



PRODUCTS INFORMATION



Pecce11 Technologies, Inc.

I N D E X

- 1** IPCE measurement apparatus (PEC-S20)
- 2** Solar Simulator (PEC-L15)
- 3** Solar Simulator (JIS AAA) (PEC-L12)
- 4** Portable Solar Simulator (PEC-L01)
- 5** I-V Curve Analyzer with Kethley 2400 series (PECK2400N2 serie)
- 6** Silicon Photodiode for tuning solar simulator (PEC-SI serie)
- 7** Peltier cooling and heating stage (PEC-T serie)
- 8** Doctor blade coating system (PECE-DB)
- 9** Functional plastic flm (PECF serie)

- **Main unit**

Dimension : W355 x D408 x H441 mm
Measurement mode : DC mode (default)
Certifiable wavelength range : 400 nm - 800 nm (default)
Available wavelength range : 300 nm - 1000 nm
Intensity of monochromatic light : ca. 2 mW at 480 nm (default)
Wavelength purity : ca. 30 nm (default)
Light source : 150 W Xe lamp (ozone less type)
Monochromator
 Optics system : modified asymmetric Czerny-Turner design
 Focal length : 100 mm Focal ratio : F=3.0
 Diffraction grating : 600 lines/mm, Blaze Wavelength 500nm (default)
 Incident slit : W2×H3.5 mm, fixed slit
Interface : USB

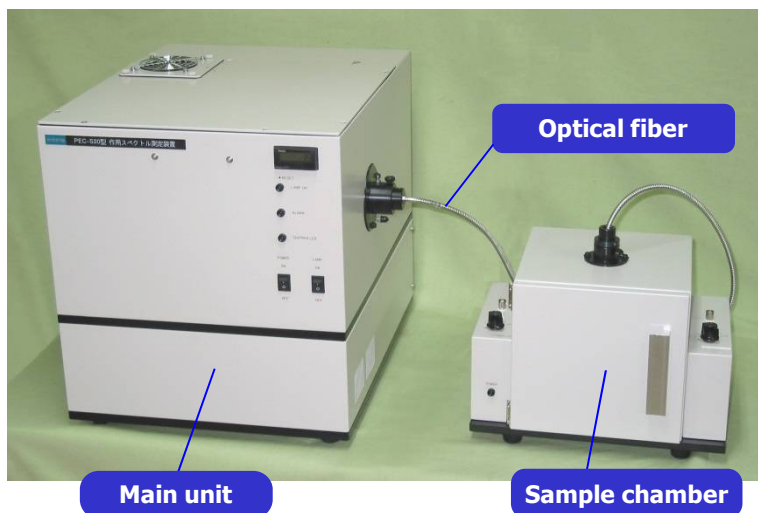
Optical fiber
Optical fiber : bundled fiber (SUS) Fiber length : 1 m
Exit diameter : ID 3 mm, ED 5 mm Folder : detachable folder

Sample chamber
Dimension : W300×H218×D200 mm
IV amp : selectable (x1, x10, x100, x1k) Output voltage : 10 V

Calibrated reference photodiode
Si photodiode : S1337-1010BQ (with calibrated spectral sensitivity data)

Software for operation and analysis
Software : PEC-PRO
Wavelength control : step scanning Filter control : auto
Data analyzing : conversion to spectral sensitivity, quantum efficiency and Jsc,
spectral calculation

- ▲ A. Standard DC measurement
- ▲ B. AC measurement
- ▲ C. White Bias
- ▲ D. with Keithley 2400 DC
- ▲ E. 1mm achromatic lens DC
- ▲ F. 1mm achromatic lens
+ Keithley DC



Overviews

- PEC-L15 is a wide area solar simulator with an illumination area of 16 cm x 16 cm equipped with air mass 1.5G filter for measuring solar cells.
- L15 with built-in feedback circuitry can control an always steady power of irradiation by the automatic operation.
- Easily change a setting of the equipment, such as a lamp current, shutter timer by the touch panel controller.

Features

- Small foot-print Lamp House with considering Usability and Safety
- Easily set a input power voltage 90-120V and 180-240V by a switch
- Easily change a setting of the equipment, such as a lamp current, shutter timer by the touch panel controller
- An illumination head is rotatable by 90°. From Up, Down, and Side, samples can be illuminated
- Light shielding shutter is moved by a DC motor not by a conventional solenoid coil. The DC motor is a low-noise one, and opens/closes a shutter without rebound. It makes maintenance of the shutter easier.
- Optical Filters can be set in the illumination head by a very easily way.



- Maximum two set of optical filters can be set in the filter holder.
- A double shell housing provides lower surface temperatures than 45°C.
- A thermostat controller avoiding heat is equipped.
- Power supply is equipped within the main body. It is the minimum size of a large area solar simulator with an illumination area larger than 160 mm x 160 mm.

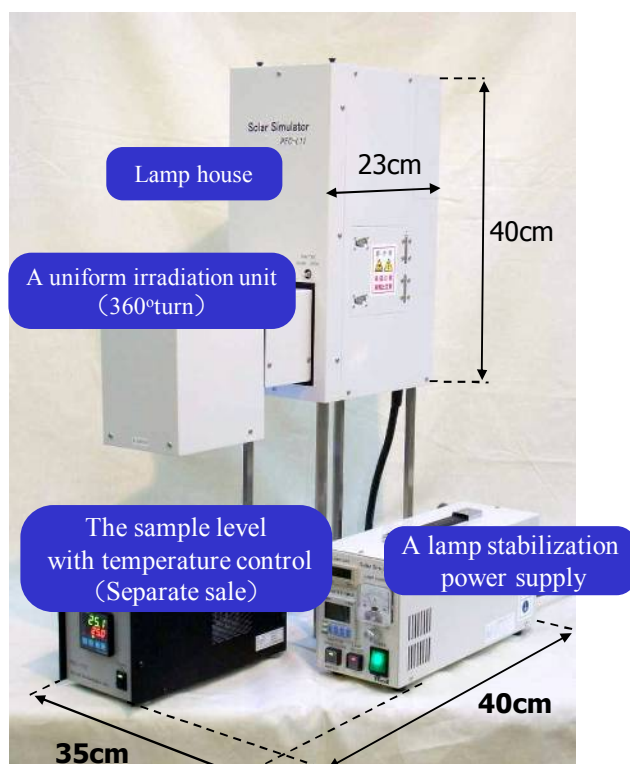
Components	<ol style="list-style-type: none"> 1. Main body Lamp unit and power unit 2. Controller Touch panel controller 3. Irradiance unit 4. Cable Power cable, Serial cable
Specifications	<p>Main body</p> <p>W250±2 × D690±7 × H356±2 mm</p> <p>Optical specifications</p> <p>Lamp : Xe short arc lamp (specified by us)</p> <p>Mirror unit : 45° all wavelength reflection aluminum mirror type</p> <p>Air Mass filter : A.M. 1.5G</p> <p>Electric specifications</p> <p>Input power : AC90-120V and AC180V-240V (Switchable) Single phase 50/60Hz</p> <p>Other</p> <p>Light shielding shutter : Pulse motor movement</p> <p>Lamp alignment : XYZ triaxial stage</p>
Function of irradiance	<ol style="list-style-type: none"> 1. Irradiance : 100 mW cm⁻² (1.0 sun) (Effective area) 2. Illumination area : 160 mm x 160 mm (Effective Illumination area) 3. Spectral mach : 0.75 to 1.25 (Effective area) (JIS C 8933, JIS C8933 Class A) 4. Illumination distance : 100 - 400 mm (From the illumination head) 5. Irradiation wavelength : 400 - 1100 nm (JIS C 8912) 350 - 750 nm (JIS C 8933) 6. Uniformity : ≤±2% (Effective area) 7. Temporal stability : ≤1%/h MAX

Summary

- PEC-L12 is a high-quality and uniform light source, which can irradiate intense light (100 mW/cm^2) to an area more than $6 \text{ cm} \times 6 \text{ cm}$. *Parallel light of uniform intensity* is generated by combination of a 150-W xenon arc lamp and an optical system including integrator lens, which set in a *compact body*.
- The spectral profile of the emitted light matches that of the sun under the AM1.5 conditions, which means the profile matches *Class-A quality* (Top quality) certificated by JIS (Japanese Industrial Standards). The maximum irradiance is as high as 150 mW cm^{-2} .
- The system can generate white light from a xenon-arc lamp with a spectral profile in the wide wavelength range from ultra-violet to infrared. The introduction of an interference filter makes the system a *monochromic parallel light source* with incident intensity.
- PEC-L12 is designed for a variety of experiments in which you use a light source to obtain *quantitative results such as quantum efficiency*. Thus, the system can apply to extensive purposes such as photochemical experiments, evaluation of solar cells and photocatalysts, and degradation and stability test.
- The absolute irradiance of the system is determined by using pseudo-amorphous silicon cell (supplied as accessory equipment).
- For usage of a solar cell evaluation system, the combination of PEC-L12 with a temperature-controlled sample stage (PEC-T10), a current-voltage (I-V) detection apparatus, and the analysis software is highly recommended.
- Pecell Technologies Inc. will serve best equipment for your advanced experiments.

Advantages and features

1. **Applying a 150-W xenon arc lamp with High Intensity.** Improving the collector optics of a 150-W xenon arc lamp provides much higher irradiance by 50% than the former type consisting of a 500-W xenon arc lamp. Applying a 150 W xenon arc lamp contributes not only a power saving but also a cost saving for changing of the lamp. The lifetime of the lamp bulb is over 1500 hours.
2. **Irradiation to a wide area with stable, uniform, and parallel light.** The emitting light is unified by an integrator lens providing high quality parallel light with an intensity distribution within 5%, and the effective illumination area more than $6 \text{ cm} \times 6 \text{ cm}$. The lenses made of BK7 reduce UV-C irradiation, and the switching regulator circuit in the power supply also contributes highly stable irradiation intensity.
3. **Easily changing irradiation direction and position of the lamp.** adjustable at any angle in 360° ; Irradiation from the top, the bottom, or the side, can be carried out. The XYZ three-axis adjuster can easily adjust the position of the xenon lamp.



4. **Low-noise cooling system of the lamp.** The lamp bulb is covered with the thermal insulation board to avoid overheating the outer jacket. In addition, the fan with a size of 120 mm cools off the lamp house. The cooling system gives the long lifetime of the Xe lamp, achieving a 5-hours operation in a day without changing the lamp in ca. 1 year.
5. **Compact size, easily set even on a small desk.** The user can set up the system even in a small space.
6. **Irradiation time reserved by the timer.** The illumination can be turned on or off by the electric shutter. The irradiation time can be controlled by the timer switch.
7. **Reducing Electromagnetic Noise.** The electromagnetic noise, caused by turning on the lamp, is reduced by putting the lamp starter inside the lamp house.

Components

1. **Lamp house:** NDXH-150ESS with a setting base and a stand (Changeable)
2. **Lamp unit:** ITE50-AM1.5G (Removable)
3. **Power supply for lamp:** NDXP-150E (Possible to set apart from the lamp house)
4. **Power source for shutter:**
5. **Power cables:** AC input

Optional products

- **Pseudo amorphous silicon cell for light intensity calibration** The equipment applies to determine illumination power.
- **Filter holder for monochromic light irradiation** PEC-L12 can provide monochromic uniform parallel light (360 nm to 900 nm).
- **Temperature-controlled sample stage (PEC-T10)** Temperature of sample is controlled by the equipment instantly.
- **I-V curve analyzer (PEC2400-N)** Current-voltage (I-V) detection apparatus (**Keithley 2400 Source Meter**) with the **I-V analysis software** (PECCELL original).

The software is strongly recommended for evaluation of the dye-sensitized solar cells, which specially developed for obtaining reliable I-V curves of the dye-sensitized solar cell.



System constitution example

Specifications

1. Lamp house: LHX-150ESS

Matched lamp: 150 W Xe arc lamp (USHIO UXL-151D-O)
 Back mirror: Al-spattered concave mirror
 Lamp bulb retainer: Small size XYZ three axis adjuster
 Exhaust fan: 120 mm box-shaped fan
 Shutter: Solenoid, wing type.
 Dimension: Lamp house: W 150 x D 150 x H 400mm
 Foot of stand: W 200 x D 200 x H 20 mm
 Legs of stand: H 200 mm, four hexagonal legs (changeable)

2. Uniform-irradiation unit: ITE50-AM1.5G

Mirror: All wavelength reflection aluminum mirror

Integrator lens: Drum lens made of BK7

Collimator lens: 100 mm in diameter made of BK7

Air mass filter: AM1.5G

3. Power supply for lamp: NDXP-150E

Control system: High frequency PWM constant current control (switching regulator)

Electrical input: AC 100V, 50-60Hz, 900VA

Output voltage: DC 20V \pm 3V (depending on the property of lamp bulb)

No-load open circuit voltage: Over 120V

Output Current: DC 5 – 8A (variable)

Total fluctuation: Less than 4%

Dimensions: W 120 x D 320 x H 160 mm

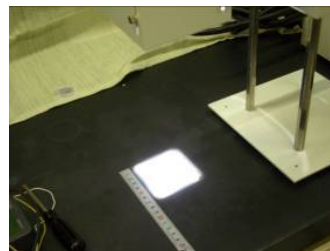
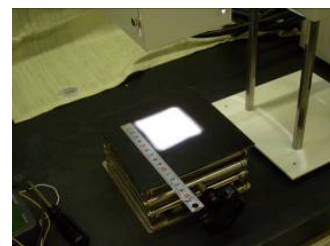
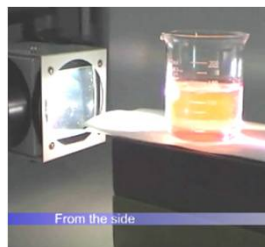
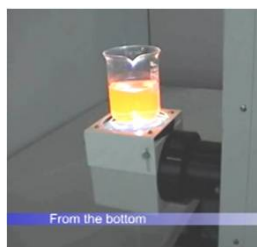
Function of the system

1.High Intensity of illumination as a solar simulator: The system provides white light with a spectral profile as matched with AM1.5, the intensity is as much as 150 mW cm^{-2} (1.5 sun).

2.Wide Range of the Effective Illumination Area: Effective illumination area is as much as 36 cm^2 (ca. 6 cm x 6 cm) in the case of a parallel light source. The usage as a non-parallel light source achieves the wide area more than 60 cm^2 .

3.Easily Adjustment of Illumination Intensity: Easy operation of adjustment of a current of the power supply, a distance between the lamp and the sample stage can control the intensity of illumination continuously. In addition, the direction of the light is adjusted at any angle in 360°.

4.Usage for Monochromatic Light Source: The combination with the special holder and interference filters (accessories sold separately) makes the system a high quality monochromatic parallel light source. In addition, pseudo-amorphous silicon cell for light intensity calibration (an accessory sold separately) provides you information about a number of photon in your experimental setup, and therefore, the determination of quantum yield of photochemical reactions will be done.



The uniform-irradiation unit is able to be turned around

Irradiation from the top, side and bottom are possible.

Irradiation with monochromatic light is possible

The number of incident photons is able to be determined quantitatively.

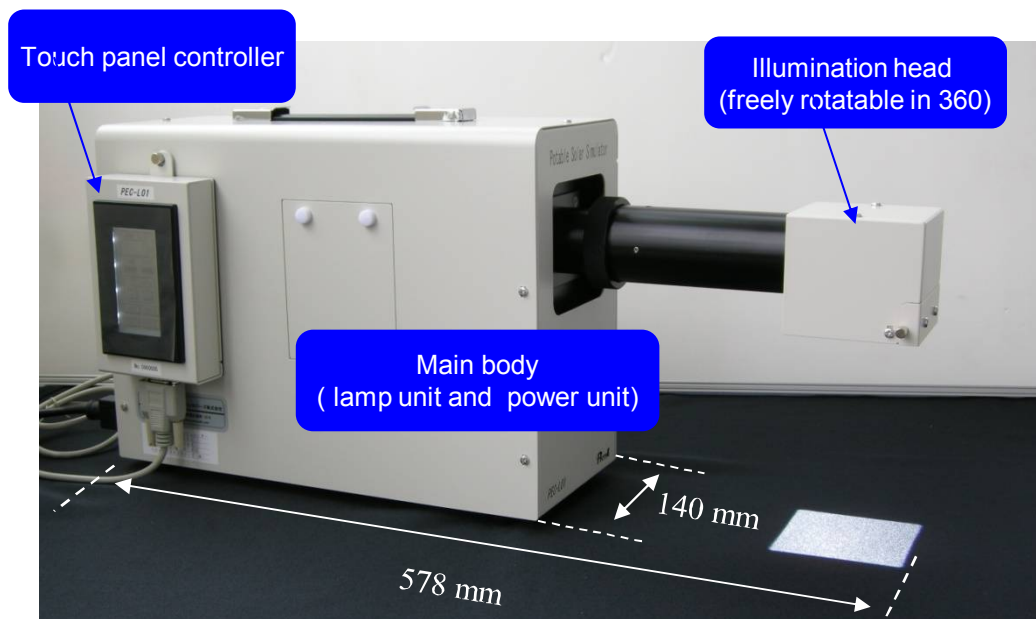
Uniform parallel light
The area is constant with different distance

Overviews

- PEC-L01 is a handy type narrow area solar simulator equipped with air mass 1.5G filter for measuring solar cells.

Features

- ★ A Light weight • Compact • Handy type solar simulator is achieved by a unique optical arrangement.
 - Illumination area $\cdots 40 \times 40$ (mm)
 - Spectral match $\cdots \leq \pm 25\%$ (JIS C 8912 Class A)
 - Uniformity $\cdots \leq \pm 2\%$ (JIS C 8912 Class A)
 - Temporal Stability $\cdots \leq \pm 1\%$ (JIS C 8912 Class A)
 - Irradiance $\cdots 150 \text{ mW/cm}^2$ (maximum irradiance in the illumination area)
- ★ Small foot-print Lamp House with considering Usability and Safety
 - Easily set a input power voltage 100-120V and 200-240V by a switch
 - Easily change a setting of the equipment, such as a lamp current, shutter timer by the touch panel controller.
 - An Illumination head is freely rotatable in 360o.
 - Light shielding shutter is moved by a pulse motor not by a conventional solenoid coil. The pulse motor is a low-noise one, and opens/closes a shutter without rebound.
 - Optical Filters can be set in the illumination head by a very easily way.
 - A double shell housing provides lower surface temperatures than 45oC.
 - A thermostat controller avoiding heat is equipped.
 - A main body consists of a lamp unit and a power unit in a one-body.



Components

1. Main body

Lamp unit and power unit

2. Controller

Touch panel controller

3. Irradiance unit

4. Cable

Power cable, Serial cable



Touch panel controller

Specifications

Main body

Dimensions	: W140 × D578 × H250 mm
Weight	: ca. 8 Kg

Optical Specifications

Xe lamp	: 150 W short-arc Xe lamp
mirror unit	: 45° all wavelength reflection aluminium mirror
Air Mass filter	: A.M. 1.5 G

Electric Specifications

Input power	: AC 90-120 V or AC 200-240 V (Changeable) Single phase 50/60 Hz
Output voltage	: DC 20 V(Depending of light)
Output current	: DC 8 A (Changeable 4 to 8A by 0.1A)
Other	
Light shielding shutter	: Pulse motor movement
Lamp alignment	: XYZ triaxial stage

Function of irradiance

1. Irradiance	: 150mW cm ⁻² (1.5 sun) max in the illumination area (A.M. 1.5G, Effective illumination area)
2. Effective illumination area	: 40 mm square (Effective illumination area)
3. Spectral much	: ≤±25% (JIS C 8912 or JIS C 8933 Class A)
4. Illumination distance	: 80-100 mm (From the illumination head)
5. Uniformity	: ≤±2 % (JIS C8912 Class A)
6. Temporal stability	: 1%/h MAX (JIS C 8912 Class A)

Outline

PECK2400-N2 is an apparatus for measuring I-V curve (current - voltage characteristic) of a semiconductor. We supply particular function that is suitable for characterizations of Si solar cells, the dye sensitized solar cells, and organic solar cells. Measurement software is design for 2400 Keithley source meters.

Components

- Source meter

Keithley 2400 source meter

Current limit : 1 nA – 1.05 A、 Voltage limit : 200 mV – 210 V

A measurement range is controllable by the software (PEC-IV2).

- Software

Peccell I-V curve analyzer (PEC-IV2)

Operating system : Windows 7 (32bit)

It was design for setting measurement parameter of the Keithley 2400 source meter, and for analyzing data.

- A serial cable for the source meter

The cable was design for the connection between PC and the Keithley 2400 source meter in the usage of the software (PEC-IV2).

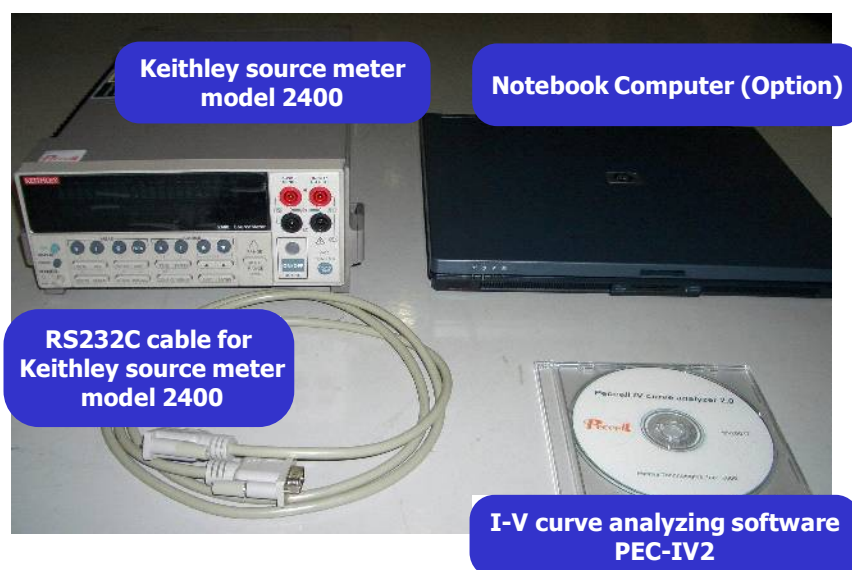
Line of products

Products name Source Meter

PECK2400N2 : Keithley 2400 source meter

PECK2401N2 : Keithley 2401 source meter

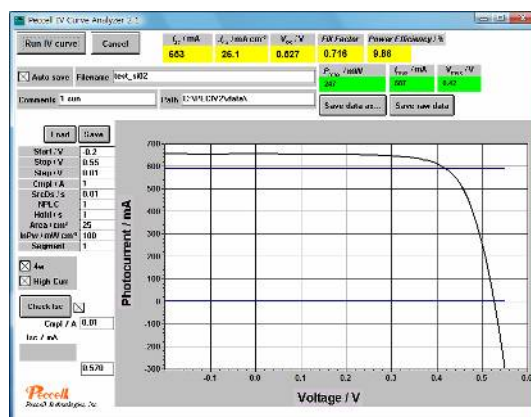
PECK2420N2 : Keithley 2420 source meter



■ The personal computer with Windows XP equipped with serial port is necessary separately. We had confirmed operation of the software for nx6320 (Hewlett-Packard). Correspondence for Windows Vista is under consideration.

Features

- 1) You can cancel the measurement anytime you want just clicking "cancel" button.
The partially measured data until middle part can be also stored.
- 2) Measuring I-V curve can be displayed in real time, and the displayed curve can be printed out immediately.
- 3) The software supports both-way and one-way scanning measurement.
The both-way scanning method is more suitable for characterization of the dye sensitization solar cell because of slow response for incident light.
- 4) The software calculates the photovoltaic parameters which are necessary for evaluations, e.g. open circuit voltage, short circuit current, conversion efficiency, fill factor, the maximum electric power, can be automatically displayed. The parameters are stored automatically as text file.
- 5) The form of saved data is easy to manage.
You can recognize measurement parameters at one view.
The I-V data are automatically calculated to data with unit area dimension.
The measured raw data are also stored.
You can draw a graph by MS-Excel, and comparison between data are easy, also.
The date and time for measurement are saved automatically within the text file.
- 6) Measurement of large area solar cell with large-photocurrent is possible.
The measurement of a solar cell with output current more than 100 mA is possible.
The maximum limitation of photocurrent is 1 A for Keithley 2400 source meter.
- 7) Easy to check the incident power
The short circuit current of standard Si-cell and the circulated incident power can be easily checked by just clicking the button. You don't have to operate a front panel of a Keithley 2400 source meter.



A measurement example of a silicon solar cell

I	A	C	D	E	F	G	H	I
1	Photocurrent	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	Open Circuit Voltage	0.550000	0.550000	0.550000	0.550000	0.550000	0.550000	0.550000
3	Short Circuit Current	-0.500000	-0.500000	-0.500000	-0.500000	-0.500000	-0.500000	-0.500000
4	Maximum Power	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
5	Fill Factor	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6	Conversion Efficiency	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
7	Incident Power	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8	Area	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9	Area / cm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
10	Area / in²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
11	Area / ft²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
12	Area / m²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
13	Area / dm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
14	Area / cm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
15	Area / mm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
16	Area / μm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
17	Area / nm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
18	Area / Å²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
19	Area / m²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
20	Area / dm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
21	Area / cm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
22	Area / mm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
23	Area / μm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
24	Area / nm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25	Area / Å²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
26	Area / m²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
27	Area / dm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
28	Area / cm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
29	Area / mm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
30	Area / μm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
31	Area / nm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
32	Area / Å²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
33	Area / m²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
34	Area / dm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
35	Area / cm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
36	Area / mm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
37	Area / μm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
38	Area / nm²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
39	Area / Å²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
40	Area / m²	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Saved data format

Outline

This standard silicon cell has passed the ruled-based inspection, and the certification is attached to the cell. (The short circuit current measured under the illumination condition with the standard sun light spectrum)

- The inspection institute
4-8, Takakuramachi, Hachioji, Tokyo
Bunkou keiki Co., Ltd.
- Example of a certification
Light source : 100mW/cm² AM1.5G Class A
Temperature : 25 °C
Output current : 0.6123 mA



Application

PEC-SI01

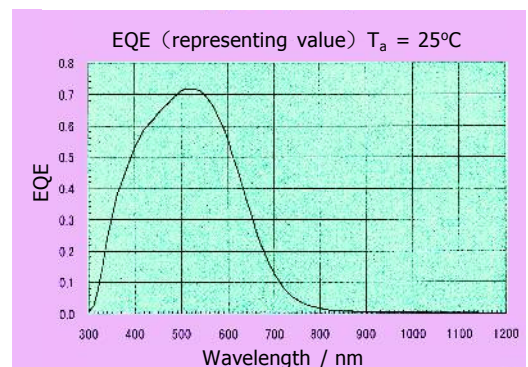
Solar simulator for Dye-sensitized /amorphous silicon solar cells
Perovskite solar cells

PEC-SI02

Solar simulator for crystalline silicon solar cells

Attention for handling

- 1.The standard silicon cell is a photo diode .Please use it for verification of a solar simulator.
- 2.Please only use it for measurement of short circuit current. The maximum limitation of current is 10 mA. Please avoid measuring a I-V curve.
3. Please avoid using under high temperature, high humidity and strong light. The capable operating temperature is between -20 to +60°C. Please avoid outdoor usage.
- 4.If you need to correct proof for pseudo sunlight, please give official approval in the certification organization.
- 5.The electrical output of the cell is different from a spectral distribution of incident light. On this account, you cannot use it for correcting proof of light sources.
- 6.A quantum efficiency spectrum is available with charge if you need. A right spectrum is typical example of a EQE spectrum.



Example of PEC-SI01 spectrum

Outline

The equipment is a Peltier type temperature controllable unit for solar cells. The cell stage consists Peltier device, TEC driver, temperature adjuster and DC power supply, which are all included in a body. Controllable temperature range is between 0 to 80 °C by 0.1 °C.

Specific**PEC-T10**

- **Sample stage area** 80×80 mm (PEC-L01, PEC-L12 type)
- **Input power supply** AC100V 50/60Hz 2A
- **Temperature range** 0 °C -80°C (@25°C)
- **Control system** PID control
- **Dimensions** W180 x H120 x D255 mm ● **Weight** 4.0kg

PEC-T15

- **Sample stage area** 200×200 mm (PEC-L15 type)
- **Input power supply** AC100V 50/60Hz 2A
- **Temperature range** 0°C-80°C (@25°C)
- **Control system** PID control
- **Dimensions** W354 x H250 x D143 mm ● **Weight** 8.5kg



PEC-T series decreased measurement error by black coating sample stage. (Figure PEC-T10)

Outline of operation

With turn on the power, it began to start controlling temperature. You can set temperature easily by input your desired value. The inputted value has been memorized after turn off the power.

Outline

After hold on a film substrate on the plate to vacuum up, titania paste is coated by applicator with constant thickness.

Method of application

1. Set an suction plate to horizontal position.
2. Hold on a film substrate on suction plate to vaccum up lightly.
3. Set an applicator to arbitrary film thickness (1mil = 25.4 μ m).
4. Hold both ends of an applicator with finger and pull the applicator to near side at equal speed.
5. After application, wash the applicator immediately with a suitable solvent.

Composition

Suction plate, Baker-type applicator, Vacuum pump

Specifications

■ Suction plate

External dimensions W205 x D300 x H40 (mm)

Plate dimensions W200 x D300 (mm)

Main body materials

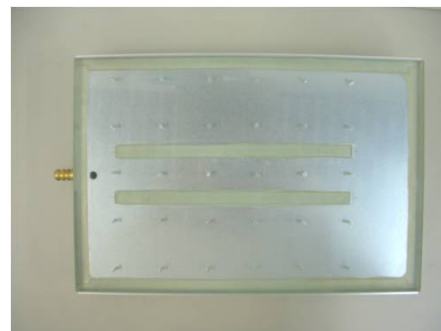
AL (Alumite treatmented), SUS

Glass plate materials float glass

Absorption hole ϕ 2mm

Hose end ϕ 10.5 x 14 mm

Weight ca. 3kg



■ Baker-type applicator

Dimension H20 x D35 x W220 (mm)

Application width ca. 150 mm

Application thickness 0 - 10 mil

Weight ca. 0.4 kg

Material SUS 304



■ Vacuum pump

Type APN-215MV-1

Exhaust velocity 15 l/min

Arrival pressure 26.66 x 10³ Pa

Materials of diagram Fulham

Fluorine rubber

Inlet port ϕ 9mm

Electric power supply AC100V 50/60Hz



Outline

The PECF series is an electro-conductive plastic film for a transparent electrode. The polyethylene naphthalate (PEN) film is used as the substrate, which has high transparency, high thermo-stability, low moisture permeability, and high chemical stability. PECF-IP shows high conductivity of ca. $13 \Omega / \text{cm}^2$ to coat indium tin oxide (ITO). PECF-CAT is alloy containing Pt and Ti coated film, and it can be apply for a counter electrode with Pt catalyst.

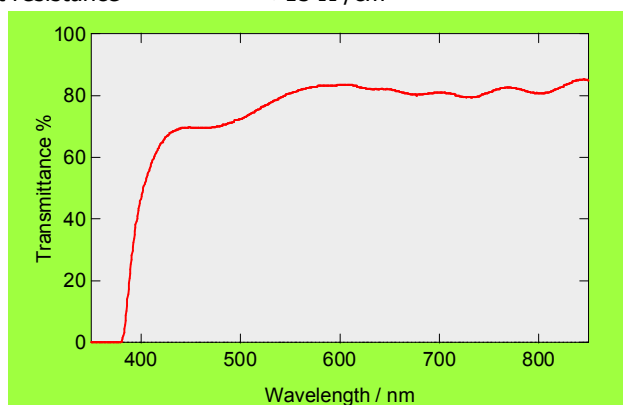
Characteristic of a PEN-film

Characteristic	Test method	Unit	PEN
Tensile strength	Base on JIS C-2318	MPa	280
Tensile elongation	Base on JIS C-2318	%	90
Consecutive use temperature (mechanical)	UL-746B	°C	160
Consecutive use temperature (electrical)	UL-746B	°C	180
Glass transition point	TDFJ method by DMA	°C	155
Melting point	DSC	°C	269
Breakdown voltage	JIS C-2318	kv/mm	300
dielectric constant (1KHz)	JIS C-2318	-	2.9
Absorbing water rate	TDFJ method	%	0.3
Density	JIS C-2151	g/cm^3	1.36
Flame resistance	UL-94		VTM-2

Conductive Plastic Film

● PECF-IP

Film substrate material	polyethylene naphthalate (PEN)
Size	A4 (29.7 cm x 21 cm)
Film thickness	125 μm
Transmission factor	80 % @550 nm
Conductive material	Indium Tin Oxide; ITO
Seat resistance	$< 15 \Omega / \text{cm}^2$



Transmission spectrum of PECF-IP

● **PECF-IP-BF2**

Film substrate material	polyethylene naphthalate (PEN)
Size	A4 (29.7 cm x 21 cm)
Film thickness	125 μ m
Conductive material	Indium Tin Oxide; ITO
Surface coating	Titanium oxide buffer layer

● **PECF-CAT**

Film substrate material	polyethylene naphthalate (PEN)
Size	9.6 cm x 9.6 cm
Film thickness	125 μ m
Surface state	metallic luster
Conductive material	Ti / Pt alloy
Sheet resistance	ca. 5 Ω /cm ²

● **PECF-CAT03**

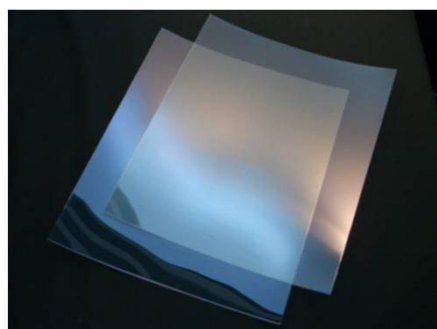
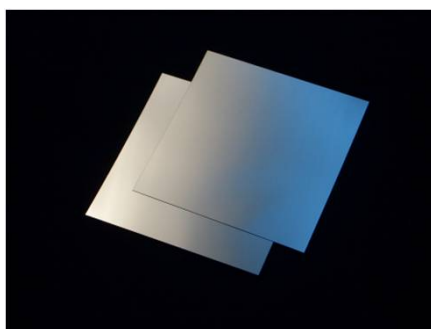
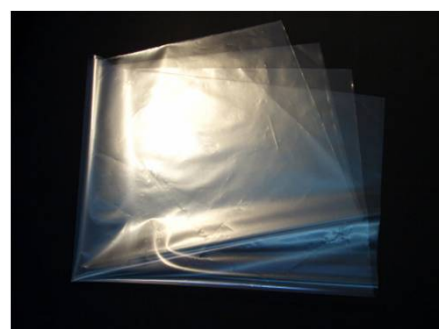
Film substrate material	polyethylene naphthalate (PEN)
Size	9.6 cm x 9.6 cm
Film thickness	125 μ m
Conductive material	Indium Tin Oxide; ITO
Surface coating	Platinum
Transmittance	60%

Hot melt film● **PECHM-01**

Type	1652
Ion type	Zn
Size	1m x 1m
Film thickness	50 μ m

● **PECHM-02**

Type	1652
Ion type	Zn
Size	0.3m x 1.2m
Film thickness	25 μ m

**PECF-IP****PECF-CAT****PECHM-01**



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AUTHORIZATION CERTIFICATE

TO WHOM IT MAY CONCERN

Date : November 6, 2013

We do hereby certify that Opvtech New Energy Co.Ltd.,
is our Authorized Representative in China.

They can participate in Tender Opening and can negotiate
Technical & Commercial matters on our behalf.

For any kind of clarifications / information, please contact them
as our Chinese Representative or can contact us directly.

Peccell Technologies, Inc

A handwritten signature in dark ink, appearing to read "H. Toriyama", written over a faint, stylized circular stamp or watermark.

Hidesada Toriyama

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