CS electrochemical workstation (potentiostat / galvanostat) contains a fast digital function generator, high-speed data acquisition circuitry, a potentiostat and a galvanostat. With high performance in stability and accuracy with advanced hardware and well-functioned software, it is a comprehensive research platform for corrosion, batteries, electrochemical analysis, sensor, life science and environmental chemistry etc.

Application

Reaction mechanism of Electrosynthesis, electrodeposition, anodic oxidation, etc;
Electrochemical analysis and sensor;
New energy materials (Li-ion battery, solar cell, fuel cell, supercapacitors), advanced functional materials, photoelectronic materials;
Corrosion study of metals in water, concrete and soil, etc;
Fast evaluation of corrosion inhibitor, water stabilizer, coating and cathodic protection efficiency.

Specifications

Specifications	
Support 2-, 3- or 4-electrode system	Potential and current range: Automatic
Potential control range: ±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:10^{12}Ω||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
Operating System: Windows 2000/NT/XP/7/8/10	Interface: USB 2.0
Weight / Measurements: 6.5kg, 36.5 x 30.5 x16 cm	

EIS (Electrochemical Impedance Spectroscopy)	
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:10^6 cycles or 10^5s
Measurement delay: 0~10^5s	
DC offset compensation	
Potential automatic compensation range: -10V~+10V	Current compensation range: -1A~+1A
Bandwidth: 8-decade frequency range, automatic and manual setting	

Electrochemical methods/Techniques (Models' comparison)

Guidance:

Hardware specs and appearance are the same for various models, difference is in software part.

Model CS350 (with built-in EIS) is the most comprehensive model, includes all methods incl. EIS. It's suitable for various applications, and also for teaching

Model CS310 (with built-in EIS) also includes EIS module. But it has less voltammetry methods compared with CS350. CS310 is a cost-effective model if you need EIS. It's an ideal model for corrosion, battery studies etc.

Model CS300 (w/o EIS) includes all the voltammetry methods but EIS, usually used in heavy metal ions detecting etc.

Model CS150 (w/o EIS) is the basic model incl. basic methods such as CV, LSV, charge and discharge, Tafel plot, etc

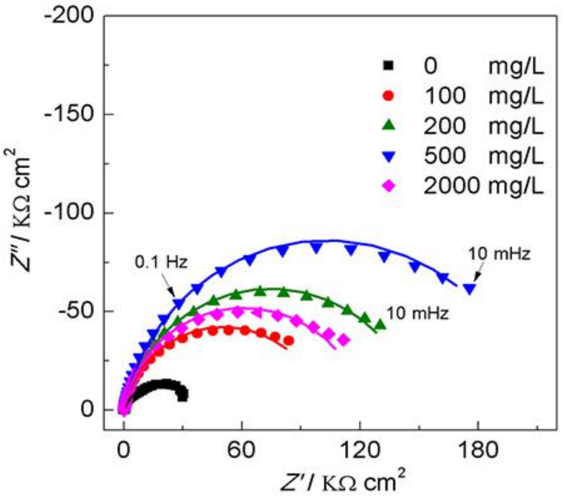
Model CS120 is the simplest model with only potentiostat function without galvanostat. If people only use Cyclic voltammetry (CV) in their experiment, CS120 will be a choice.

Techniques		CS120 W/O EIS	CS150 W/O EIS	CS300 W/O EIS	CS310 With EIS	CS350 With EIS
Stable polarization	Open Circuit Potential (OCP)	√	√	√	√	√
	Potentiostatic (I-T curve)	√	√	√	√	√
	Galvanostatic		√	√	√	√
	Potentiodynamic(Tafel plot)	√	√	√	√	√
	Galvanodynamic		√	√	√	√
Transient polarization	Multi-Potential Steps	√	√	√	√	√
	Multi-Current Steps		√	√	√	√
	Potential Stair-Step (VSTEP)	√	√	√	√	√
	Galvanic Stair-Step (ISTEP)		√	√	√	√
Chrono methods	Chronopotentiometry (CP)		√	√	√	√
	Chronoamperometry (CA)		√	√	√	√
	Chronocoulometry (CC)		√	√	√	√
Voltammetry	Cyclic Voltammetry (CV)	√	√	√	√	√
	Linear Sweep Voltammetry (LSV)(I-V)	√	√	√	√	√
	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 A.C.Voltammetry (SHACV)			√		√
Amperometry	Differential Pulse Amperometry (DPA)					√
	Double Differential Pulse Amperometry (DDPA)					√
	Triple Pulse Amperometry (TPA)					√
	Integrated Pulse Amperometric Detection (IPAD)					√
EIS	EIS vs Frequency (IMP)				√	√
	EIS vs Time (IMPT)				√	√
	EIS vs Potential (IMPE)(Mott-Schottky)				√	√
Corrosion test	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)		√	√	√	√

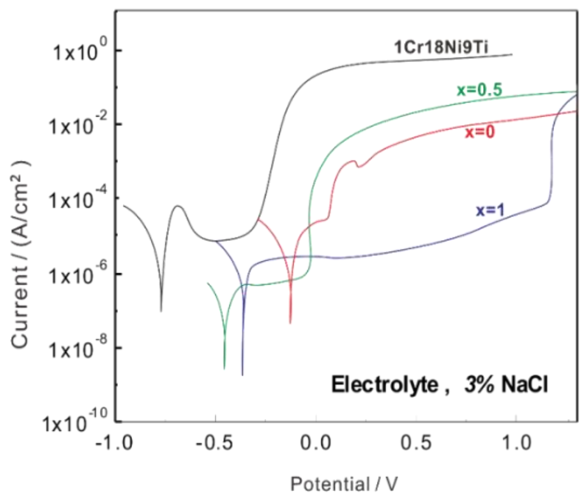
Technical advantages

1. Impedance (EIS)

CS350potentiostat 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



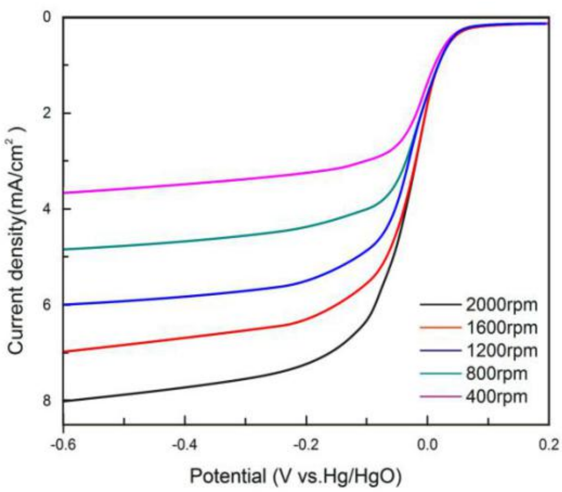
Polarization curve of Ti-based amorphous alloy & stainless steel in 3%NaCl solution

2. Polarization curve

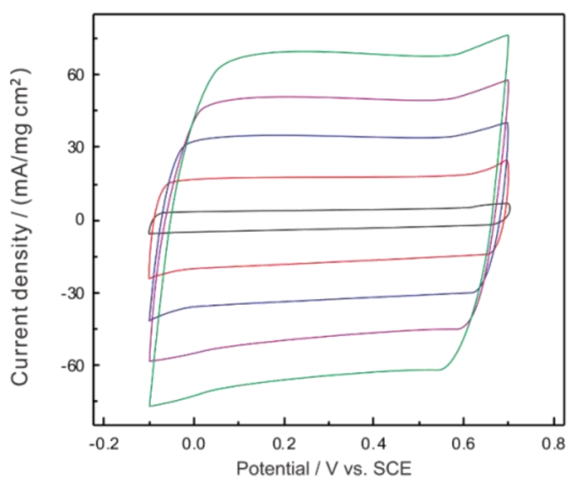
Tafel plot can be obtained. The user can set the anodic reversal current (passivation film breakdown current) of the cyclic polarization curve to obtain material's pitting potential and protection potential and evaluate the its susceptibility to intergranular corrosion. The software uses non-linear fitting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

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.



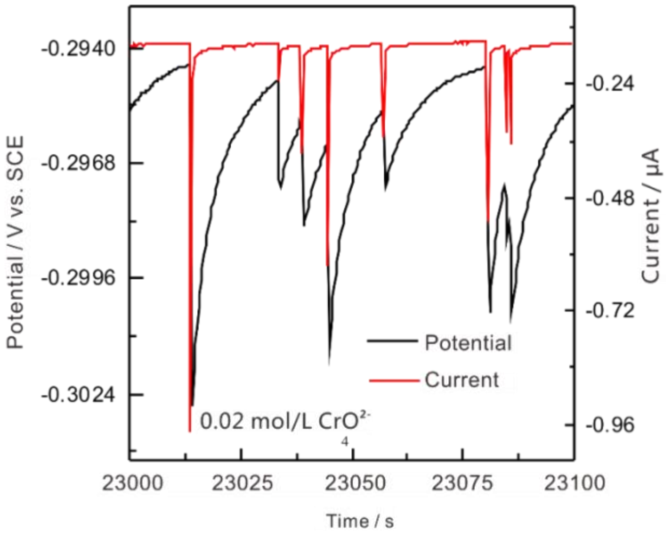
LSV: mesoporous carbon material in 0.1M KOH



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.



Electrochemical noise of low-carbon steel in 0.05mol/L Cl^-+0.1mol/L $NaHCO_3$

5. Full floating measurement

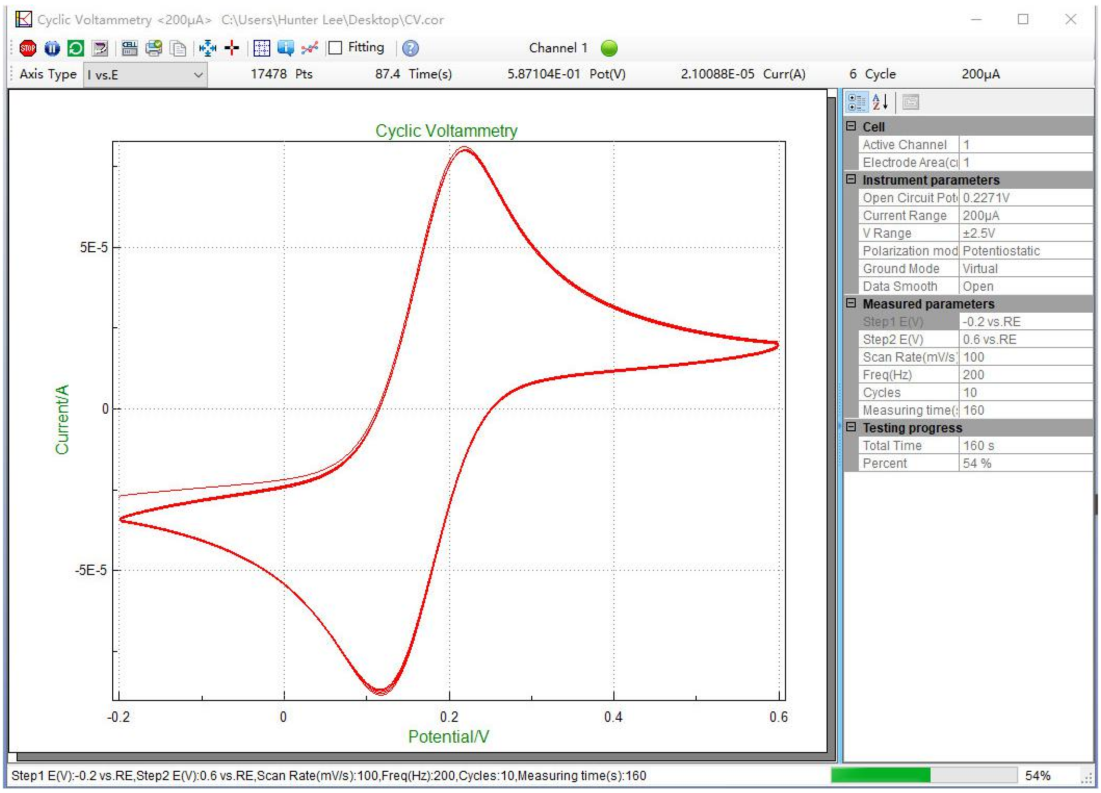
Full-floating mode be used for autoclave electrochemical measurements, on-line corrosion monitoring of metallic components under the ground (rebar in concrete, etc.)

6. User-defined methods

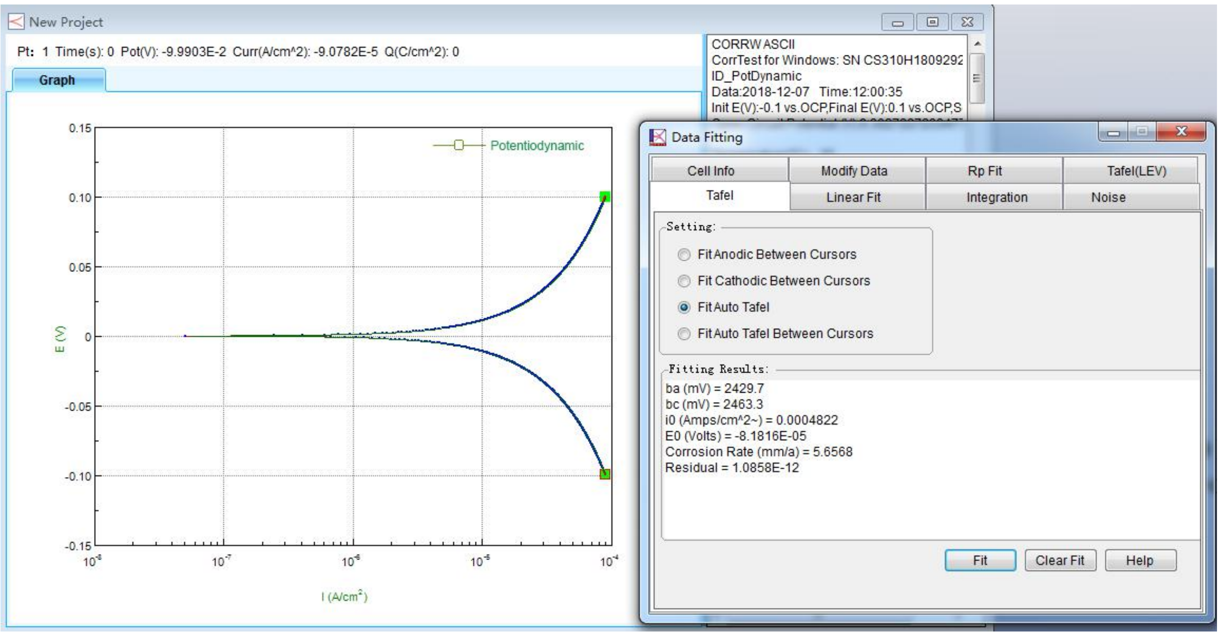
We are able to provide API functions and development examples, which facilitates some users' requirements for secondary development and self-defined measurements.

Software Features

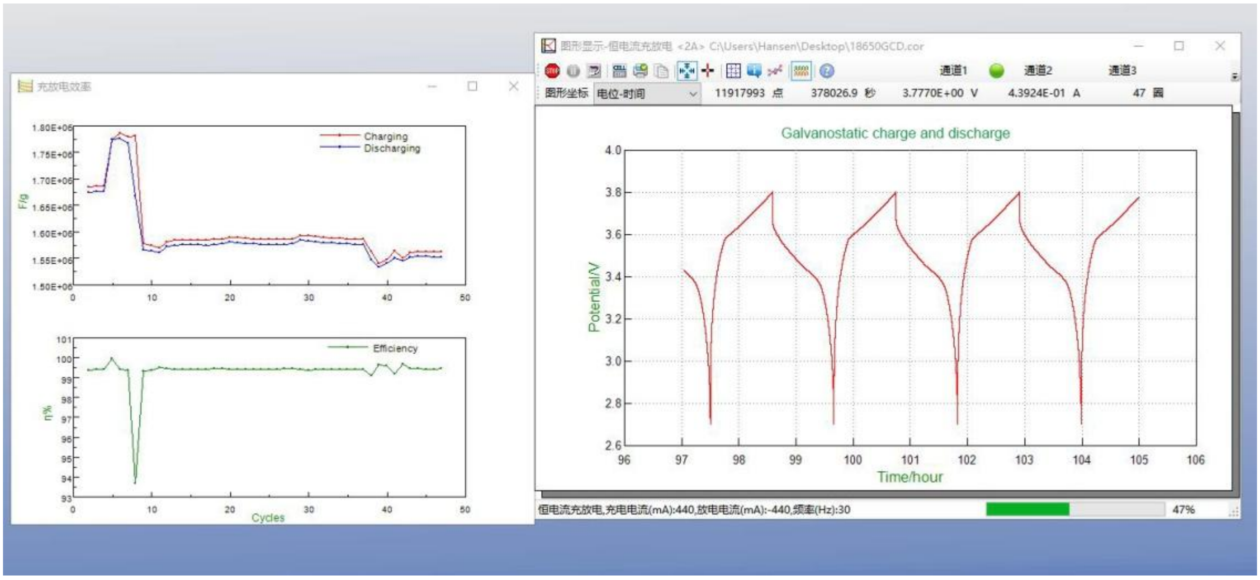
Cyclic voltammetry: CS studio software provides users a versatile smoothing/differential/ integration kit, which can complete the calculation of peak height, peak area and peak potential of CV curves. In CV, during the data analysis, there is function of selecting exact cycle(s) to show. You can choose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



Tafel 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.

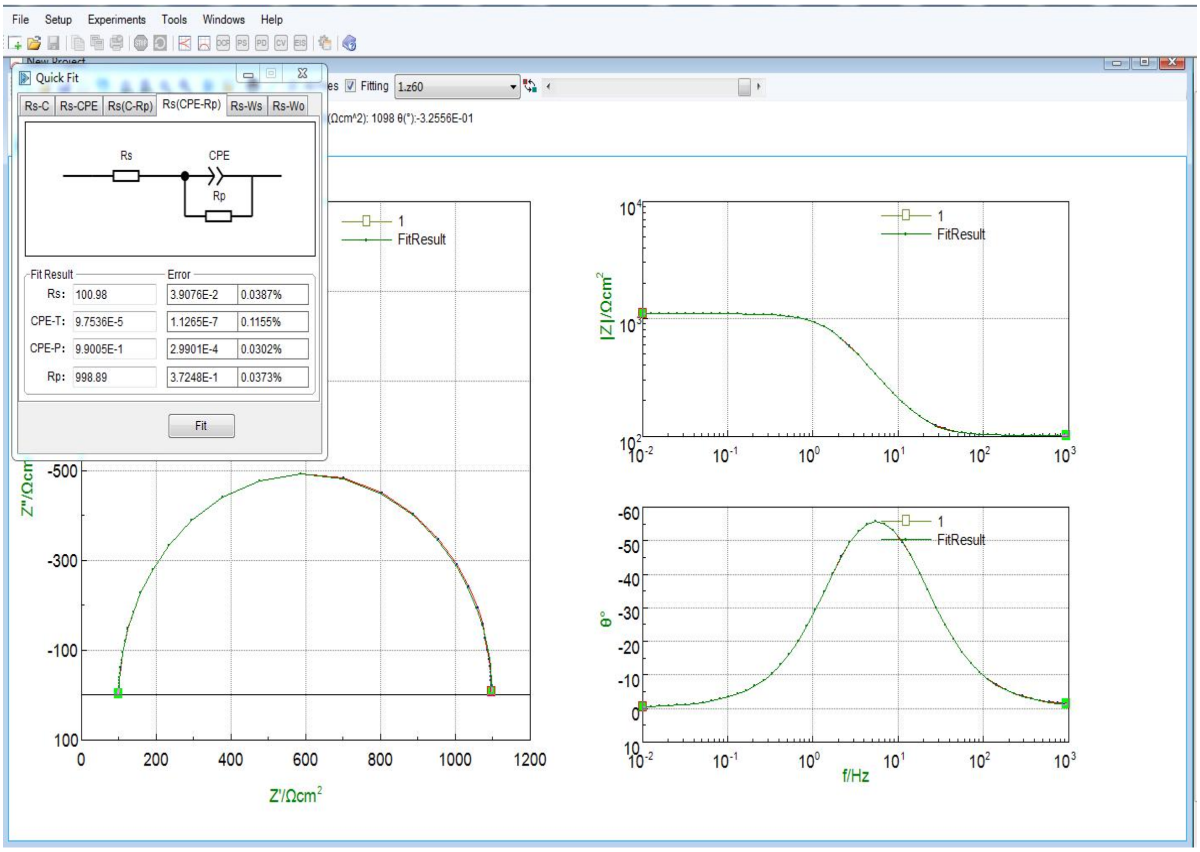


Battery test and analysis: charge & discharge efficiency, capacity, specific capacitance, charge & discharge energy.



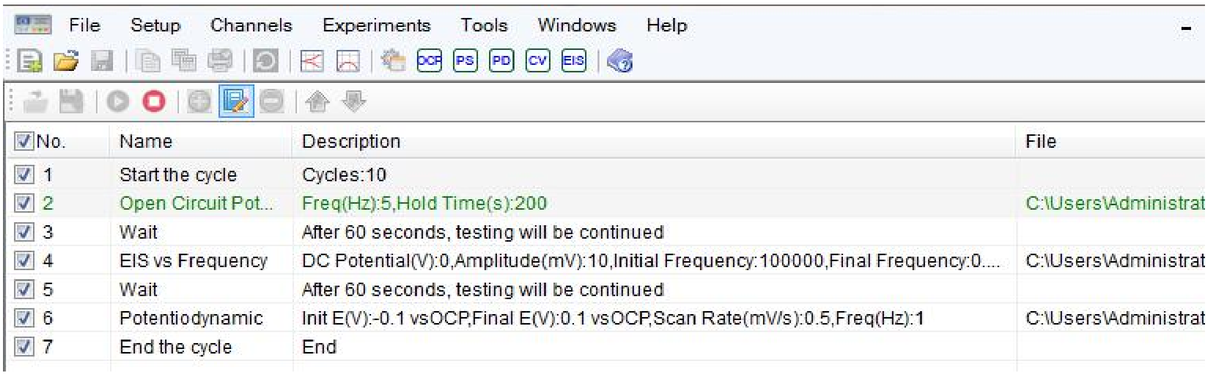
EIS analysis: Bode, Nyquist, Mott-Schottky (M-S) plot

During EIS data analysis, there is built-in fitting function to draw the custom equivalent circuit. Firstly, draw the equivalent circuit, use the “Quick Fit” to obtain the parameters’ value, and then substitute the value into the equivalent circuit.



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

Combined measurements: It facilitates the automation of experiments and save time. You can choose several techniques, and set the wait time, the start time, and the cycles. Choose the experiments you want to run, then you can make auto measurement of the set experiments as you want without having to wait in the lab.



No.	Name	Description	File
1	Start the cycle	Cycles:10	
2	Open Circuit Pot...	Freq(Hz):5,Hold Time(s):200	C:\Users\Administrat
3	Wait	After 60 seconds, testing will be continued	
4	EIS vs Frequency	DC Potential(V):0,Amplitude(mV):10,Initial Frequency:100000,Final Frequency:0....	C:\Users\Administrat
5	Wait	After 60 seconds, testing will be continued	
6	Potentiodynamic	Init E(V):-0.1 vsOCP,Final E(V):0.1 vsOCP,Scan Rate(mV/s):0.5,Freq(Hz):1	C:\Users\Administrat
7	End the cycle	End	

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