EIS Portable potentiostat model CS100E

(Note: The model **CS100E** is carved on the back panel)

The CS100E includes built-in EIS module. It is internally powered by a lithium battery, which can be placed in a glove box or used outdoors. The li-ion battery can be charged in advance, and the type-C interface is used for charging and communication. The circuit adopts a floating-ground design, and the electrochemical parameters of the grounding system can be measured without an isolation transformer.

CS100E is mainly used for battery testing, electroanalytical chemistry, and corrosion electrochemical testing. The voltage control range is ±10V, compliance voltage is ±12V, the current output range is ±45mA, and the minimum current resolution can reach 100fA. The EIS frequency range is 10μHz~1MHz.

For its small size wit comprehensive electrochemical functions, it's typically used for:

- Performance testing of battery materials in the glove box
- Ultra-low detection limit of heavy metal ions, for water quality testing in environmental protection
- Small current detection in biosensor thanks to high current accuracy
- Active ingredients detection in food and drug field
- Bridge corrosion and soil corrosion measurements

Etc.

Features

- Small and light, portable and convenient
- Simple to install and easy to operate
- High accuracy, current resolution is 100fA, and measurement accuracy is 0.1% of the range.
- Internal lithium battery facilitates the outdoor on-site measurement

Specifications

Potential control range: **±10V**
Maximum current: **± 45mA**
Compliance voltage: **±12V**
EIS frequency range: 10μHz ~ 1MHz
Potential range: ±2.5V, ±5V, ±10V
Current range: 200pA~50mA, 9 ranges
(2nA, 20nA, 200nA, 2uA, 20uA, 200uA, 2mA, 20mA, 50mA)
Potential accuracy: 0.1%× full range
Minimum potential resolution: 10μV
Current accuracy: 0.1%× full range
Minimum current resolution: 100fA
Reference electrode input impedance: $10^{13}\Omega||8pF$
AC amplitude: 0~±2.5V
Signal response bandwidth: 1MHz
Max. acquisition rate: 150,000 data points/s
CV and LSV scan rate: 0.001mV~ 10V/s
Support 2-, 3-or 4-electrode system
Communication: USB or Bluetooth
Power supply: built-in li-battery 6000mAH@3.7V / USB
Size / weight:150mm x 90mm x 30mm, 500g

Electrochemical techniques – CS100E with built-in EIS

Stable polarization

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

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)

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)
- Galvanostatic EIS
- EIS vs Potential (IMPE)(Mott-Schottky)
- EIS vs Time (IMPT)
- Galvanostatic EIS vs Time

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(PCD)
- Potentiostatic Intermittent Titration Technique(PITT)
- Galvanostatic Intermittent Titration Technique(GITT)

Extensions

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

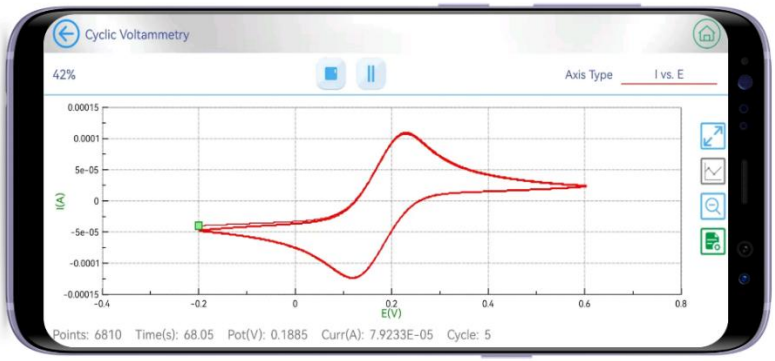
Overview

CS100E is composed of DDS digital signal synthesizer, constant potential control, dual-channel high-speed 16bit/high-precision 24bit AD converter. The DDS and dual-channel signal correlation integral circuit improve the AC impedance measurement accuracy. EIS frequency range is 10μHz~1MHz. It can automatically perform electrochemical impedance test under OCP or any DC bias voltage. Built-in DC offset compensation circuit effectively improves the measurement accuracy of AC signals. The amplitude of the exciting sine wave can be set between 0 ~±2.5V. The EIS data format is compatible with ZView which can be directly used for impedance spectrum analysis. CS100E potentiostat can also output sine wave, square wave, triangle wave, sawtooth wave, pulse wave, etc., and the output frequency is 0~100KHz.

The test control and data analysis are realized through the CS Studio software. The software has multi-coordinate graphic display and zooming, data/graphic storage/printing, and interactive help. The software has techniques for materials and corrosion electrochemistry, including automatic or manual reverse sweep of passivation curve, electrochemical reactivation method, solution resistance (IR drop) measurement and compensation.

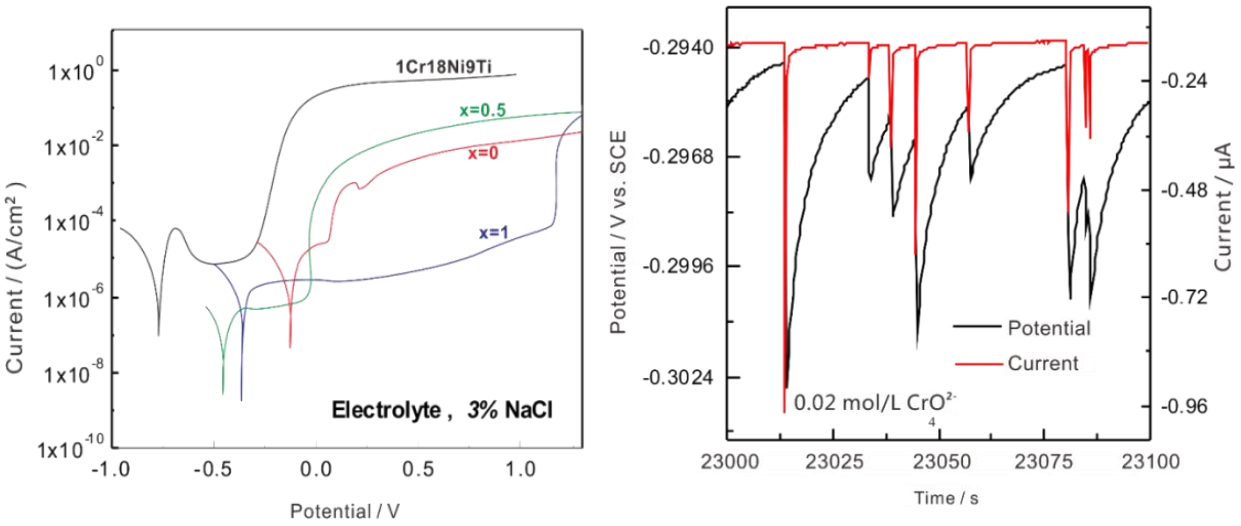
CS Studio software also has a complete data analysis function, which can achieve the volt-ampere curve smoothing, the peak height and area integration, and the electrochemical parameters analysis of the polarization curve, including polarization resistance R_p, Tafel slope b_a, b_c, and corrosion current density i_{corr}, corrosion rate calculation, etc., noise resistance R_n and power spectrum can also be calculated, and the graph can be copied to other files in vector mode.

The CS100E potentiostat is controlled software CS studio. You can also use App(see below figure).



Application

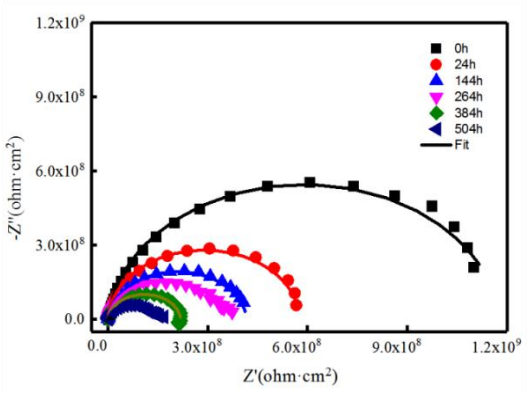
Corrosion: Corrtest CS100E includes all the electrochemical techniques for corrosion measurement such as OCP, polarization curve, EIS, Cyclic polarization CPP (passivation curve), Electrochemical Potentiokinetic Reactivation (EPR), Hydrogen diffusion test, ZRA, Electrochemical noise, etc. It can be used to study metal corrosion mechanism and corrosion resistance, and evaluate the coating durability and sacrificial anode current efficiency. It can also be used for rapid screening of corrosion inhibitors, fungicides, etc.



Polarization curves of Ti-alloy& stainless steel in 3%NaCl solution(left)

EN of low-carbon steel in 0.05mol/LCl+0.1mol/LNaHCO3(right)

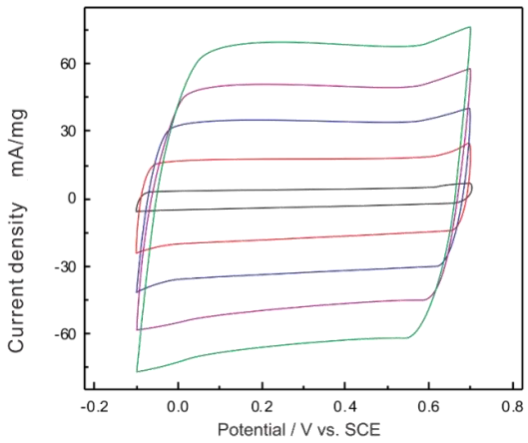
It uses correlation integral algorithm and dual-channel over- sampling technique, and has strong anti-interference ability. The internal resistance of the instrument is up to $10^{13}\Omega$. It's suitable for EIS measurements of high-impedance system (such as coating, concrete etc.)



Salt spray aging test of high impedance coating

Energy

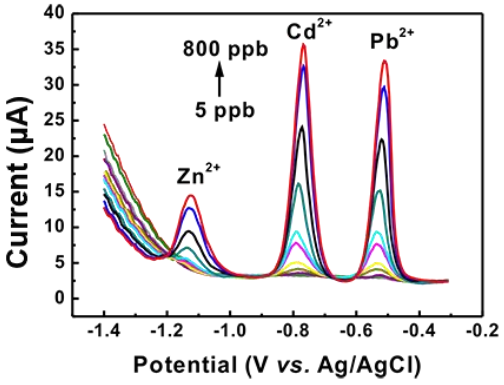
With techniques LSV, CV, galvanostatic charge and discharge (GCD), Constant potential/ current EIS, and precise IR compensation circuit, CS100E potentiostat can be used in supercapacitor, Li-ion batteries, sodium-ion batteries, fuel cell, Li-S batteries, solar cell, solid-state batteries, flow batteries, metal-air batteries etc. It is an excellent scientific tool for researchers in the fields of energy and materials.



CV curve of PPy supercapacitor in 0.5 mol/L

Electroanalysis

CS100E potentiostat includes all the voltammetric methods such as NPV, DNPV, SWV, ACV, and can be used for fast analysis of the trace elements in the solution. Voltammetry stripping methods can do the Quantitative analysis according to the stripping peak current.

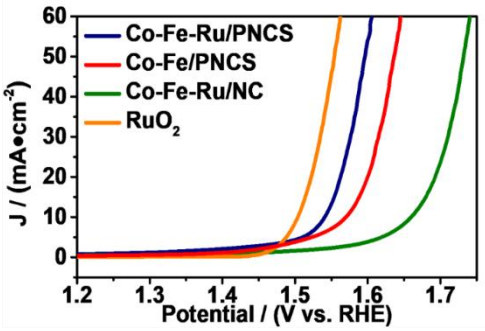


Stripping voltametric curves in solution of different Pb2+, Cd 2+,Zn2+ concentration

Electrocatalysis

- It can measure the half-wave potential (ORR), overpotential (HER, OER) of the catalyst, and has the function of peak power density and energy density calculation.

- Long-term cyclic measurement for ORR, OER, HER, CO2RR by techniques such as cyclic voltammetry, potentiostatic, galvanostatic. Faraday efficiency can be measured with a bipotentiostat.



LSV curve of catalysts in alkaline solution

Sensors

CS100E handheld potentiostat can be used in the field of biosensors and chemical sensors, and many others. With the size of a mobile phone, it can be carried easily for lab and on-site use. Potential resolution is 3μV, and current resolution can be 1pA.

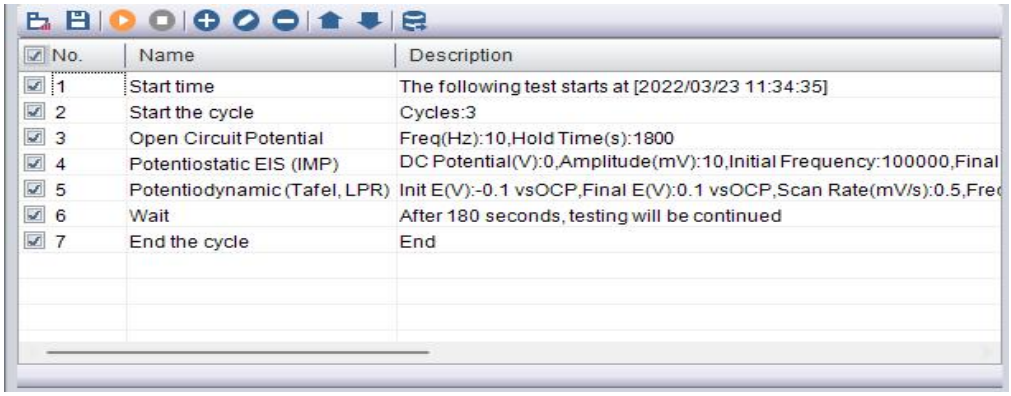
Advantages

Electrochemical impedance spectroscopy (EIS)

- CS100E potentiostat uses correlation integral algorithm and dual-channel over-sampling technique, and has strong anti-interference ability. The internal resistance of the instrument is up to $10^{13}\Omega$. It's suitable for EIS measurements of high-impedance system (such as coating, concrete etc.)
- With constant current carrier and DC bias technology, Corrtest potentiostat can be used for battery impedance measurement under charge and discharge state

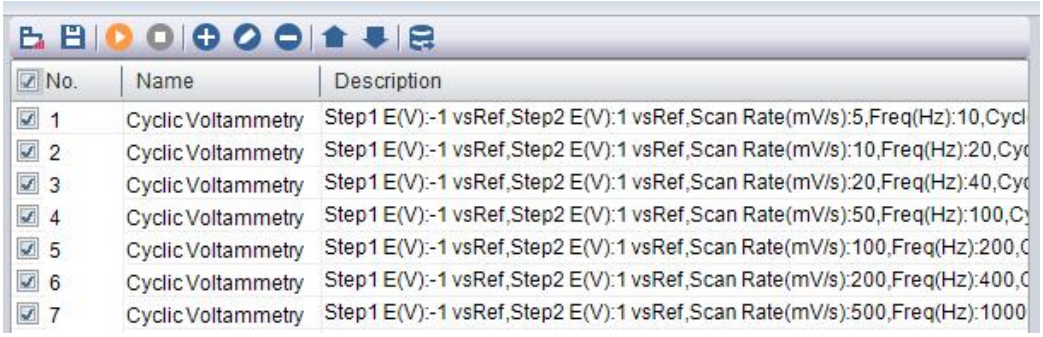
Combination test

CS studio software supports the combination test for various experiments to achieve flexible and unattended test. You can set the parameters for each experiment in advance, and set the intervals, wait time etc between each experiment.



No.	Name	Description
1	Start time	The following test starts at [2022/03/23 11:34:35]
2	Start the cycle	Cycles:3
3	Open Circuit Potential	Freq(Hz):10,Hold Time(s):1800
4	Potentiostatic EIS (IMP)	DC Potential(V):0,Amplitude(mV):10,Initial Frequency:100000,Final
5	Potentiodynamic (Tafel, LPR)	Init E(V):-0.1 vsOCP,Final E(V):0.1 vsOCP,Scan Rate(mV/s):0.5,Fre
6	Wait	After 180 seconds, testing will be continued
7	End the cycle	End

Combination Test: corrosion tests



No.	Name	Description
1	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):5,Freq(Hz):10,Cycl
2	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):10,Freq(Hz):20,Cyc
3	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):20,Freq(Hz):40,Cyc
4	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):50,Freq(Hz):100,Cy
5	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):100,Freq(Hz):200,C
6	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):200,Freq(Hz):400,C
7	Cyclic Voltammetry	Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):500,Freq(Hz):1000

Combination Test: Pseudocapacitor tests

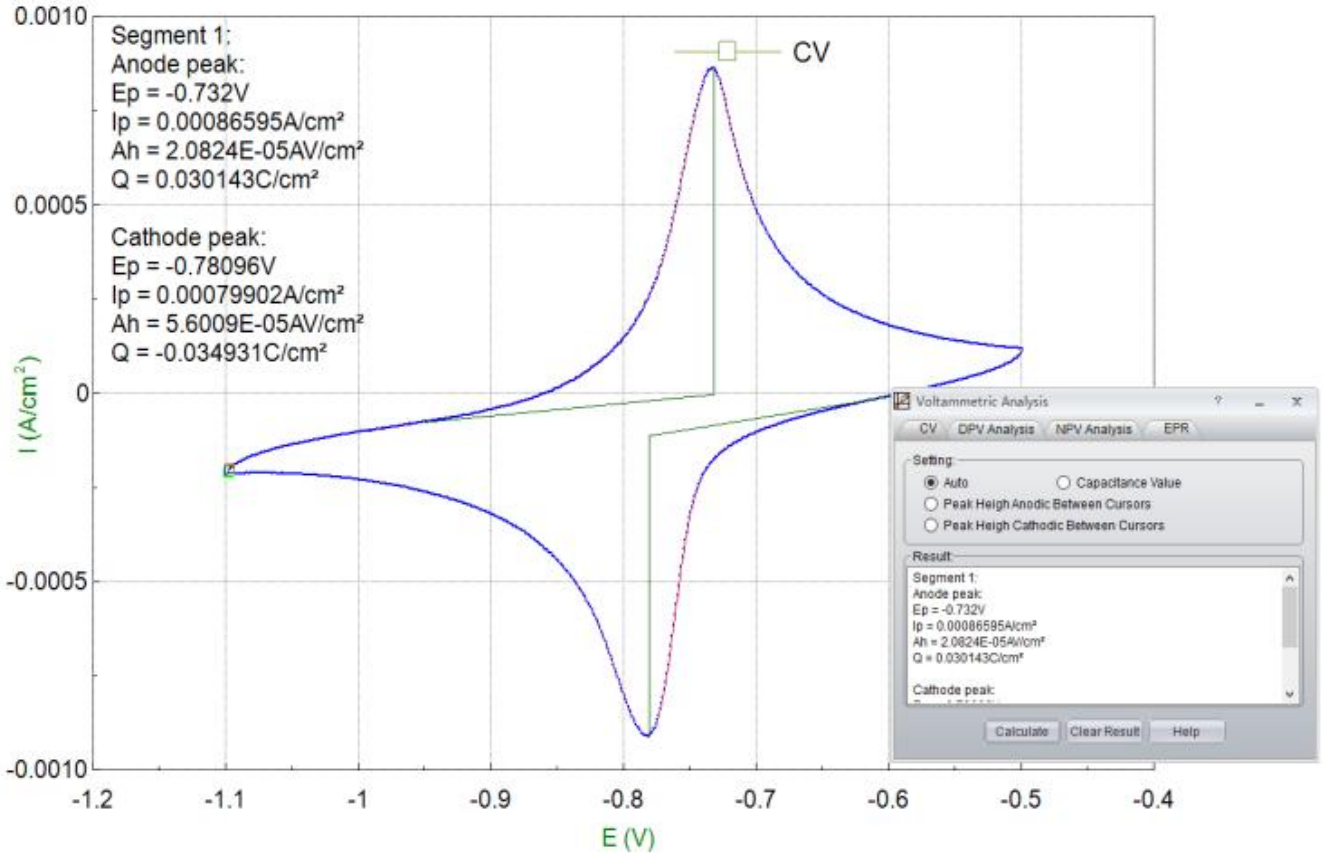
Real-time data storage

Experiment data can be stored in real time. Even if the test is interrupted by a power failure, the data will be automatically saved. The data is compatible with Excel, Origin, and can be directly opened in third-party software for data processing and curve drawing.

Versatile data analysis

CS Studio is the software for Corrtest potentiostat for experiment control and data analysis. It can do: multi-parameter Tafel curve fitting, derivation, integration and peak height analysis of voltammetric curve, EIS equivalent circuit customization and impedance spectrum fitting, etc.

- Multi-parameters Polarization curve
- EIS fitting
- Electrochemical noise analysis
- Pseudocapacitance calculation
- GCD specific capacitance, efficiency
- Mott-Schottky plot analysis
- CV analysis



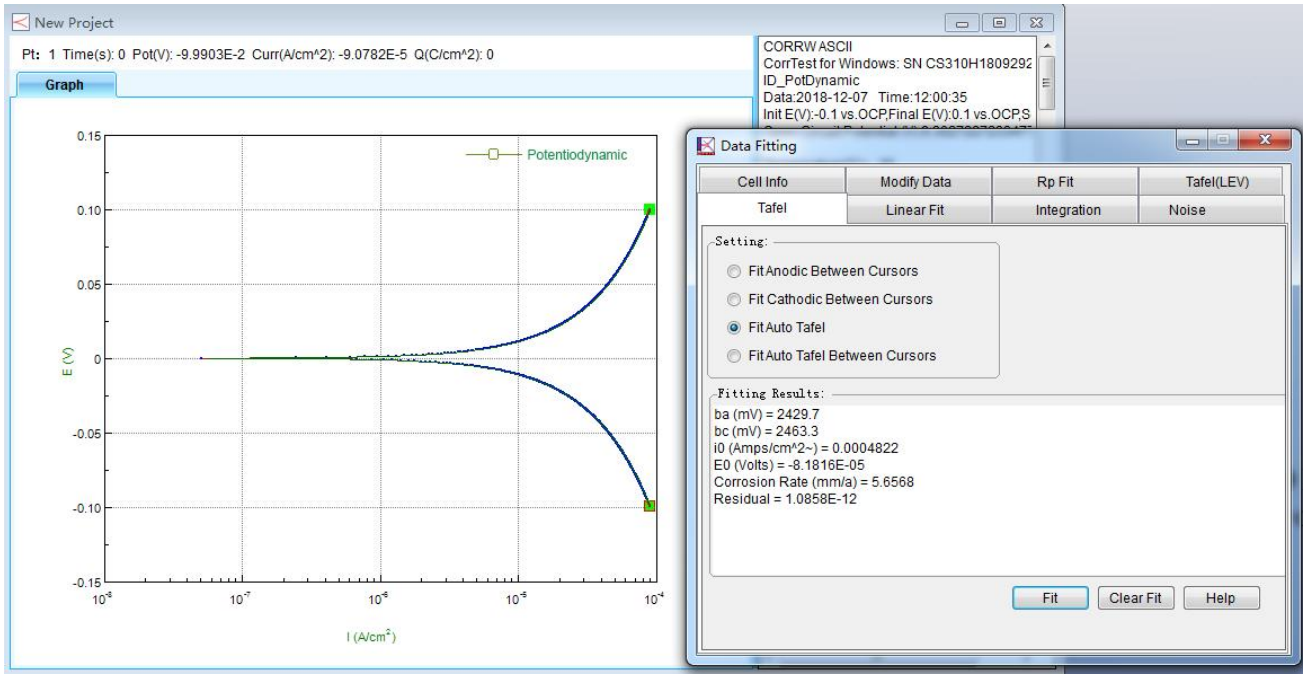
Software Features

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. In CV technique, 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.