Solar Cell IV Curve

Purpose

This test is to demonstrate solar cell's IV curve test. You can use Potentiostatic IV curve technique or Galvanostatic IV curve technique for this purpose.

These two techniques use stair case wave form (Potentiostatic stair case wave form for Potentiostatic IV curve and Galvanostatic stair case wave form for Galvanostatic IV curve.

Smart manager will apply stair case waveform using constant DAC value increment or decrement with constant time duration. Smart Manager calculate DAC increment/decrement value nearby step height(or sampling interval) which user defined and time duration to meet nearby scan rate which user defined.

User can select averaging sampling condition.



This demonstration's test condition is;

- Potentiostatic IV Curve
 - Voltage range: From Eoc to 0V
 - Scan rate: 20mV/sec
 - Staircase height: 20mV
 - Data sampling (100% average at each step)
- Galvanostatic IV Curve
 - Current scan rate: 0A to -10mA
 - Cutoff potential: 0V
 - Scan rate: 100uA/sec
 - Staircase height: 100uA
 - Data sampling (100% average at each step)

Preparation

- ZIVE SP/MP electrochemical workstation
- Solar cell
- Light source (75Watt halogen lamp)

Cell Connection

+ electrode(Green lead & Blue lead)

- electrode(White lead & Red lead)



Procedure

- 1. Turn the Power switch on the ZIVE SP/MP electrochemical workstation
- 2. Open the SM software by clicking the SM icon. The following progress box will appear, and will show the progress of checking instrument configuration and communication between ZIVE SP/MP electrochemical workstation and PC.



If the link is successfully connected, Click "OK" button on the box then the progress box will automatically disappear and SM software will appear. If the link failed, The following progress box will display then click the "Retry" button.



If the link failed again after clicking "Retry" button, you need to check USB cable connection.

3. Galvanosatic IV curve technique file: Click New technique function icon (or select Experiment-Techniques on Experiment menu) Then you can see the following menu

asic IV EIS IV Energy IV Corrosion IV	Ecriem ^	Parameters Informa	Open				
Ru Measurement		ITEM	VALUE	1	Option	-	Save
G-Ru Measurement		Initial current(A)	0.0000e+0				
EIS package(EIS) Static fragmency scapping		Final current(A)	-10.000e-3				Save as
Potentiostatic EIS	100	Step current(A)	100.00e-6				
Galvanostatic EIS		Scan rate(A/s)	100.00e-6				Apply to CH
		Step sampling	LAST 100%	+			
Dynamic frequency scanning		Limit potential(V)	0.0000e+0	-			Close
Potentiodynamic PEIS		IR Measure	□ On				
Galvanodynamic GEIS		I Range(A)	1 A	+	Auto	-	
Potentiostatic HFR Galvanostatic HFR Galvanostatic HFR Galvanodynamic HFR Multisme Multisme PEIS Multisme GEIS Energy package(BAT) CC/CV Test CC/CC Test Dischame test	ľ						

- 4. Click "Save" button to save the technique file which contains the above parameter and save it as "solarcell.giv" file name and click "Apply CH" button to assign this technique file on channel.
- 5. To start experiment, click Start button
- 6. After click start button, you can see the following box.



You can see real time plot as the following.



You can display graphic or data editor by clicking right mouse on data file name

Data file name	134710	0.1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Filo cizo	01	Open DC Graph
	10	Open EIS Graph
DI On/Off	0(Open CYCLE Graph
Booster	N	
		Open data editor

7. You can see voltage, current vs test time when you selected those parameter on DC graph



8. You can see voltage vs. current when you selected those parameter on DC graph



coninge	iration & Dat	ta Filter				×
		[Se	et Axes]—			[Data Filter]
Item	Axis-X	Axis-Y1	Axis-Y2	Axis-Y3	Axis-Y4	Test time I: 0 ~2:44
lame	I	Eref	None	None	None	
Scale	Auto	Auto	Auto	🔽 Auto	Auto	□ File number :
4aximum	161.76e-6	4.2015e+0	161.76e-6	10.000e+0	10.000e+0	Cycle number :
1inimum	-8.2500e-3	210.03e-3	-8.2500e-3	0.0000e+0	0.0000e+0	
Direction	✓ Invert	🗌 Invert	☐ Invert	Invert	Invert	□ Step number :
Color		ĺ.				
						Kerresh Cancer
3- .5- 2-						
.5-						
1-						
m-						L
m -						
)m -						

1.0

-1

9. You can see Current vs. voltage by clicking on DC graph



Plot Config	uration & Da	ta Filter				×			
		[S	et Axes] —	[Data Filter]					
Item	Axis-X	Axis-Y1	Axis-Y2	Axis-Y3	Axis-Y4	Test time v: 0 ~2:44			
Name	Eref	I	None	None	None				
Scale	Auto	🔽 Auto	🔽 Auto	🔽 Auto	Auto	File number :			
Maximum	4.2015e+0	161.76e-6	161.76e-6	10.000e+0	10.000e+0	Cycle number :			
Minimum	210.03e-3	-8.2500e-3	-8.2500e-3	0.0000e+0	0.0000e+0				
Direction	Invert	✓ Invert	Invert	🗌 Invert	Invert	Step number :			
Color						Befrech Cancel			
						Kellesh Callee			
-8m -						[Legend] solarcel_gv_01[1]			
-6m									
-5m						<u>\</u>			
-4m —									
-3m									
-2m									
- TW -									
	i 500m	1	1.5	2	2.5	i i i 3 3.5 4			
				Eroff					

10. Potentiostatic IV curve technique file: Click New technique function icon (or select Experiment-Techniques on Experiment menu) Then you can see the following menu

Cyclic voltammetry	^	Parameters Informat	tion				
Ru Measurement		ITEM	VALUE		Option	-	Save
		Initial delay	Enable		1		
G-Ru Measurement		-Duration(s)	1:40				ds
Static frequency scanning		-Stability(V/s)	1.0000e-3				107
Potentiostatic EIS		Initial potential(V)	0.0000e+0		Eoc	-	Apply to CH
Galvanostatic EIS		Final potential(V)	0.0000e+0		ERef	•	
Pseudo gavanostatic EIS		Step pontial(V)	4.0000e-3			-	Close
Supervision State		Scan rate(V/s)	10.000e-3				
Potentiodynamic PEIS		Step sampling	LAST 100%	•	Í		
Intermittent frequency scanning		IR Measure	∏ On				
🖉 Intermittent potentiostatic EIS		I Range(A)	1 A	-	ľ.		
Fitemitten: gawanostatic EIS Fitemitten: gawanostatic EIS Potentiostatic HFR Galvanostatic HFR Galvanodynamic HFR Galvanodynamic HFR Multisine Multisine GEIS Energy package(BAT) CC/CV Test CC/CV Test Discharge test EVS Test Variable scan rate CV Pstat IV Curve	ľ					_	

11. Click "Save" button to save the technique file which contains the above parameter and save it as "solarcell.piv" file name and click "Apply CH" button to assign this technique file on channel.

Data Analysis

2.

4.

Open "IVMAN photo voltaic analysis" by clicking IVMAN photo voltaic icon
 To use this analysis software, you must install IVMAN software package. This software package is on setup CD.



You can see the following independent software display. IVMAN Photovoltaic Cell Analysis v1.2 [solarcell_giv_01.sdo] ↔ 1223 X File Zone Conditions Model I-V Curve Parameters Data Model to fit Init 1 10 minx² minx² Current 5 o Fitted Power 🦰 None 9m 24m Error ^ -22m 8m -20m 7m -18m 5 cm' бт -16m -14m p 2 5m Density -12m 🕺 4m -10m ≧ ^ Current 3m -8m -6m 2m None -4m 1m -2m 0 -0 2 2.5 3 Potential [V] 4.5 ò 500m 1 1.5 3.5 4 十间零

3. Input parameters





1 $min \chi^2$ min x² 5. Fitting by click

10



٨

You can see analysis result in parameter tab. 6.

I-V Curve	Parameters	Data		
			Eye-fitted	Best-fitted / Error
- CONDITI	ONS -			
Area [cm^	2]		49	
Irradiation	[W/m^2]		15300	
Temperatu	ire [K]		300	
- PARAME	TERS -			
Open-circu	uit voltage [V]		4.119126	4.118494
Short-circuit current [A/cm^2]			0.000166	0.000167
Voltage @ max power [V]			3.233027	3.208627
Current @ max Power [A/cm^2]			0.000141	0.000141
Max power	r [W/cm^2]		0.000455	0.000452
Fill factor			0.665127	0.656717
Efficiency	[%]		0.029707	0.029564
- ONE DIODE MODEL -				
Photo-ind	uced current [A	/cm^2]		0.000168 / 12.33%
Sat. curren	t [A/cm^2]			7.868528E-10 / 1002.98%
Diode quality factor				13.089217 / 1.65%
Series resis	tance [Ohm]		58.30307	15.155998 / 5.96%
Shunt resis	tance [Ohm]		5336.66487	5336.665227 / 5.70%
- GOODNE	SS OF FIT -			

7. To fit the model, this software use first 2 point and last 2 point to make initial guessing. Some of data file may show incorrect initial guessing value as the followings.



In this case, you must select Zone manually and try to select model.





Copyrighto 2011 ZiveLab