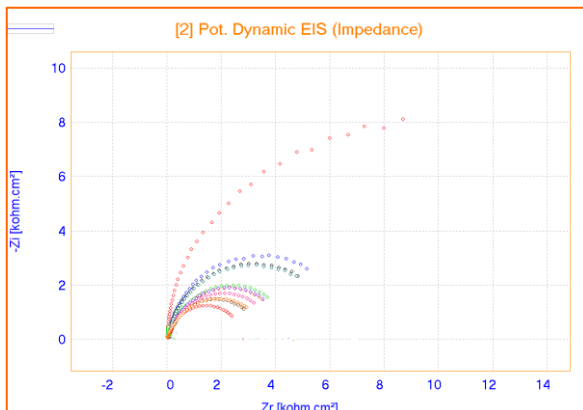
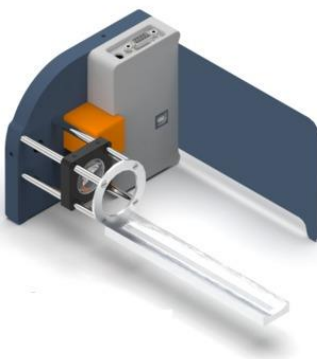


Battery AP-B04



Photovoltaic Study on Solar Cell



In this Application Note electrochemical behavior of solar cell was studied under different light source through OCP and Impedance methods. It could be seen that the results of Nyquist and OCP curves are directly depended to the wavelength of light source.

Introduction

Recent years photoelectrochemical cells have attracted much more attention thanks to their feasibility as low-cost solar energy conversion devices and hence a number and variety of applications have demanded.

The principle on which the most efficient photovoltaic cells are based is the neutralization (“passivation”) of different states that result from different chemical bonds at surfaces and at grain boundaries.

This application note covers the electrochemical behavior of photovoltaic cell operation through changing the wavelength of light source using OCP and EIS methods, but also recent advances in research and development for industrial applications could be done by changing the power and intensity of light source as well.

Starting with photoelectrochemical processes, relevant theoretical background is needed, sometimes including redox potentials, interface of the semiconductor-liquid junction (if the test is performing in the liquid electrolyte) current range of sample and Butler-Volmer relation, etc. So it is highly recommended users to pay attention while selecting the parameters of their tests.

About the Light Source

LED revolver used in this application note is a light source that contains 9 high power LEDs placed on a revolving disc. Only one of the LEDs can be turned on at the time. LED selection, light intensity, duration and other parameters are driven from a dedicated PC Software (figure 1).



Figure 1: LED revolver



NOTE: The device could be supplied with a cage type of sample holder with a manually adjustable lens that is used to focus light on a sample or on a waveguide.

Parameters

This experiment was performed by OrigaMaster software. The parameters of the OCP method is shown in figure 2.

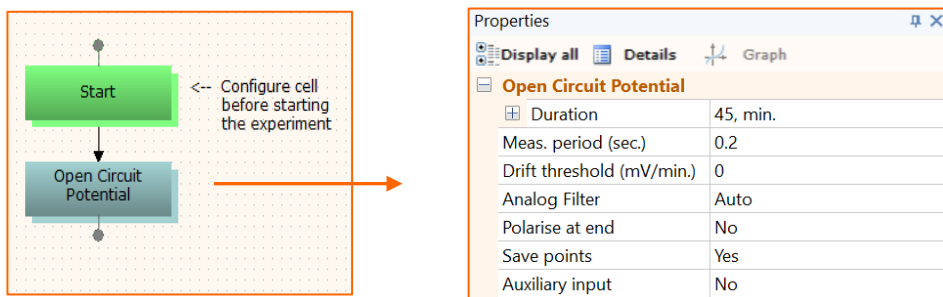


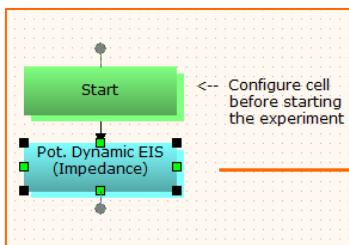
Figure 2: Parametres of OCP method

With the above default settings, the OCP of solar cell is measured during 45 minutes in different wavelengths: 371, 390, 400, 422, 522, 590, 628, 735 nm, light with and without light.

The measured current is changed by changing the wavelength.

TIPS: in OCP method no current or potential is imposed, so any change in current comes from the reaction of solar cell with light.



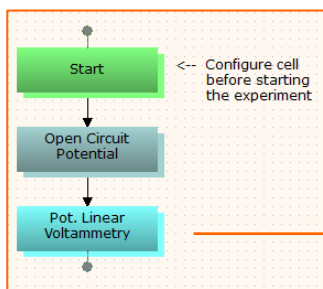


Properties		
Display all	Details	Graph
Pot. Dynamic EIS (Impedance)		
DC signal : Stabilisation phase		
DC Potential (mV)	free	
Stability max duration (sec.)	60	
Stability criterium (µA/min.)	0	
Analog Filter	Auto	
AC Signal : Frequency scan definition		
Initial frequency	1, kHz	
Final frequency	100, mHz	
Freq. per decade	20	
Frequency distribution	Log	
AC sine wave amplitude zero to peak (mV)	10	
Delay before integration (sec.)	0.1	
Average Measurement		
Number of zones	1	
Average zone 1	5, 1, kHz	
Global parameters		
AC current range	50 µA	
Real time plot	Nyquist	
Open circuit at end	Yes	

Figure 3: Parametres of EIS method

The parameters of EIS method could be found in figure 3. The DC potential is set as OCP value (Free). The frequency range is between 1 KHz to 100 mHz. The AC current range is defined as 50 µA correspond to the current that achieved by running Linear Voltammetry method on the sample.

The parameters of Linear Voltammetry method is found in figure 4.



Properties		
Display all	Details	Graph
Pot. Linear Voltammetry		
Potential 1 (mV)	-40, FREE	
Potential 2 (mV)	40, FREE	
Scan rate (mV/sec.)	1, 0.45, 0.45	
Sampling rate	1:1	
Maximum current (mA)	500	
Minimum current (mA)	-500	
Ohmic Drop Comp.	0.45	
Maximum range	Auto	
Minimum range	Auto	
Open circuit at end	Yes	
Save points	Yes	
Analog Filter	Auto	
Digital Filter	0	
Auxiliary input	0	

Figure 4: Parametres of Linear Voltammetry method



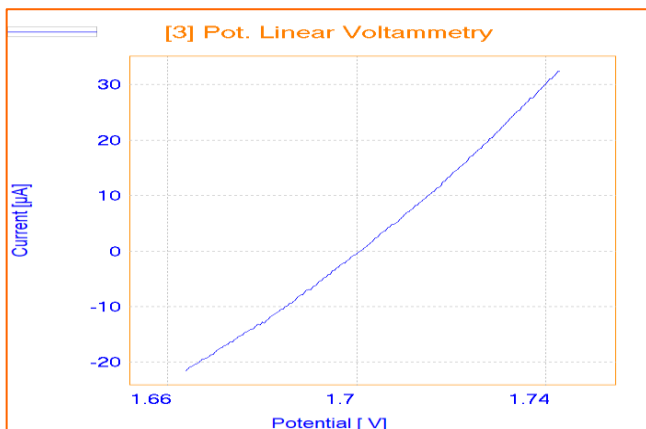


Figure 5: Linear Voltammogram of solar cell, this curve declare the maximum current range

TIPS: in this application note the Linear voltammetry is used just to know the current range. As it can be seen in figure 5, the maximum current is about 30 μA so the AC current range in the Impedance method is defined as 50 μA because the potentiostat that is used for this test is OGF500.

Results

Figure 6 shows the OCP curve of solar cell in front of light in different wavelength.

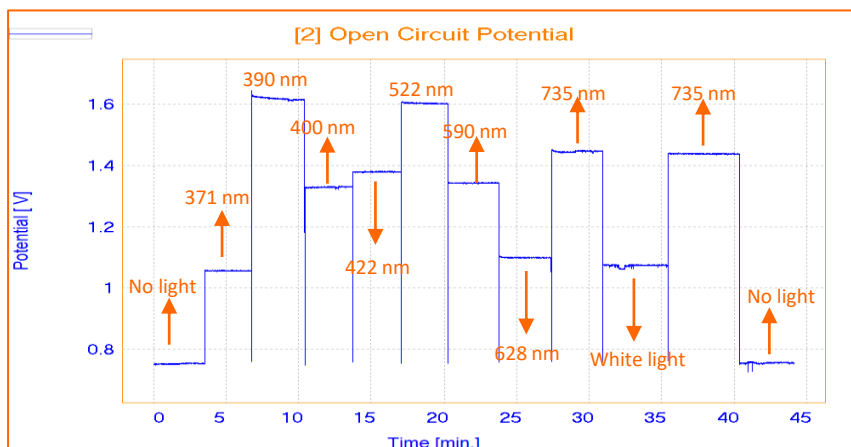
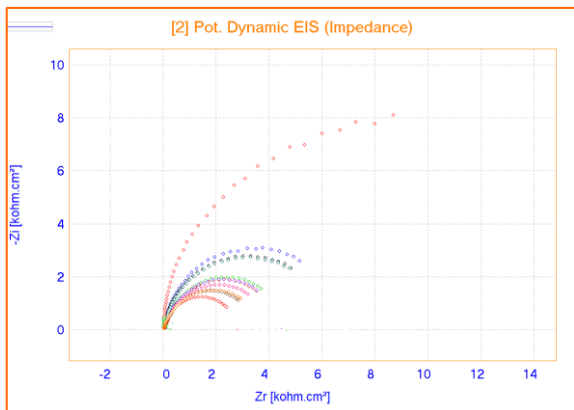


Figure 6: OCP curve of solar cell



In figure 7, 9 Nyquist curves of impedance tests are overlaid. The resistance of solar cell is changed by changing light source.



Curves :

Curve name
eis-371_n600_000_01z.crv
eis-390_n601_000_01z.crv
eis-400_n602_000_01z.crv
eis-422_n603_000_01z.crv
eis-465_n604_000_01z.crv
eis-522_n605_000_01z.crv
eis-590_n606_000_01z.crv
eis-628_n607_000_01z.crv
eis-735_n608_000_01z.crv
eis-no light_n599_000_01z.crv
eis-white light_n609_000_01z.crv

Figure 7: Nyquist curves of solar cell in different wavelengths

Instrument and Sample



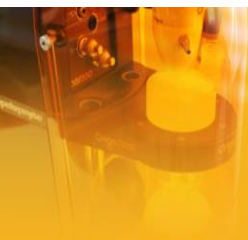
Figure 8: OrigaStat OGF500 + EIS module

Electrode setup

Sample	Solar Cell (Figure 9)
Instrument	OrigaFlex 500 + Impedance Module
Software	OrigaMaster



Figure 9: solar cell sample



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