Peccell I-V Curve Analyzer ver. 2.0

(Software for the measurement of I-V characteristic of solar cells)

Operation manual

Peccell Technologies, Inc.

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Peccell I-V Curve Analyzer ver.2.0

1) The software displays an I-V curve on a display while measuring and prints the curve.

The display image is shown in Figure 1.

2) The software supports the round-trip bias voltage scan when measuring IV curve.

The voltage scan of $I_{sc} \rightarrow V_{oc}$ as well as $V_{oc} \rightarrow I_{sc}$ is possible. In addition, the both scans are possible in succession. High reliability I-V curve by averaging a forward scan and a reverse scan is automatically calculated and saved as a csv format.

3) The software supports the characteristic evaluation of dye-sensitized solar cells, which have slow photoelectric response.

4) The software automatically computes the characteristic value which is necessary for the research.

It computes an open circuit voltage (V_{oc}), a short circuit current (I_{sc}), energy conversion efficiency (η), a fill factor, a maximum output power and so on automatically and it displays them on the display. Of course, these values are saved as a text file.

5) The software saves I-V curves and characteristic values as a format easily processed.

The saved format helps you easily find measurement parameters, characteristic parameters of an I-V curve. An I-V curve is saved after calculating current density by dividing current data by a cell area. Of course, raw data are saved together. With Microsoft Excel, you could make a graph immediately.

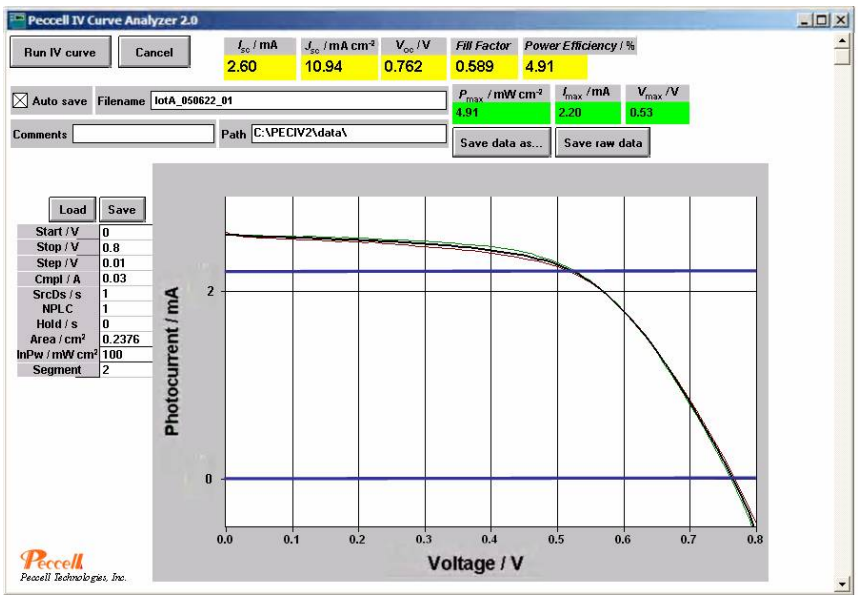

Figure 1. The snapshot of the measurement panel. The red line stands for I-V curve when bias voltage scan from 0 to 0.8 V, while the green line stands for I-V curve when bias voltage scan from 0.8 to 0 V. The black solid line show the data of the averaged I-V curve of forward and reverse scans. The blue line is guiding the current which gives maximum output electric power.

A method for measurement and analysis of I-V characteristics of solar cells

Peccell IV Curve Analyzer ver. 2.0 (hereinafter, the software) supports controlling Keithley.2400 source meter (hereinafter a source meter), which is connected to a Windows PC by RS-232C cable.
When measuring, you should set the following parameters.

The explanation of the parameter

Start / V	start voltage in a measurement (example "0")
Stop / V	end voltage in a measurement (example "0.8")
Step / V	interval voltage in a measurement The recommendation value is 0.01 V or less (example "0.01")
Cmpl / A	current limit in a measurement (Compliance limit) of a source meter. (example "0.03" (Note 1))
SrcDs / s	a delay time (search delay) for measuring current after reaching to a setting bias voltage. (example "1" (Note 2))
NPLC	NPLC is the abbreviation of number of power line cycle. It determines an acquiring time of data. A source meter runs in accordance with a AC power source frequency. For example, the frequency is 50Hz in eastern Japan. In the case, 1NPLC is 1/50 (= 20 ms). (example "1")
Hold / s	waiting time before measurement begin. During the hold time, a solar cell exists a short circuit condition. (example "0")
Area / cm^2	An active area of a solar cell. When your solar cell has a cell active area with 1 x 1 cm square, you fill “1” in the field.. (example "1")
InPw / mW cm^{-2}	an irradiance power The standard irradiance is 100 mW cm^{-2} under 1 sun.
Segment	When you measure both forward and reverse voltage scan, you fill “2” in the field. While you measure one direction bias voltage scan condition, you fill “1” in the field. ("1”)

(Note 1)

In the case of a dye-sensitized solar cell with a cell area of less than 1 cm^2, a recommended compliance limit is 0.03 (30 mA). In the case of a large area cell, you could set a compliance limit according to the area.
The relation between set Compliance limit and the measurement possible voltage value and so on is Refer to the manual of Keithley 2400.

(Note 2)

In case of the dye-sensitized solar cell, delay time of 1 second is recommended due to its slow photoelectric response.
Search delay depends on preparation of TiO_2 film, electrolyte, or something.

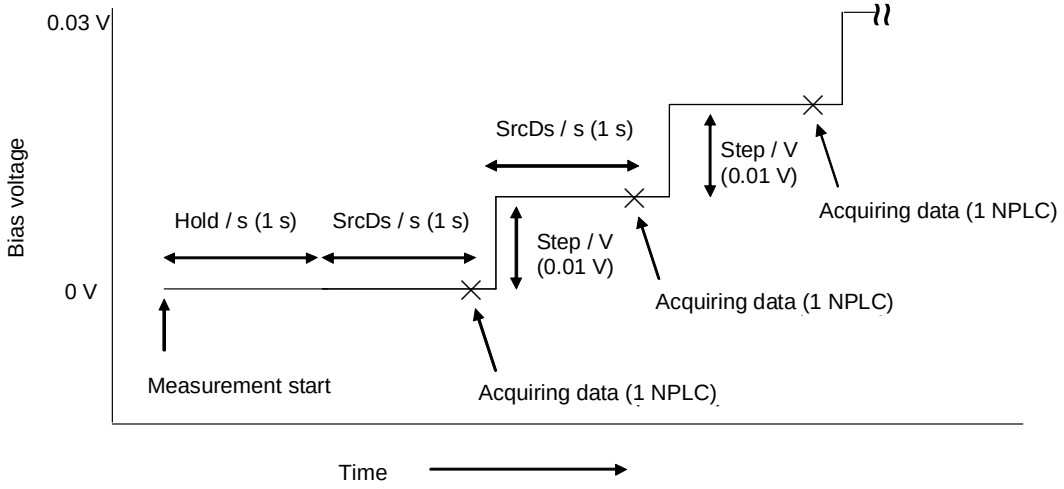

Figure 2. Scheme of I-V curve measurement, when following parameter is set. Start/ V “0”, Hold /s “1”, Step/V “0.01”, SrcDs/s “1”, NPLC “1”.

Measurement procedure

1) Turn on a solar simulator. We recommend that solar simulator is turned on first because start of Xe lamp sometimes results in fluctuation of AC voltage which may cause damage of other electric equipment such as a personal computer.
2) Turn on a PC and a sourcemeter (Keithley 2400)
3) Wait for more than 10 min, for the stabilization of the sourcemeter and the other equipment.
4) Before quantitative measurement, confirm irradiation power by the silicon standard cell (BS520 silicon cell) or the spectral analyzer (EKO LS-100 recommended).
5) Peccell I-V Curve Analyzer (hereinafter, PECIV2) is started.
6) Input parameters to the table in the measurement panel left side of PECIV2.
   Measurement parameter could be saved by using “Save” button. When you have a measurement parameter file, you could load the file by using “Load” button.
7) When there is a check mark in "Auto save" (the default setting), in the file name inputted to "Filename", it is automatically saved after measurement. The auto save path is C:¥PECIV2¥DATA.
8) When inputting a comment to "Comments" beforehand, a comment is saved with data.
9) When pressing "Run IV curve", the measurement starts.
10) When pressing "Cancel", the measurement can be ended on the way.
11) When there is not a check mark in "Auto save", you can save data by using "Save data as" after measurement ending. You also save data as a different name by by using "Save data as" option.
12) When pressing "Cancel", the raw data could be saved by pressing "Save raw data"
13) When measuring in series, measuring data is saved in the file of the same file name.
    The data can be distinguished between by entering "Comments" at this time.
14) “Ctr + Shift + P” results in printing a snapshot of measuring file.

1) The data is saved as a csv formant.
2) Commenting, a parameter, characteristic values, measuring voltage, current densitieses, electric current values such as the change efficiency and the curve factor are preserved in the data file.
3) The data of a forward scan, a reverse scan, and the averaged curve are saved when you choose parameter segment “2”.

Microsoft Excel - aaa.csv

ファイル(F) 編集(E) 表示(V) 挿入(I) 書式(O) ツール(T) データ(D) ウィンドウ(W) ヘルプ(H)

MS Pゴシック 11

F6

	A	B	C	D	E	F	G
1							
2							
3							
4	Start / V	-0.05					
5	Stop / V	0.5					
6	Step / V	0.01					
7	Compliance / A	0.03					
8	Search Delay / s	0.01					
9	NPLC	1					
10	Hold Time / s	0					
11	Cell Active Area / cm^2	0.64					
12	Input Power / mW cm^-2	100					
13	Segment	2					
14							
15	Isc / mA	0.014573475	0.014705	0.014441 95			
16	Jsc / mA cm^-2	0.022771055	0.022976563	0.022565547			
17	Voc / V	0.437486656	0.437509252	0.437463238			
18	Fill Factor	0.766468961	0.761980936	0.771 03993			
19	Efficiency / %	0.007635589	0.007611396	0.007659782			
20	Pmax / mW	0.007635589	0.007611396	0.007659782			
21	Imax / mA	0.01357438	0.01353137	0.01361739			
22	Vmax / V	0.36	0.36	0.36			
23							
24	Voltage / V	J / mA cm^-2	J1 / mA cm^-2	J2 / mA cm^-2	I / mA	I1 / mA	I2 / mA
25	-0.05	0.022613031	0.022755359	0.022470703	0.014472	0.014563	0.014381
26	-0.04	0.02259725	0.022399641	0.022794859	0.014462	0.014336	0.014589
27	-0.03	0.022241516	0.022178281	0.02230475	0.014235	0.014194	0.014275
28	-0.02	0.022680203	0.022794813	0.022565594	0.014515	0.014589	0.014442
29	-0.01	0.022557664	0.02258925	0.022526078	0.014437	0.014457	0.014417
30	0	0.022771055	0.022976563	0.022565547	0.014573	0.014705	0.014442
31	0.01	0.022273148	0.022209875	0.022336422	0.014255	0.014214	0.014295

Figure 3. The save data format.

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Thermostatic cell holding stage PEC-T10

- Flat stage cell holder is requirement.
- Temperature controlled range from 0 to 80 ^{o}C
- Piezoelectric thermo sensor.

Operation is very easy as following

1) Turn on the switch
2) Set a temperature as you expected by pressing buttons with direction mark of up and down.

Measure for safety

1) The glass fuse (3A) prevents from an over-current.
2) When the stage temperature reaches 85 ^{o}C, the power is shut down automatically.

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