



PRODUCTS INFORMATION



Pecce Technologies, Inc.

I N D E X

- 1 IPCE (Incident photon-to-current efficiency) measurement apparatus (PEC-S10)**
- 2 High quality uniform solar simulator (PEC-L11)**
- 3 Photocurrent-voltage (I-V) curve analyzer (PECK2400-N)**
- 4 Standard Si Cell for light intensity calibration (PEC-SI01)**
- 5 Temperature controllable cell stage (PEC-T10)**
- 6 Laboratory doctor-blade coating system (PECE-DB)**
- 7 Titania paste for low-temperature coating (PECC series)**
- 8 Sensitizing dye (PECD series)**
- 9 Conductive plastic film (PECF series)**
- 10 Hot-melt film for sealant (PECHM series)**

1 IPCE (Incident photon-to-current efficiency) measurement apparatus (PEC-S10)

Components & Specific

- **Lamp house** Lamp : 150W Xe lamp and stabilized power supply
Collector optics : Mirror type
- **Monochromator** Focal length : 10 cm Focal ratio : F=3.0
Resolution : 2 nm (in the case of diffraction grating with 600 lines)
Range of measurement : 400 nm~800 nm
(Available wavelength : 300~1000 nm)
Incident power of monochromatic : 5 mW / cm² at 550 nm
- **Light guide** Quartz fiber optics (external diameter : 5 mm, length : 90 cm)
Irradiate area : 3 mm in diameter
- **Sample chamber** Body : Light-shielding chamber with a optical fiber holder
Dimension : W100 x H100 x D150 mm
Sample stage : Height controllable stage
- **Calibration** Certificated Si-diode with JIS 1337
- **Interface** RS232C interface
Control : wavelength scanning, filter switching, data importing
- **Software** STD-PRO for spectral display, spectral calculation, analyzing data

Optional products

For IPCE measurement by DC method (Continuous irradiation)

DC amplifier

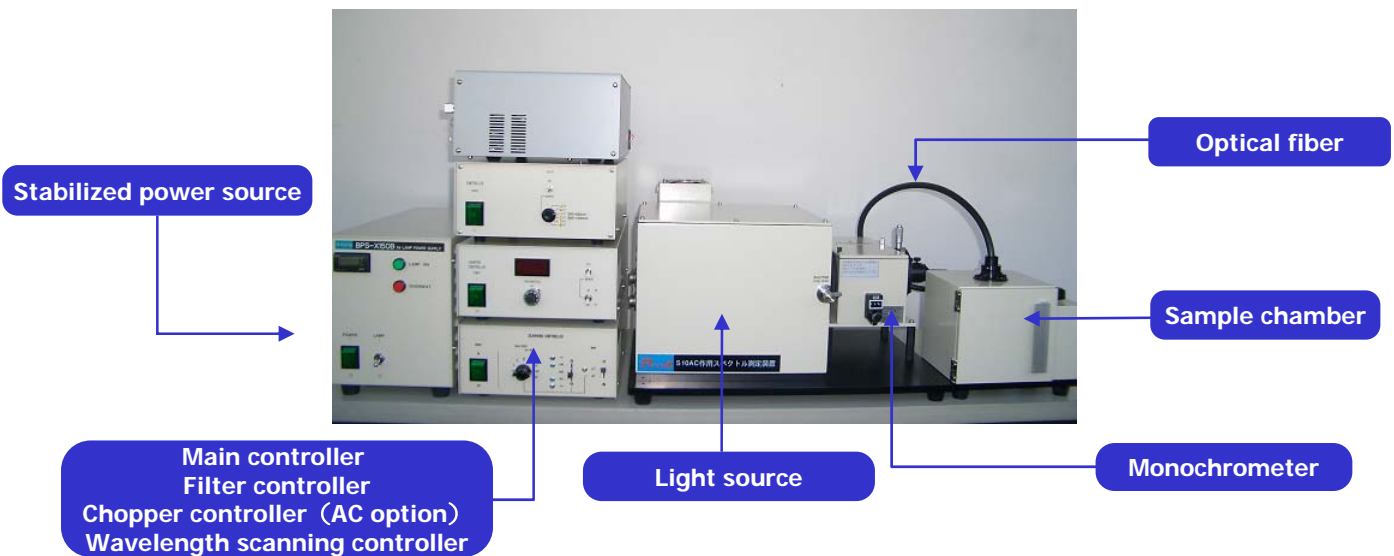
For IPCE measurement by AC method (Alternating irradiation)

Chopper controller : 13 Hz to 100 Hz

Lock-in amplifier : NF LI5630 or a similar product

■ A Windows PC with a RS232C port should be needed.

IPCE measurement apparatus : PEC-S10

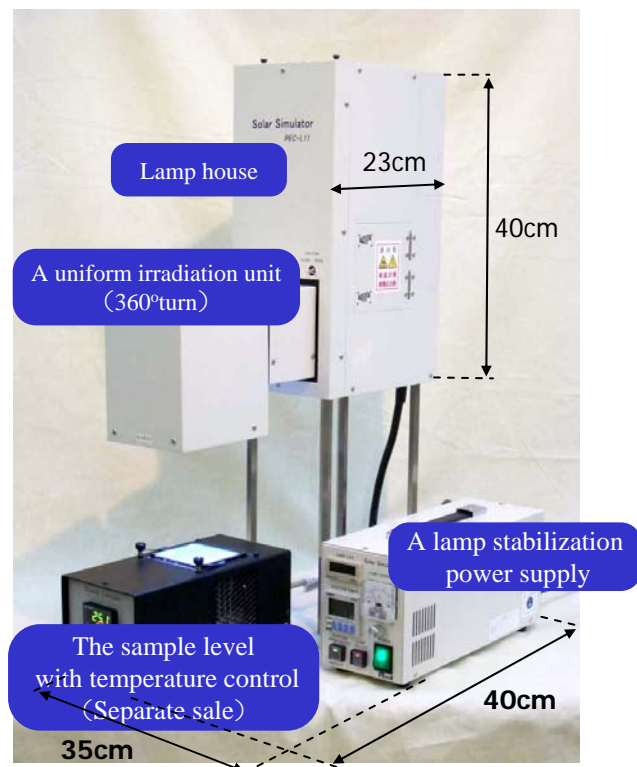


Summary

- PEC-L11 is a high-quality and uniform light source, which can irradiate intense light (100 mW/cm²) to an area more than 6 cm x 6 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-L11 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-L11 with a temperature-controlled sample stage (PEC-T10), a current-voltage (I-V) detection apparatus, and the analysis software is highly recommended.
- Peccell 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 cm x 6 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-L11 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

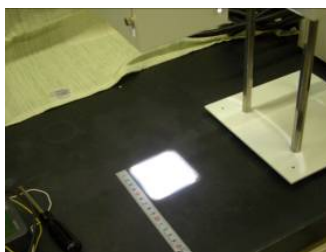
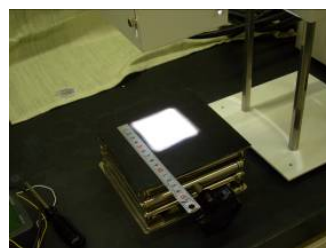
Function of the system

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 cm² (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 cm².

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

Outline

PECK2400-N 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 **NEW!**

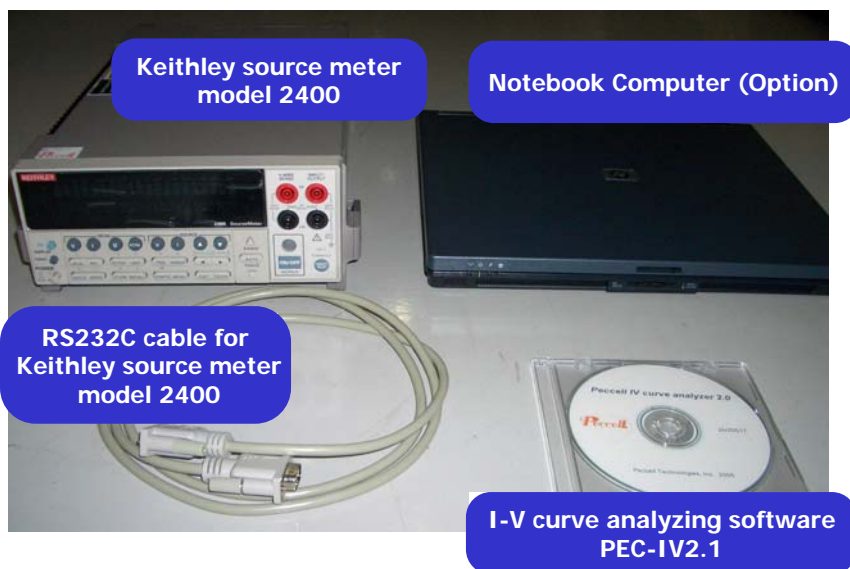
Peccell I-V curve analyzer Ver. 2.1 (PEC-IV2)

Operating system : Windows XP

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

- A serial cable for the source meter

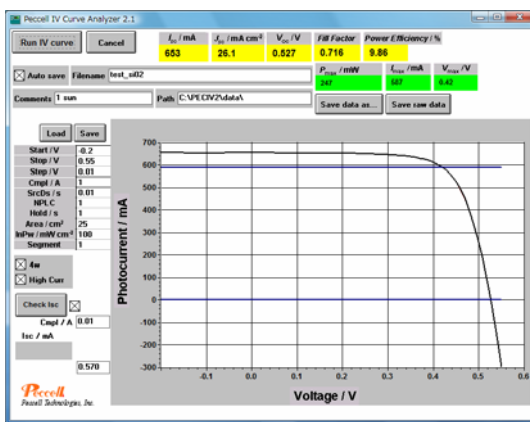
The cable was design for the connection between PC and the Keithley 2400 source meter in the usage of the software (PEC-IV2).



- 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. **NEW!**
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 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. **NEW!**
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 **NEW!**
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

Segment	Voltage / V	I / mA	P / mW	Efficiency / %
17	0.62	0.62	0.3844	4.08
18	0.57	0.62	0.3534	3.71
19	0.52	0.62	0.3224	3.34
20	0.47	0.62	0.2914	3.07
21	0.42	0.62	0.2604	2.70
22	0.37	0.62	0.2294	2.33
23	0.32	0.62	0.1984	1.96
24	0.27	0.62	0.1674	1.59
25	0.22	0.62	0.1364	1.22
26	0.17	0.62	0.1054	0.85
27	0.12	0.62	0.0744	0.48
28	0.07	0.62	0.0434	0.11
29	0.02	0.62	0.0124	0.01
30	0.00	0.62	0.0000	0.00

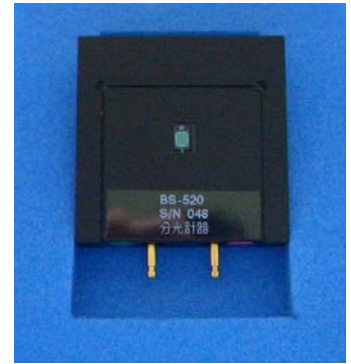
Saved data format



Outline

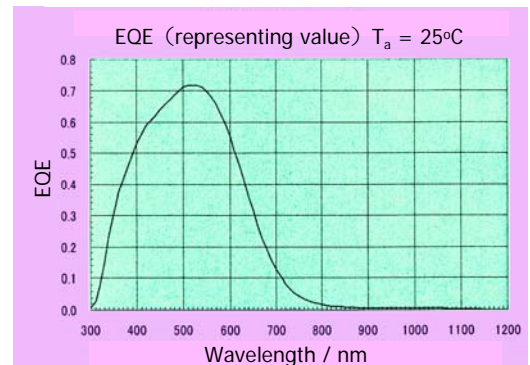
This standard silicon cell has passed the ruled-based inspection, and the certification is attached to the cell. (The short circuit current measured under the illumination condition with the standard sun light spectrum)

- 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



Attention for handling

1. The standard silicon cell is a photo diode having a similar spectral sensitivity distribution of typical dye sensitized solar cell, which was developed according to the literature by Dr. Shogo Ito (Reference). 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.



Reference

Calibration Method of Solar Simulator for Measuring Performance of Dye-Sensitized Solar Cells (201st ESC, 2002, Philadelphia)

Examples of equipment for measuring closed circuit current (Equipment needs measurement ability of DC 600 μ A)
 e.g. Digital multi-meter 83-3, 85-3, and 187 models (FLUKE)

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

- **Input power supply** AC100V \pm 10% 50/60Hz
- **Consumption electricity** MAX 250VA 200W
- **Operational condition** Temp. 20°C~40°C Humidity 20~85% (without dew condensation)
- **Temperature range** 0°C~80°C
- **Sample stage area** 80×80 mm
- **Control system** PID control
- **Control voltage** \pm 12V ● **Maximum current** \pm 5.0A ● **Built-in fan** 12V 0.2A(Max)
- **Built-in Peltier cooling unit** rated voltage 12V rated current 5A
- **Large temperature difference** 40°C(@25°C) ● **Ability for cooling** 35W (@25°C)
- **Dimensions** W120 x H120 x D255 mm ● **Weight** 4.0kg
- **Warming up time** More than 30 minutes

**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.

Safety function

When the temperature of sample stage became more than 85 °C, the equipment stops to control temperature. (initial setting)

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 treated), 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



7 Titania paste for low-temperature coating (PECC series)

Outline

The PECC series is viscous paste containing titania nano particles, which was developed for film preparation at low temperature process. You can prepare mesoporous titania thin film without high temperature sintering process by coating the paste on suitable substrate such as plastic films. Because the paste doesn't contain resin binders, the titania film can show high conductivity, and it makes possible to be apply for a photoelectrode of a dye sensitized solar cell. The mesoporous titania film with ca. 10 μm thickness can be prepared by simple coating and drying processes under following recommended condition.

Method of coating

- 1. Coating** : Coat the peast without dilution to 80-120 μm of thickness on an appropriate substrate by the doctor blade or the squeegee method.
- 2. Heat-treatment** : After drying (about 15 minutes) at room temperature, heat at 150 $^{\circ}\text{C}$ for more than five minutes.

■Attention■ There is possibility to find little separation of the paste when you receive. In such cases, please coat the paste after enough mixing, and be care that sonication for a long time may induce aggregation occasionally.

Specifications

●PECC-C01-06

The main size of TiO_2 particles	60 nm
The main component of solvents	<i>t</i> -butanol, water
Weight ratio of solid content	8 to 9 %
Character	The paste provides a better transparency mesoporous film than PECC-K01. It has higher stability and gives more easily coating than PECC-K01.
Intended use	Student experiments for photocatalyst and dye sensitization solar cell Development for dye sensitization solar cell and photocatalyst

●PECC-K01

The size of TiO_2 particles	60 nm + 250 nm (weight ratio 8:2)
The main component of solvents	<i>t</i> -butanol, water
Weight ratio of solid content	8 to 9 %
Character	The paste contains scattering component, which provides mesoporous titania film with higher scattering effect. The prepared film will show better performance than PEC-C01-06.
Intended use	Development for dye sensitization solar cell and photocatalyst

■Stability of storage

Storage in the refrigerators in the dark is suitable, which will keep stability for coating performance at least three months.

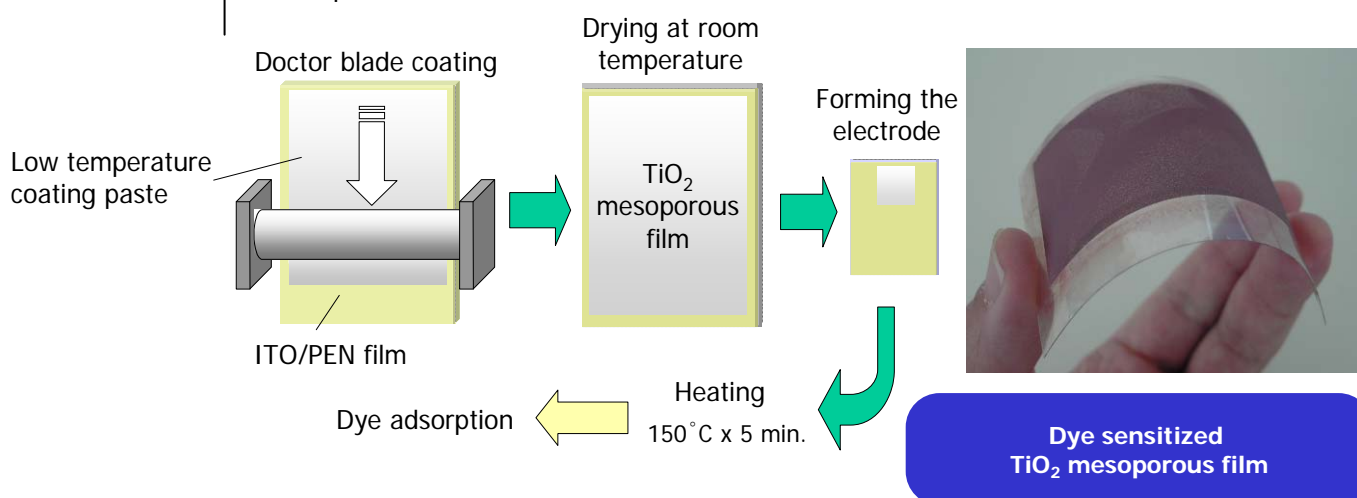
References

1. T. Miyasaka, M. Ikegami, and Y. Kijitori, *J. Electrochem. Soc.*, **154**, A455-A461 (2007).
2. Y. Kijitori, M. Ikegami, and T. Miyasaka, *Chem. Lett.*, **36**, 190-191 (2007).



■ Example of preparation method of dye sensitized film electrode

1. As mentioned above, a titania film with 10 μm thickness was prepared on a transparent film electrode (ITO/PEN film, 200 μm thickness, ca. 13 Ω/cm^2), Ruthenium dye PECD07 (popular name N719) was adsorbed on the prepared titania electrode from the dye solution.
2. A solar cell (active area : 0.64 cm^2) was fabricate to combine the dye adsorbed photoelectrode and a counter electrode, and then the 3-methoxy propionitrile solution containing 1,2-dimethyl-3-propylimidazolium iodide (DMPImI) 0.6M, LiI 0.1M, I_2 0.05M, and 4-tert-buthyl pyridine 0.5M was injected into the cell as electrolyte.
3. To measure the I-V curve with irradiation by a solar simulator at the intensity of 100 mW/cm^2 , the conversion efficiency will be achieved more than 4% at room temperature.



8 Sensiting dye (PECD series)

Outline

PECD, which are the ruthenium complex type dye, was adsorb on the titania electrode from the solution, which provide you dye sensitized mesoporous titania electrode.

● PECD03

N3 Dye

cis-bis(isothiocyanato)bis(2,2'-bipyridyl-4,4-dicarboxylato)ruthenium(II)

● PECD07

N719 Dye

cis-bis(isothiocyanato)bis(2,2'-bipyridyl-4,4-dicarboxylato)ruthenium(II) bis-tetrabutylammonium

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 PET film, and it can be apply for a counter electrode with Pt catalyst.

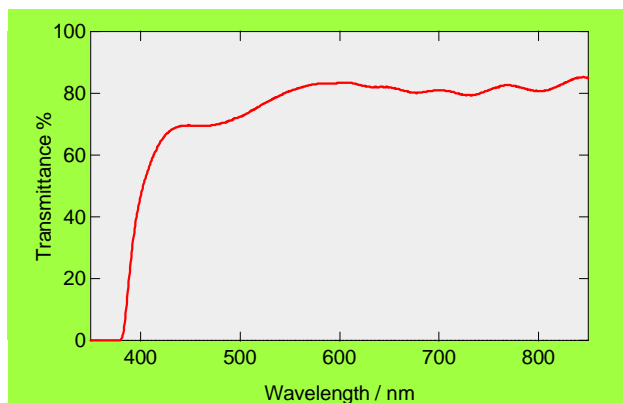
Characteristic of a PEN-film

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

Specifications

● PECF-IP

Film substrate material	polyethylene naphthalate (PEN)
Size	25 cm x 20 cm
Film thickness	200 μm
Transmission factor	80 % @550 nm
Conductiv material	Indium Tin Oxide; ITO
Seat resistance	< $15 \Omega / \text{cm}^2$

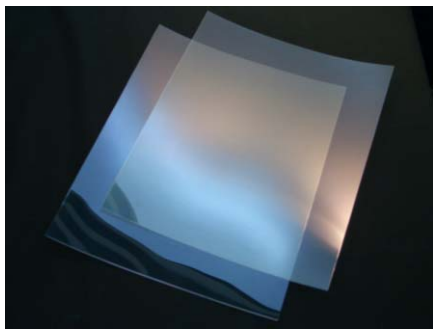


Transmission spectrum of PECF-IP

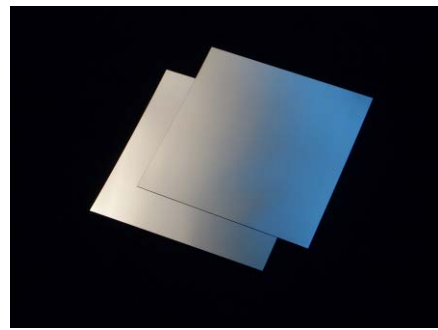
● **PECF-CAT**

Film substrate material	polyethylene naphthalate (PEN)
Size	98 mm x 98 mm
Film thickness	188 μm
Surface state	metallic luster
Conductive material	Ti / Pt alloy
Seat resistance	ca. 5 Ω /cm ²

M. Ikegami, K. Teshima, K. Miyoshi, T. Miyasaka, T.C. Wei, C.C. Wan, Y.Y. Wang
Appl. Phys. Lett., **90**, 153122-153124 (2007)



PECF-IP



PECF-CAT

10

Hot-melt film for sealant (PECHM series) *NEW!*

Outline

We handle Himilan® of Mitsui-DuPont poly chemical.

Specifications

● **PECHM-1**

Type	1702
Ion type	Zn
Size	1m x 1m
Film thickness	50 μm



PECHM-1



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