CS2350 bipotentiostat has two sets of built-in independent potentiostat /galvanostat. Experiments can be conducted simultaneously in each channel. Besides this, the two channels can jointly complete experiment of two-working electrode system such as RRDE and HDT. CS2350 bipotentiostat is the real double-channel potentiostat. It uses Ethernet connection. The customer can choose to use only one channel or both channels during experiment. EIS module is included in one channel.

(New version)

Application

(1) Electrosythesis, electrodeposition (electroplating), anodic oxidation, electrolysis

(2) Oxygen reduction reaction (ORR), oxygen evolution reaction (OER), Hydrogen evolution reaction(HER), carbon dioxide reduction.

(3) Energy and materials (Li-ion battery,solar cell, fuel cell, supercapacitor), advanced function materials, and sensor.

(4) Corrosion behavior of metals, and anti-corrosion evaluation

(5) Fast evaluation of inhibitor, water quality stabilizer, coating, and cathodic protection efficiency.

Rotating ring-disk electrode (RRDE)

Oxidation/reduction reaction (ORR) study: while measuring the polarization curve of disk electrode in the main channel, apply a constant polarization potential on the ring electrode, and thus detect the intermediate products on the disk electrode. RRDE test becomes the typical method for ORR study.

Hydrogen diffusion test (HDT)

CS2350 Bipotentiostats are combined with H-cells. By measuring current of cathode hydrogen charging (the left cell) and hydrogen atoms anode oxidation (the right cell), it can further calculate the diffusion coefficient of hydrogen atoms in metal and hydrogen flux.

Specifications

Specifications	
Support 2-, 3- or 4-electrode system	Interface: Ethernet
Potential control range: Primary Channel: ±10V second Channel: ±10V	Current control range: ±2A
Potential control accuracy: 0.1%×full range±1mV	Current control accuracy: 0.1%×full range
Potential resolution: 10μV (>100Hz), 3μV (<10Hz)	Current sensitivity:1pA
Rise time: <1μS (<10mA), <10μS (<2A)	Reference electrode input impedance:1012Ω||20pF
Current range: 2nA~2A, 10 ranges	Compliance voltage: ±21V
Maximum current output: ±2A	CV and LSV scan rate: 0.001mV~10,000V/s
CA and CC pulse width: 0.0001~65,000s	Current increment during scan: 1mA@1A/ms
Potential increment during scan: 0.076mV@1V/ms	SWV frequency: 0.001~100 kHz
DPV and NPV pulse width: 0.0001~1000s	AD data acquisition:16bit@1 MHz,20bit@1 kHz
DA Resolution:16bit, setup time:1μs	Minimum potential increment in CV: 0.075mV
IMP frequency: 10μHz~1MHz	Low-pass filters: Covering 8-decade
Potential and current range: Automatic	Weight / Measurements: 8kg,36.5 x 30.5 x16cm
Operating System: Windows 2000/NT/XP/ win7/win8/win10	
Electrochemical Impedance Spectroscopy (EIS)	
Signal generator	
Frequency range:10μHz~1MHz	AC amplitude:1mV~2500mV
DC Bias:-10~+10V	Output impedance:50Ω
Waveform: sine wave, triangular wave and square wave	Wave distortion:<1%
Scanning mode: logarithmic/linear, increase/decrease	
Signal analyzer	
Integral time:minimum:10ms or the longest time of a cycle	Maximum:106 cycles or 105s
Measurement delay:0~105s	
DC offset compensation	
Potential automatic compensation range: -10V~+10V	Current compensation range: -1A~+1A
Bandwidth: 8-decade frequency range, automatic and manual setting	

Software -Techniques/Methods of CS2350

Channel 1

Stable polarization

- Open Circuit Potential (OCP)
- Potentiostatic (I-T curve)
- Galvanostatic
- Potentiodynamic (Tafel plot)
- Galvanodynamic (DGP)

- Sweep-Step Functions (SSF)

Transient Polarization

- Multi Potential Steps
- Multi Current Steps
- Potential Stair-Step (VSTEP)
- Galvanic Stair-Step (ISTEP)

Chrono Method

- Chronopotentiometry (CP)
- Chronoamperametry (CA)
- Chronocaulometry (CC)

Voltammetry

- Linear Sweep Voltammetry (LSV)
- Cylic Voltammetry (CV)
- Staircase Voltammetry (SCV)
- Square Wave Voltammetry (SWV)
- Differential Pulse Voltammetry (DPV)
- Normal Pulse Voltammetry (NPV)#
- Differential Normal Pulse Voltammetry (DNPV)
- AC Voltammetry (ACV)
- 2nd harmonic AC Voltammetry (SHACV)
- Fourier Transform AC Voltammetry (FTACV)

Amperometric

- Differential Pulse Amperometry (DPA)
- Double Differential Pulse Amperometry (DDPA)
- Triple Pulse Amperometry (TPA)
- Integrated Pulse Amperometric Detection (IPAD)

Stripping Voltammetry

- Potentiostatic Stripping
- Linear Stripping
- Staircase Stripping
- Square Wave Stripping
- Differential Pulse Voltammetry Stripping
- Normal Pulse Voltammetry Stripping
- Differential Normal Pulse Voltammetry Stripping

Electrochemical Impedance Spectroscopy (EIS)

- EIS vs Frequency (IMP)
- EIS vs Time (IMPT)
- EIS vs Potential (IMPE)(Mott-Schottky)

Corrosion Measurements

- Cyclic polarization curve (CPP)
- Linear polarization curve (LPR)
- Electrochemical Potentiokinetic Reactivation (EPR)
- Electrochemical Noise (EN)
- Zero resistance Ammeter (ZRA)

Battery test

- Battery Charge and Discharge
- Galvanostatic Charge and Discharge (GCD)

- Potentiostatic Charging and Discharging
- Potentiostatic Intermittent Titration Technique
- Galvanostatic Intermittent Titration Technique

Extensions

- Data Logger
- Electrochemical Stripping/ Deposition
- Bulk Eletrolysis with Coulometry (BE)
- Rs Measurement

Channel 2

Stable polarization

- Open Circuit Potential (OCP)
- Potentiostatic (I-T curve)
- Galvanostatic
- Potentiodynamic (Tafel plot)
- Galvanodynamic (DGP)
- Sweep-Step Functions (SSF)

Transient Polarization

- Multi Potential Steps
- Multi Current Steps
- Potential Stair-Step (VSTEP)
- Galvanic Stair-Step (ISTEP)

Voltammetry

- Linear Sweep Voltammetry (LSV)
- Cylic Voltammetry (CV)

Corrosion Measurements

- Cyclic polarization curve (CPP)
- Linear polarization curve (LPR)
- Electrochemical Potentiokinetic Reactivation (EPR)
- Electrochemical Noise (EN)
- Zero resistance Ammeter (ZRA)

Battery test

- Battery Charge and Discharge
- Galvanostatic Charge and Discharge (GCD)
- Potentiostatic Charging and Discharging
- Potentiostatic Intermittent Titration Technique
- Galvanostatic Intermittent Titration Technique

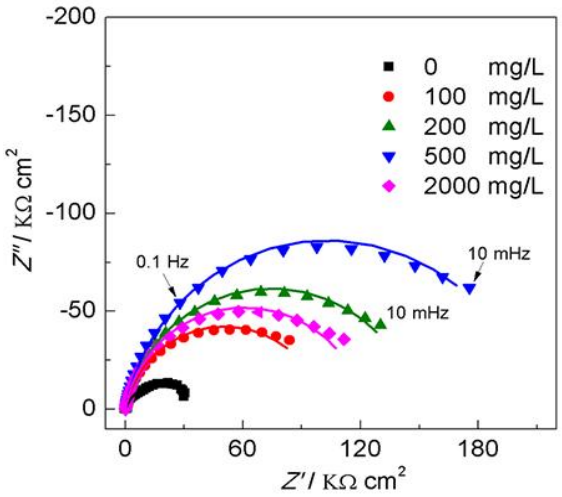
Extensions

- Data Logger
- Electrochemical Stripping/ Deposition
- Bulk Eletrolysis with Coulometry (BE)
- Rs Measurement

Technical advantages

1. Impedance (EIS)

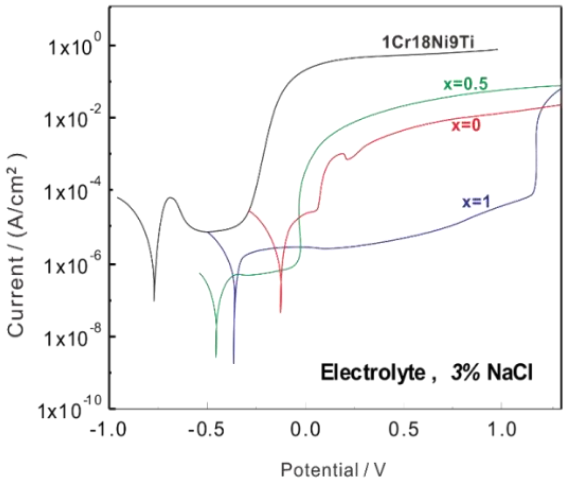
CS2350 bipotentiostat applies correlation integral algorithm and dual-channel over-sampling technique, and has strong anti-interference ability. It is suitable for EIS measurements of high-impedance system (>$10^9\Omega$, such as coating, concrete etc.).



EIS of AA6063 Al alloy in Ce^{3+} containing 3% NaCl solution

2. Polarization curve

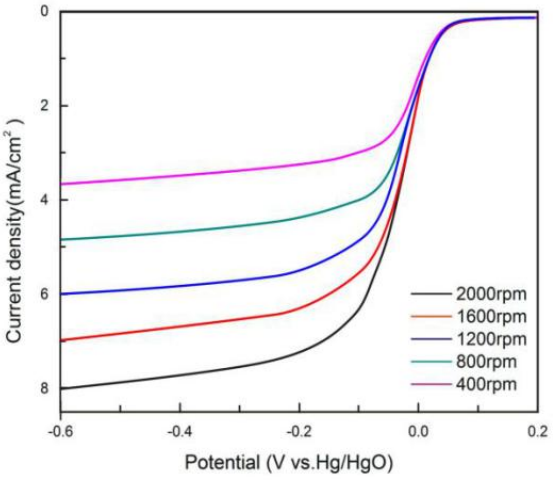
Tafel plot can be obtained. The user can set the anodic reversal current (passivation film breakdown current) of the cyclic polarization curve to obtain material's pitting potential and protection potential and evaluate the its susceptibility to intergranular corrosion. The software uses non-linear fitting to analyze polarization curve, and can make fast evaluation of material's anti-corrosion ability and inhibitors.



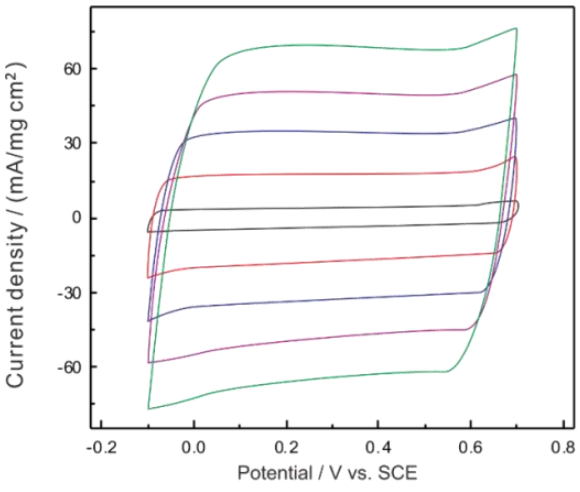
Polarization curve of Ti-based amorphous alloy & stainless steel in 3%NaCl solution

3. Voltammetry

Linear Sweep Voltammetry (LSV), Cyclic Voltammetry (CV), SCV, SWV, DPV, NPV, ACV, Stripping voltammetry etc. It integrates calculation of peak area, peak current and standard curve analysis.



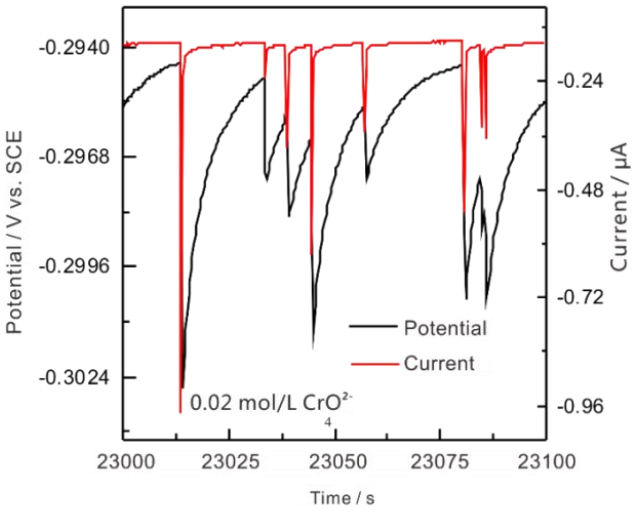
LSV: mesoporous carbon material in 0.1M KOH



CV of PPy supercapacitor in 0.5 mol/L H_2SO_4

4. Electrochemical Noise

With high-resistance follower and zero-resistance ammeter, it measures the natural potential/current fluctuations in corrosion system. It can be used to study pitting corrosion, galvanic corrosion, crevice corrosion, and stress corrosion cracking etc. Based on calculation of noise resistance and pitting index, it can complete localized corrosion monitoring.



5. Full floating measurement

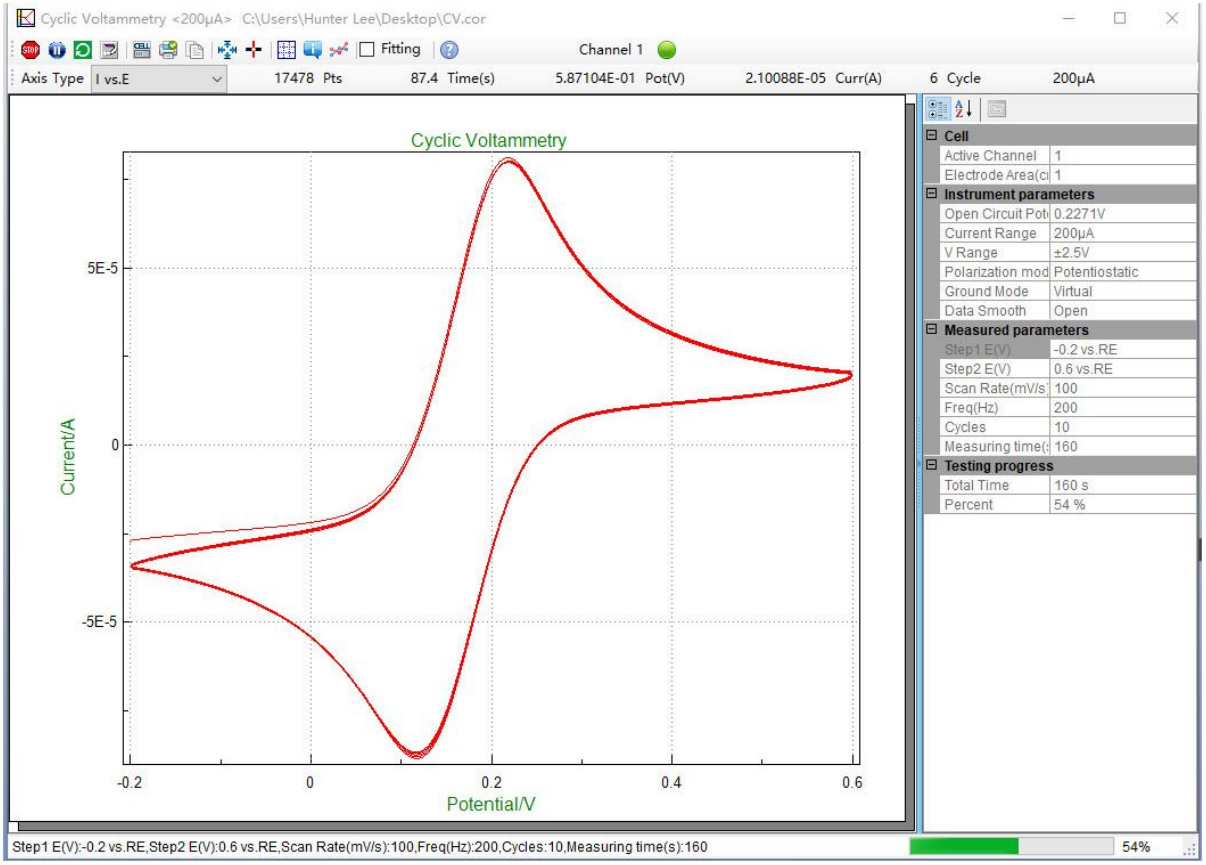
Full-floating mode be used for autoclave electrochemical measurements, on-line corrosion monitoring of metallic components under the ground (rebar in concrete, etc.)

6. Software development kit (SDK)

We are able to provide API functions and development examples, which facilitates some users' requirements for secondary development and self-defined measurements. We can provide .dll file.

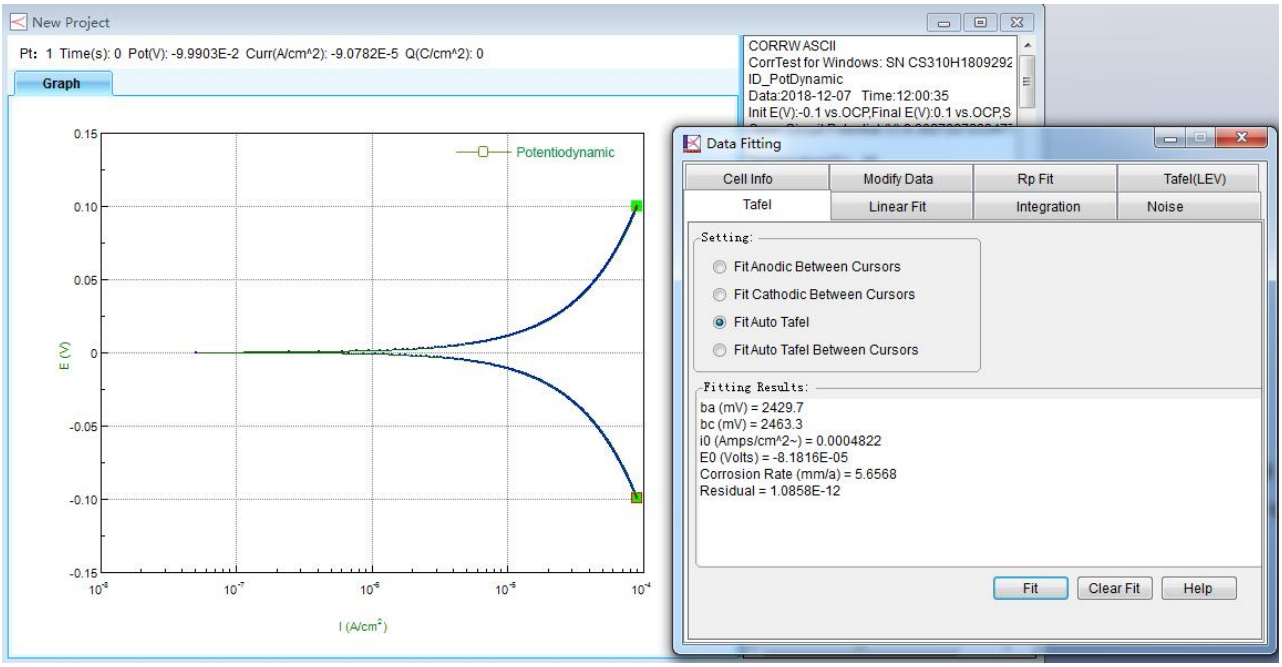
Software Features

Cyclic voltammetry: CS studio software provides users a versatile smoothing/differential/ integration kit, which can complete the calculation of peak height, peak area and peak potential of CV curves. During the data analysis, there is function of selecting exact cycle(s) to show. You can choose to see a cycle or some cycles as you want. You can also export data or vector graph of an exact cycle or several cycles.



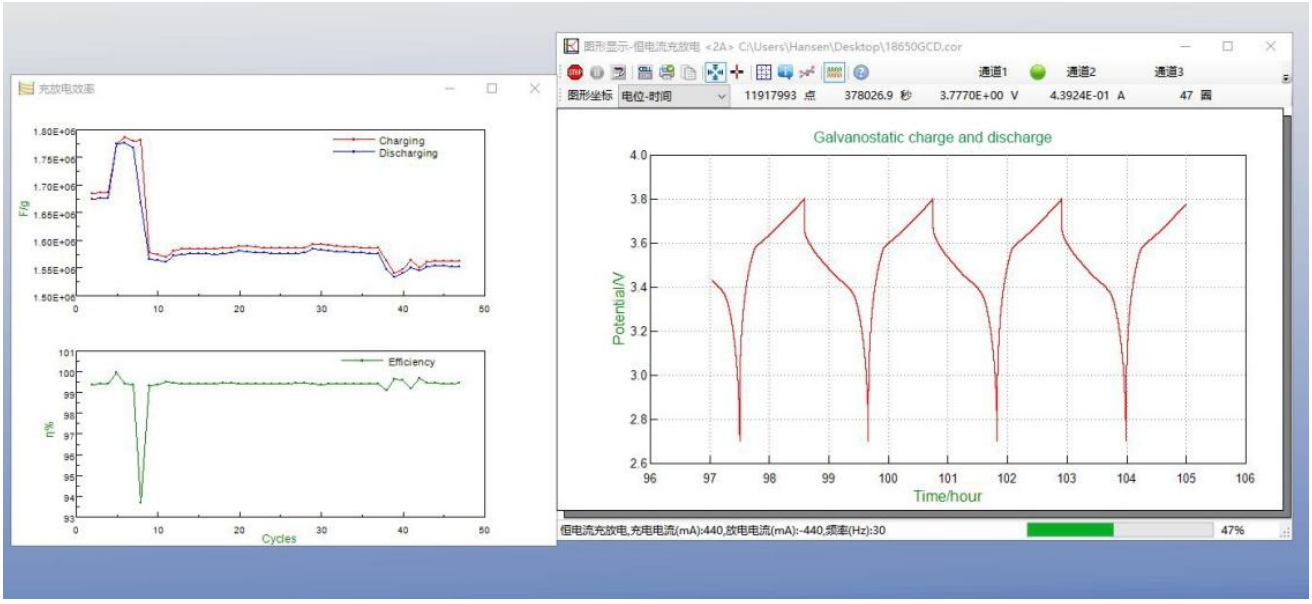
Tafel plot and corrosion rate:

CS studio also provides powerful non-linear fitting on Butler-Volmer equation of polarization curve. It can calculate Tafel slope, corrosion current density, limitation current, polarization resistance, corrosion rate. It can also calculate the power spectrum density, noise resistance and noise spectrum resistance based on the electrochemical noise measurements.



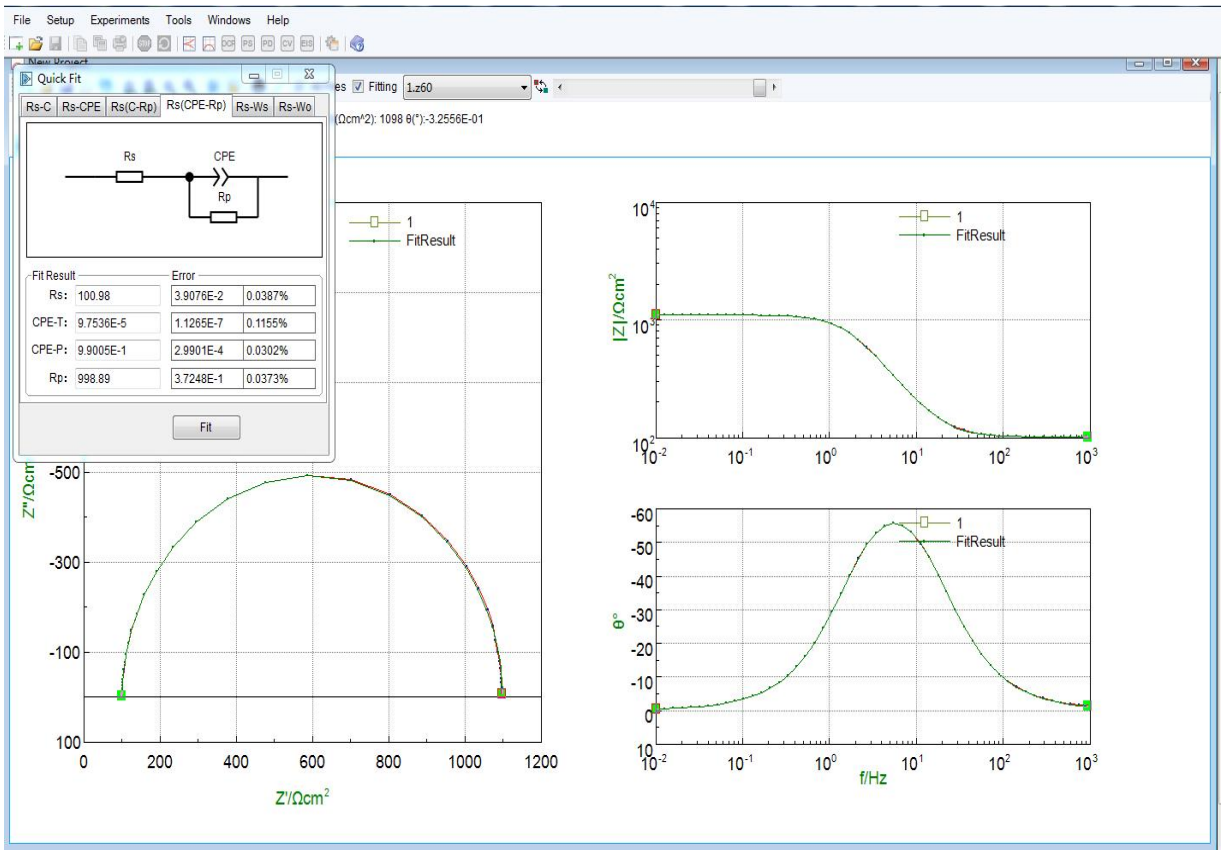
Battery Test and analysis:

charge & discharge efficiency, capacity, specific capacitance, charge & discharge energy.



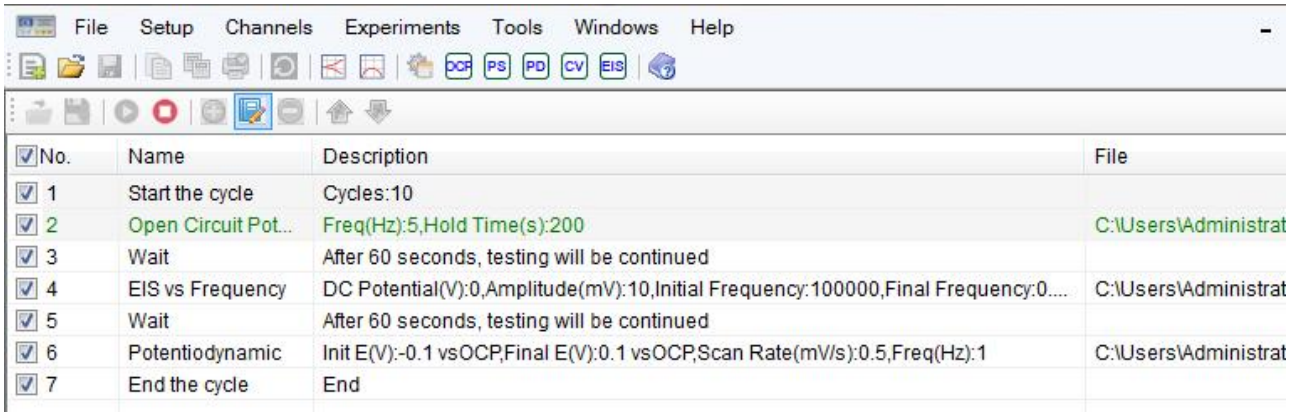
EIS analysis: Bode, Nyquist, Mott-Schottky plot

During EIS data analysis, there is built-in fitting function to draw the custom equivalent circuit.



Real time saving of data: The data can be automatically saved even in case of sudden power off.

Combination test: it can achieve automation of experiments and save time. With the unique function of combination test, you can choose several experiments you want to run. Then you can make auto run of the pre-set experiments as you want without having to wait in the lab. This function is especially useful if you have multi experiments to run and save your time greatly.



Data open: You can open the data files by txt format in notepad. Data can also be opened in Origin