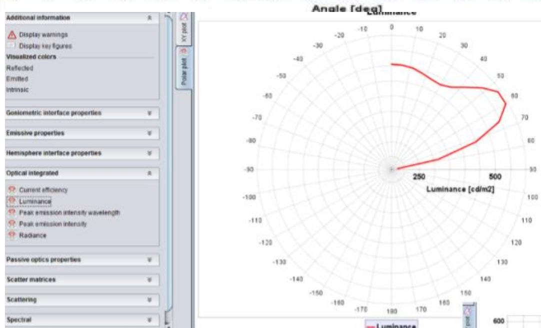




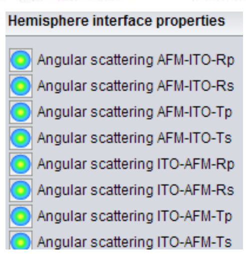
兩層材料介面間進與出兩大方向光之穿透(T)、反射(R)與角度關係畫成同心圓

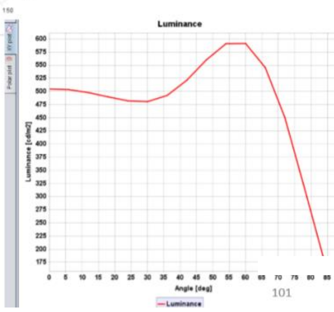
Hemisphere output of setfos does **not represents emission** of OLED but **only 'scattering pattern'** created **by** the **interface** if a **ray shines directly** the **interface with** an **default angle** that set in GUI.

This plot **represents scattering properties (reflectance , transmittance)** for **both sides** in **two layers surrounding the interface**.

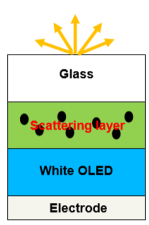


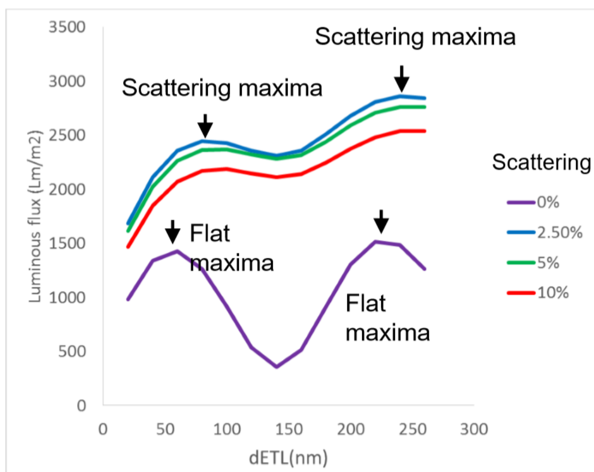
(polar plot)





Joint optimization of stack + particle concentration





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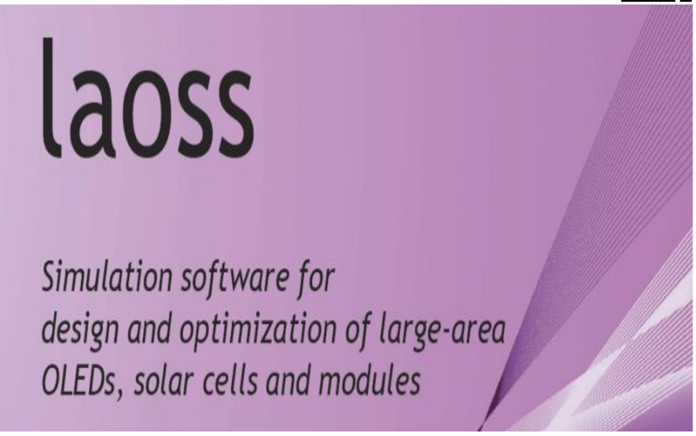


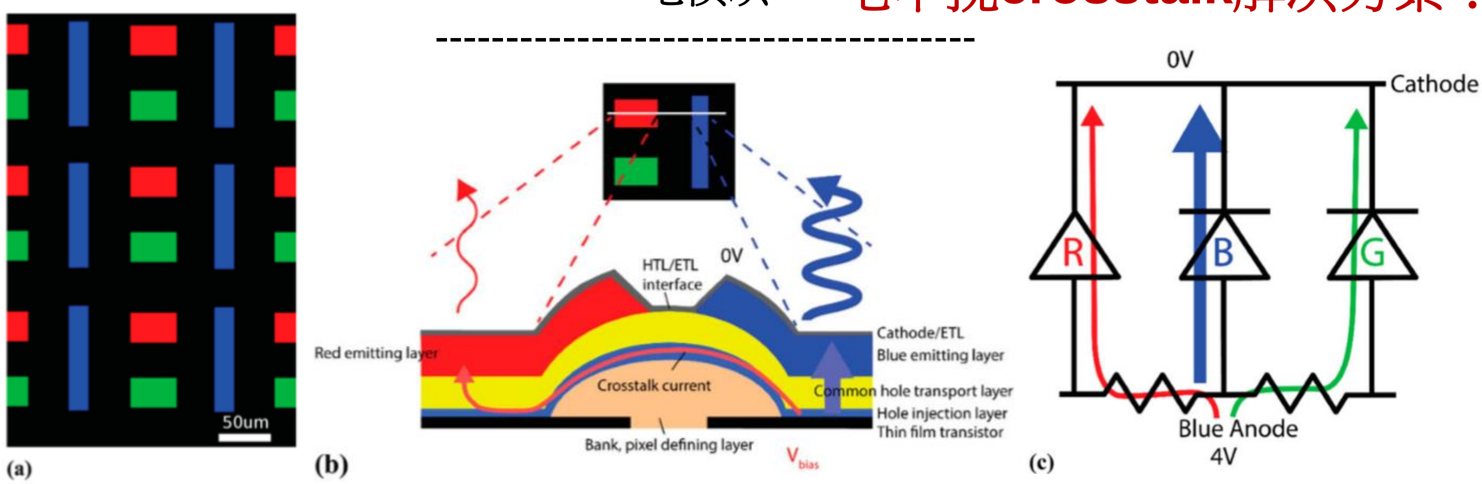
LAOSS：针对大面积OPV、OLED器件的专业模拟软件！！

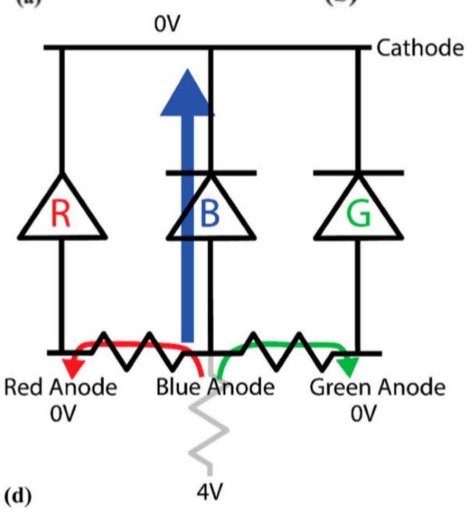
电模块: 模拟大面积OLEDs和太阳能电池的特性(填充因子 vs. 电导率, 2D电位分布,电流密度,奥姆损耗, 总输出功率..等等)

热模块: 模拟OLED或太阳能电池中的热生成和电流（电热耦合）之间的双向相互作用。

光模块: 模拟具有复杂3D光学组件或表面纹理化的OLEDs和太阳能电池的耦合

电模块　电串扰crosstalk解决方案！





Side-by-sidepixellayout(a)oftheproducedRGBOLED display. The pixels share common hole transport and injection layers, which leads to a crosstalk current (b). In this normal operation mode, the crosstalk current flows through the commonlayer resistance and the diode (c). If the anodes of the neighboring pixels are connected to the ground, then the current flows onlythroughthecommon-layerresistance(alternativeoperation mode) (d). The gray resistance represents the series resistance of thedevice.

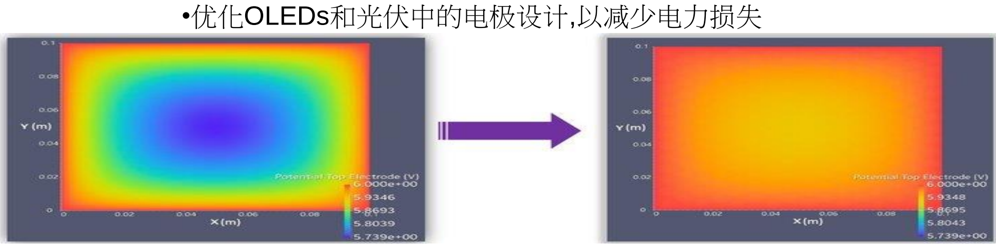
了解 RGB OLED像素数组中的电串扰

OLED像素数组中的电位图 通过层与层之间的漏电流会造成未开启OLEDs的光发射

以二元有限元素分析得到电极中奥姆定律的解, 后者可结合到小面积参考装置的一维 I-V特性曲线

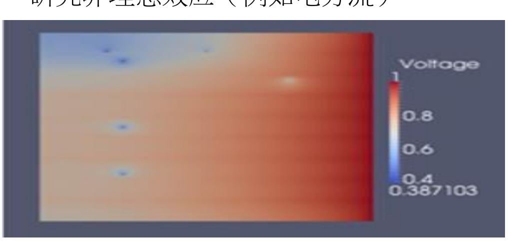
•优化OLEDs和光伏中的电极设计,以减少电力损失

沒有金屬網格的10x10 cm2 OLED頂部電極的電位圖



具有金属网格的OLED电位分布。 插图显示了模拟和 实验之间的一致性

• 研究非理想效应（例如电分流）



•自动优化电极的几何形状

swiss made

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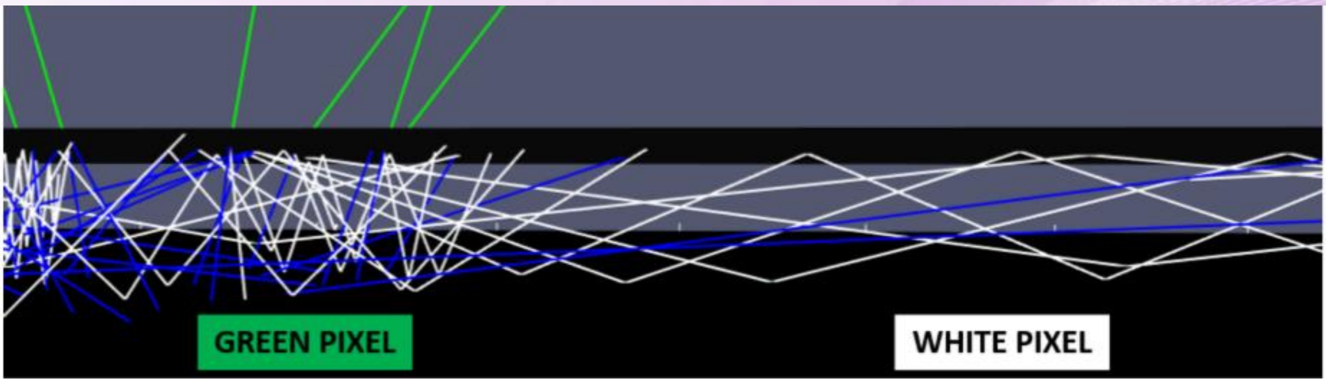
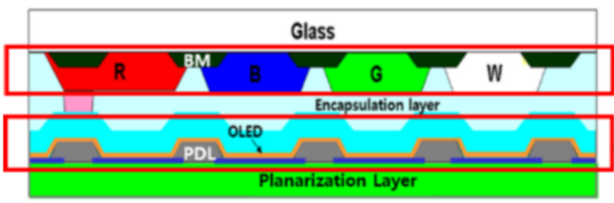
光模块

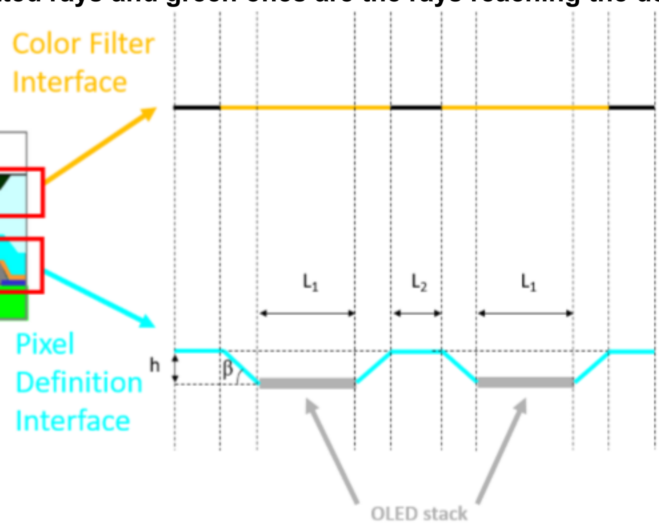
易于使用的光线追踪系统，用于仿真3D光学组件。 该模块可以容易地与Setfos [4]结合，
以分析具有复杂光耦合几何结构的OLEDs和太阳光电系统



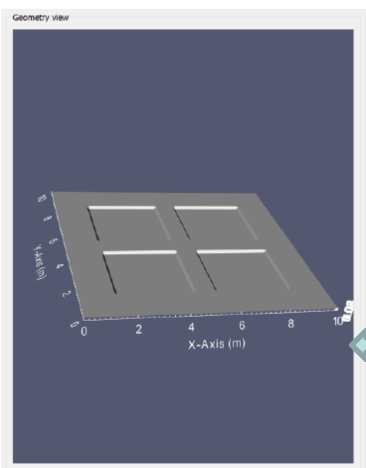
Cross-section view of an WOLED/CF display. Blue rays are assigned as primary rays, which are emitted from the white OLED. White rays are reflected/transmitted rays and green ones are the rays reaching the detector.

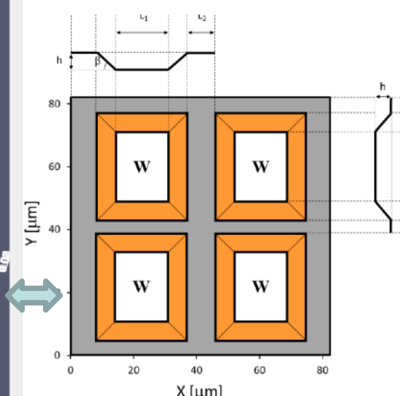
光串扰crosstalk解决方案！



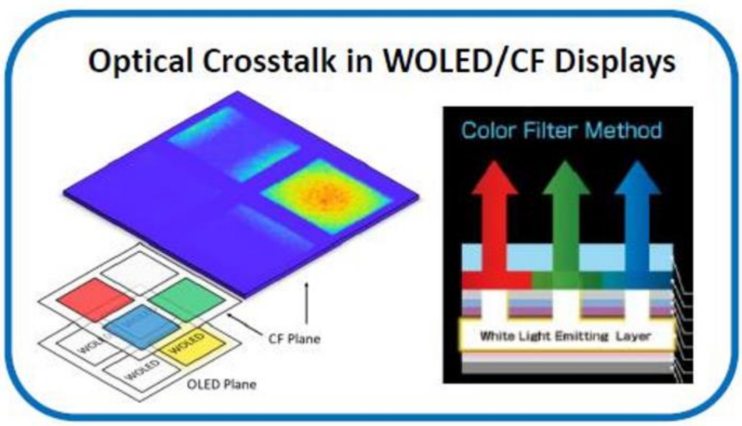


Geometry of the OLED layer.

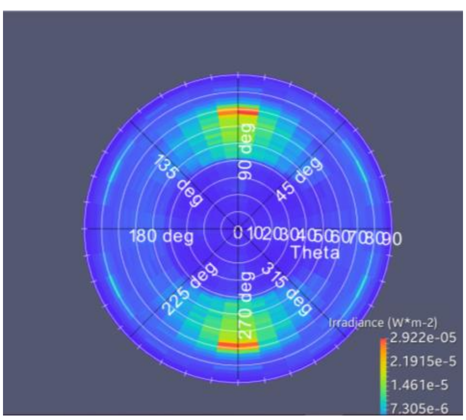


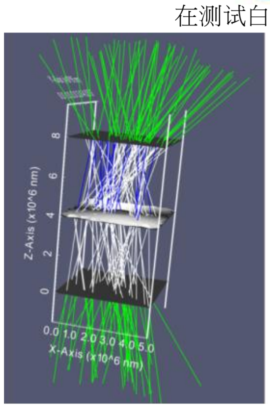


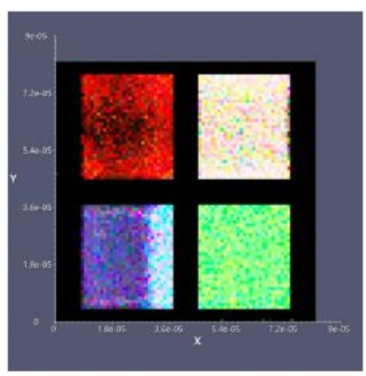
· 模拟OLED显示器中的光学串扰



在测试白光OLED / 色彩滤波矩阵中透过未开启单位 的滤色器（CF）漏光







swiss made

GSI／台北廣集, HTTR／北京華通

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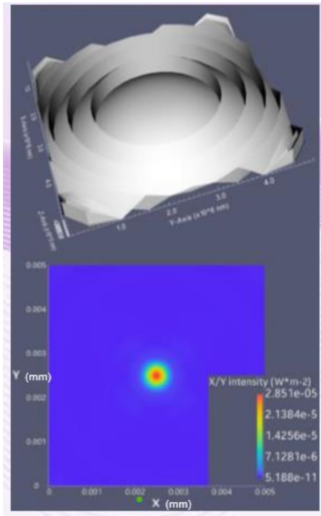
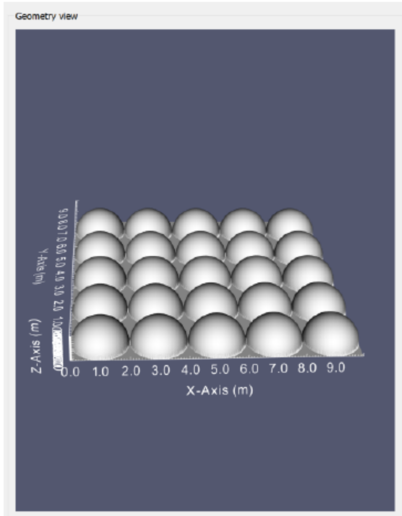
光模块

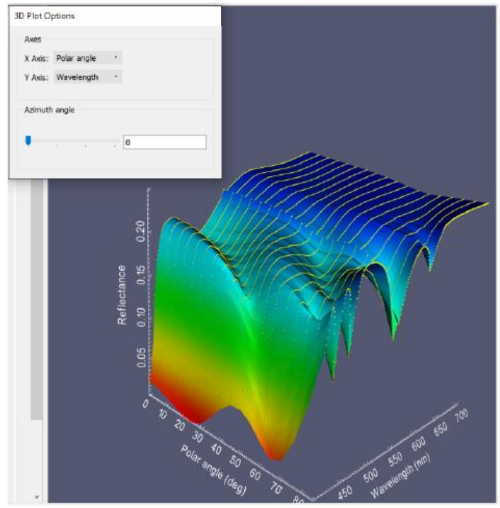
易于使用的光线追踪系统，用于仿真3D光学组件。 该模块可以容易地与Setfos [4]结合，以分析具有复杂光耦合几何结构的OLEDs和太阳光电系统

· 建模独立的**3D**光学组件及其对**OLEDs**和太阳 能电池的贡献



菲涅耳透镜在白光照射下的光输出

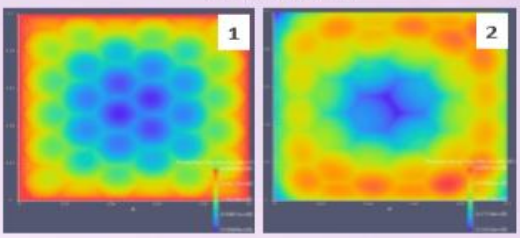




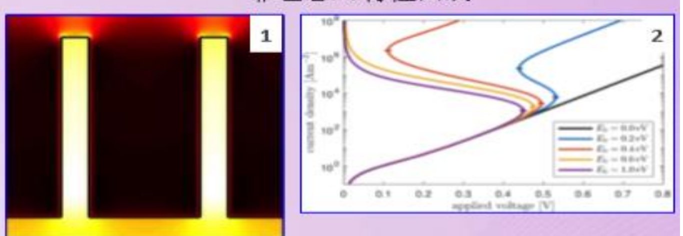
热模块

电↔热耦合方法去模拟OLED和太阳能电池中热生成与电流之间的双向相互作用

- 在标准作业程序下计算OLED和太阳能电池中的温度分布
- 解释由于电热耦合导致的OLED和太阳能电池的非理想I-V特性曲线



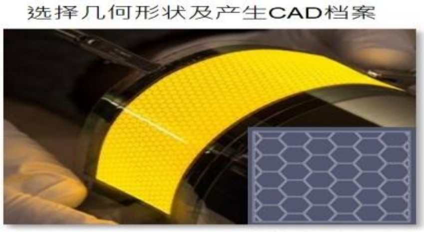
具有六角形栅极的OLED中的电位分布（1）和温度分布（2）



(1)具有金属指叉电极的OLED中的温度分布
(2) OLED的模拟I-V特性曲线显示负微分电阻（S形）

LAOSS工作流程

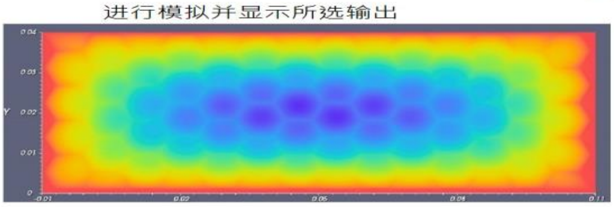
选择几何形状及产生CAD档案



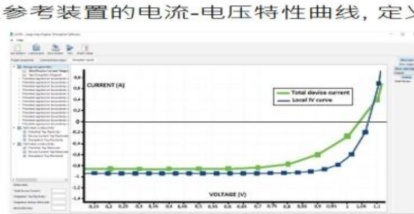
具有Holst Centre及蜂窝状金属电极的 oled面板

汇入CAD图文件或在LAOSS创建几何图形，接着 产生几何图

进行模拟并显示所选输出



导入参考装置的电流-电压特性曲线，定义材料



可将大面积器件的特性与局部I-V曲线进行比较

* http://www.osadirect.com/news/article/1353/holst-centre-and-flex-o-fab-take-the-first-step-towards-lighting-by-the-mile/

Phelos

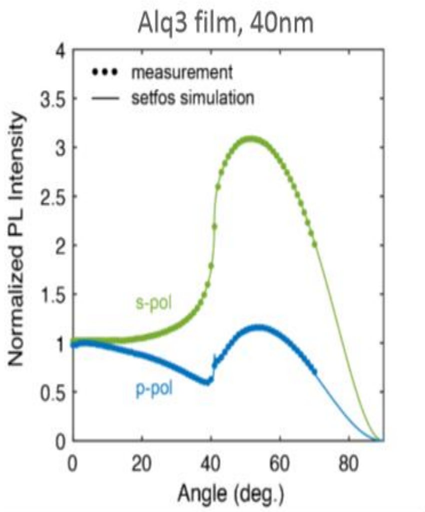
phelos

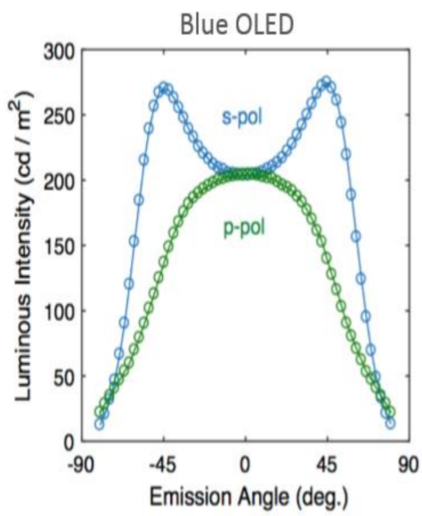
angular luminescence spectrometer

- OLED efficiency
- Viewing angle
- Emitter orientation and position
- One-click operation

Phelos是针对OLED器件的发光特性量测而设计的，它可以量测再不同角度不同偏振下的器件的EL和有机材料PL光谱，再通过计算或者与Setfos模拟软件搭配获得OLED器件或者有机材料的其他参数，例如：IVL, EQE, lm/W, Cd/A, CIEx,y ,以及发光层材料分子取向，以及分子分布情况等。

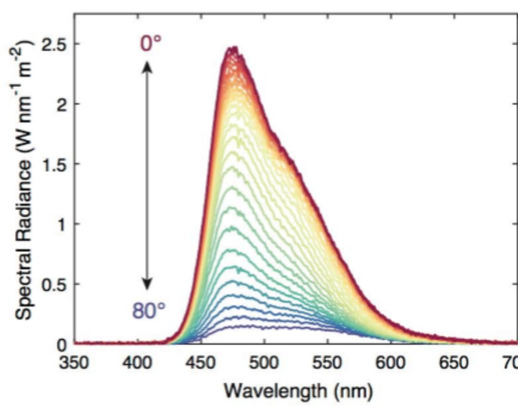
光致发光和电致发光:发射器内分子的偶极方向和位置





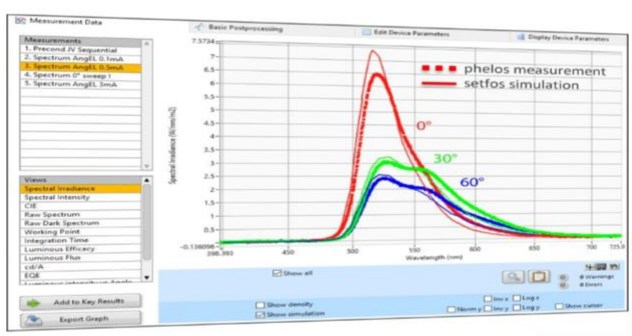
优点

- 量测单个**薄膜**或**工作装置**的特性
- 能轻松结合**Phelos**的测量及**Setfos**的模拟
- 根据发射光谱的角度变化决定**发射器**分子的**方向和位置**
- 结合实验和模拟来分析设备的内部运作
- 透过**整合**的光学**微共振腔发射模型**模拟测量结果



测量参数

- 效率: EQE, Lm/W 和 Cd/A
- 每个发射角的光谱和颜色
- 用SMU获得电流-电压-亮度曲线 (IVL)
- 光致发光
- 偏振



产品规格

- **角度**范围: -85° to +85, 解析度: < 1°
- **光谱**范围: 360 – 880/1100 nm with 1.2/2.4 nm resolution （1.2/2.4纳米的解析度）
- 配有偏光镜和用于外部耦合的半圆柱透镜
  光斑大小: 100 µm – 5 mm

swiss made

Phelos+Paios+Setfos分析并验证OLED器件发光层中Emission Zone分布情况以及解释OLED器件TEL实验turn off peak现象

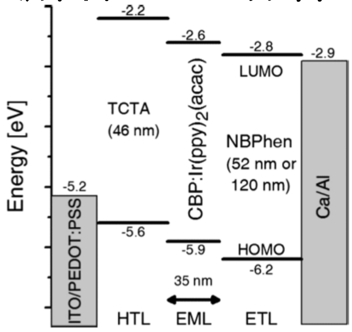
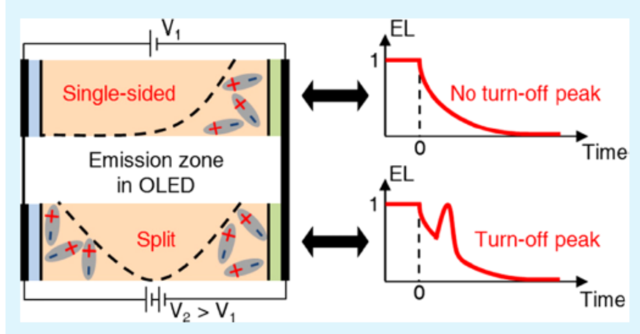


Figure 1. Energy-level diagram of the fabricated OLEDs. The emission layer is only 35 nm thin, and the thickness of the NBPhen layer is either 52 nm in the tuned OLED or 120 nm in the optically detuned OLED. 图1：分析的OLED器件结构



OLED器件TEL实验turn off peak现象

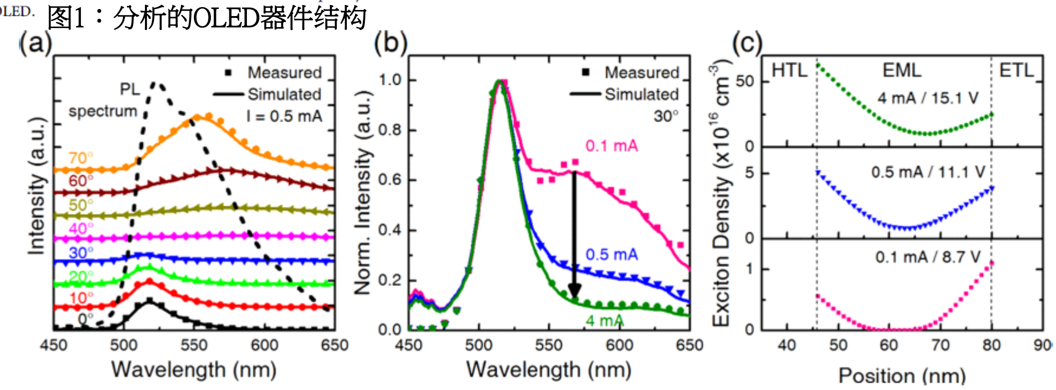


Figure 2. Measured (symbols) and simulated (solid lines) angle-dependent s-polarized EL spectra for a constant current of 0.5 mA together with the PL spectrum of the Ir(ppy)2(acac) dopant (a). (b) EL spectra at an angle of 30° for different currents. The shoulder at 570 nm is reduced significantly for increasing currents proving that the emission zone is changing with current. From these measurements, the optical model yields the emission zones shown in (c). 图2a和2b：Phelos量测OLED器件可变角度EL光谱，图2cEmission zone分布 通过Setfos模型拟合得出

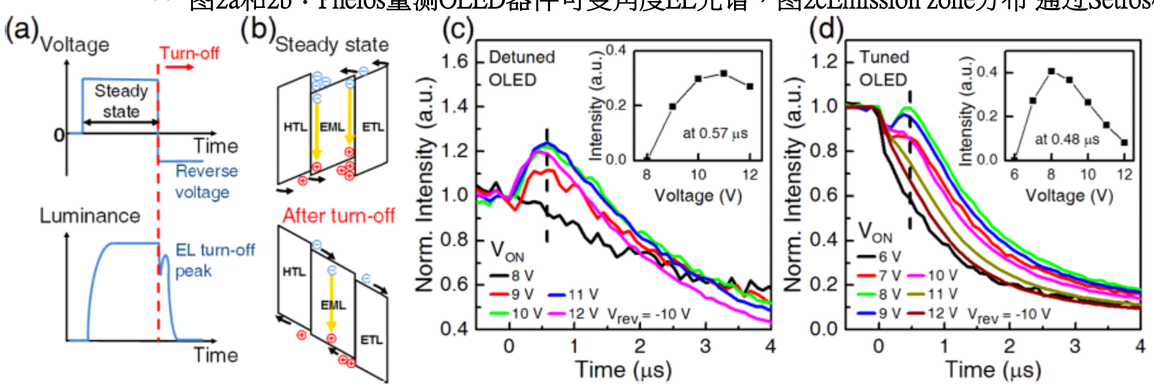
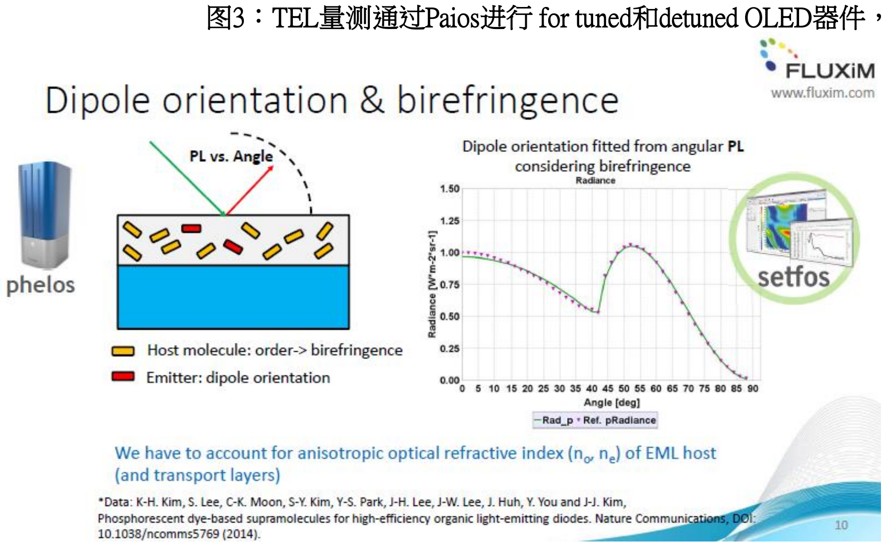


Figure 3. (a) Biasing scheme for the transient electroluminescence measurements. (b) Illustration of the energy diagram highlighting the accumulation of excess electrons at the HTL/EML and of excess holes at the EML/ETL interface that drift toward each other under reverse bias, which leads to an increased recombination and the observed EL peak in detuned (c) and tuned (d) OLEDs. The insets show that this peak intensity increases with on-voltage up to a certain voltage before it decreases.

图3：TEL量测通过Paios进行 for tuned和detuned OLED器件，都可以看到 TEL turn off peak



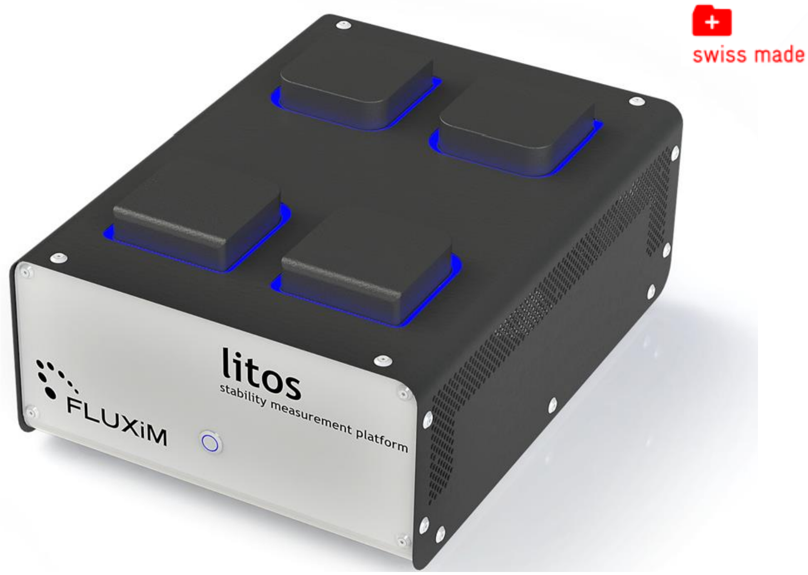
Phelos量测代入Setfos模拟求发光层Dipole orientation

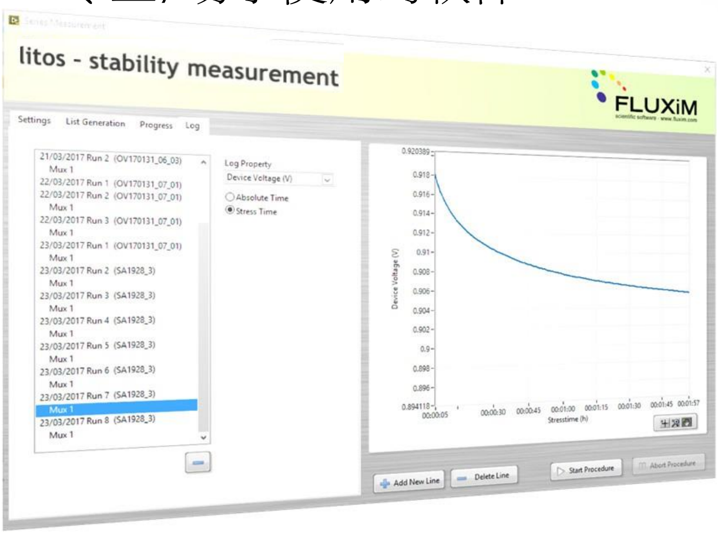
- **Phelos跟Setfos整合（SPI）可以很轻松的实现量测结果跟模拟结果**
- **Phelos跟Setfos整合(SPI) 获取diople orientation和distribution**

Litos 太阳能电池与有机发光稳定性测量平台

swiss made

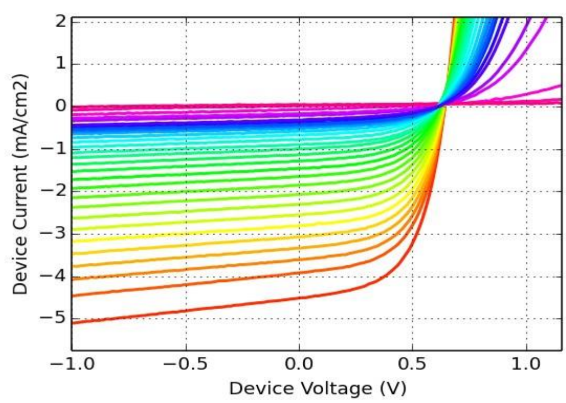
- 先进的衰退期分析技术
- 并行渠道
- 灵活的样品设计
- 温度控制
- 全自动化
- 气密风化腔
- 提供OLED和PV版本
- 具备ISOS协议的全部功能
- 专业, 易于使用的软件





产品规格

- 在四个独立的气密室中有高达32个器件 配有湿度传感器
- 电压最大值: 10 V
- 电流最大值: 20 mA /渠道
- 温度控制:0 - 150oC
- 样品尺寸可达2英寸

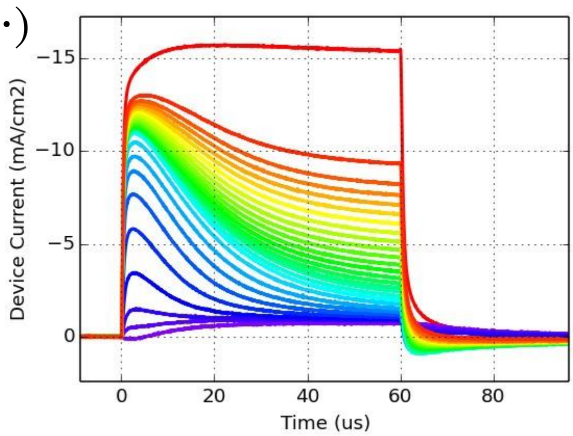


优点

- 根据顾客的样品布置客制化的设计
- 模块化：将多个系统连接在一起
- 与大气控制设备兼容
- 随时间自动参数提取与绘图

与Paios结合使用, 可以自动执行重复且完整的仪器特性分析,包括:

- 电流密度-电压曲线
- 瞬态测量(CELIV, DLTS, TPV, TPC, TEL …)
- 阻抗谱/ CV
- IMPS / IMVS (用于太阳能电池)
- 所有测量值均为温度的函数



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