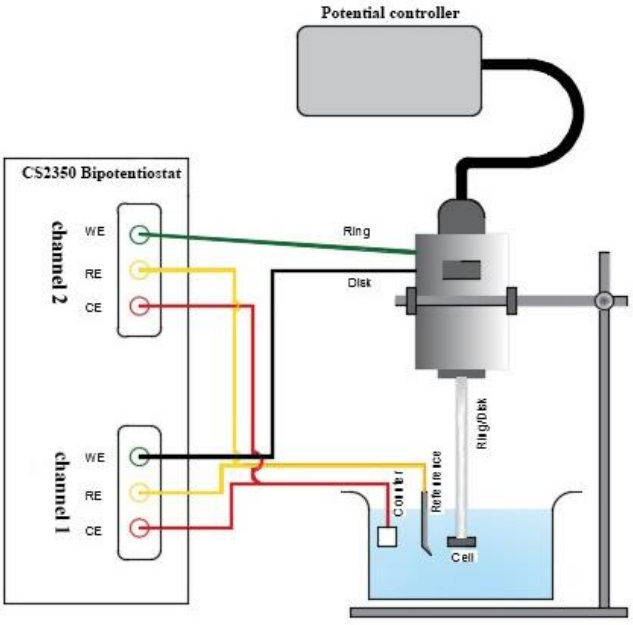
CS2350M bi-potentiostat/Bigalvanostat has two sets of independent potentiostat /galvanostat. The two channels can work together to conduct RRDE and hydrogen diffusion tests. In addition, each channel can also work independently in a complete electrical isolation mode. CS2350M bi-potentiostat is composed physically of two CS350M potentiostats.

Applications

(1) Electrosythesis, electrodeposition (electroplating), anodic oxidation, electrolysis
(2) Electrocatalysis such as Oxygen reduction reaction (ORR), OER, HER, CO2 reduction.
(3) Li-ion battery, solar cell, fuel cell, supercapacitor, advanced function materials, sensor, etc
(4) Corrosion behavior of metals, and anti-corrosion evaluation
(5) Fast evaluation of inhibitor, water quality stabilizer, coating, and cathodic protection efficiency.

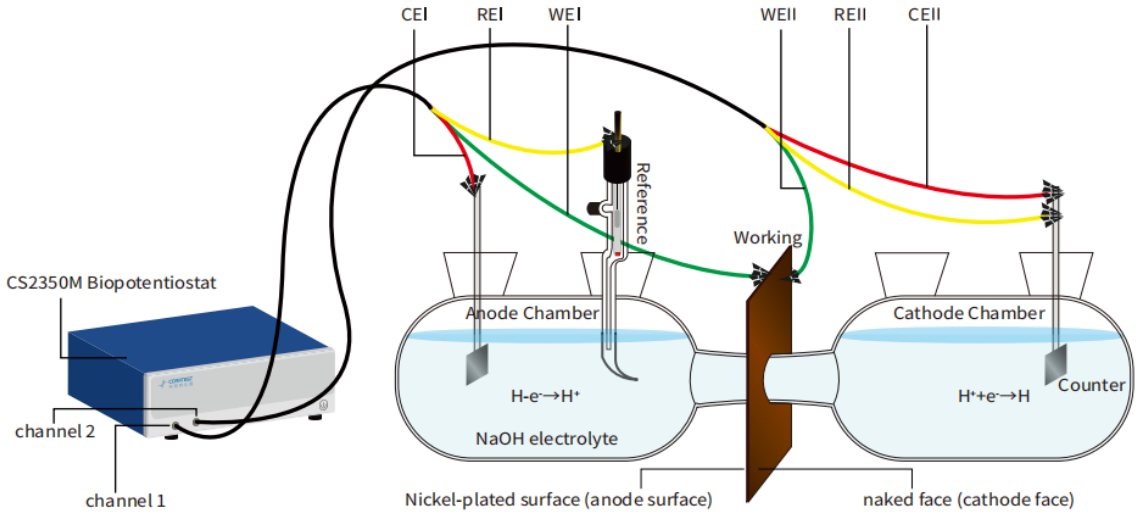
Rotating Ring-Disk Electrode (RRDE)

CS2350M can work cooperatively with the RRDE setup for the electrocatalysis study, such as LSV on the disk via channel #1 and LSV on the ring electrode via channel #2, to detect the intermediate products on the disk electrode.



Hydrogen Diffusion/permeation Test (HDT)

CS2350M can work with type H cells for hydrogen diffusion / permeating test. The H atoms diffusion coefficient in metal and hydrogen flux can be calculated by measuring the hydrogen charging current in the cathodic chamber and oxidation current in the anodic chamber.



Faradaic efficiency test

In electrocatalysis, the Faradaic efficiency is measured to evaluate the performance of the catalyst. The cable connection is shown in below picture. A constant current will be applied on the disk and occur OER and produce oxygen. A constant voltage is applied on the ring and it occurs ORR and consume oxygen. The Faradaic efficiency can be calculated based on disk current and ring current.

Specifications

Specifications	
Support 2-, 3- or 4-electrode system	Interface: Ethernet
Potential control range: Primary Channel: ±10V second Channel: ±10V	Current control range: ±1A in each channel
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: ±1A in each channel	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: 6.5kg,36 x 30 x16cm
Operating System: Windows 7/8/10/11	
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: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	

Techniques in each channel

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)

Electrochemical Impedance Spectroscopy (EIS)

- EIS vs Frequency (Nyquist, Bode)
- 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)

Bipotentiostat

- Hydrogen Diffusion Test (HDT)
- Rotating Ring Disk Electrode(RRDE)
- Faradaic efficiencyTest(FE)

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

Extensions

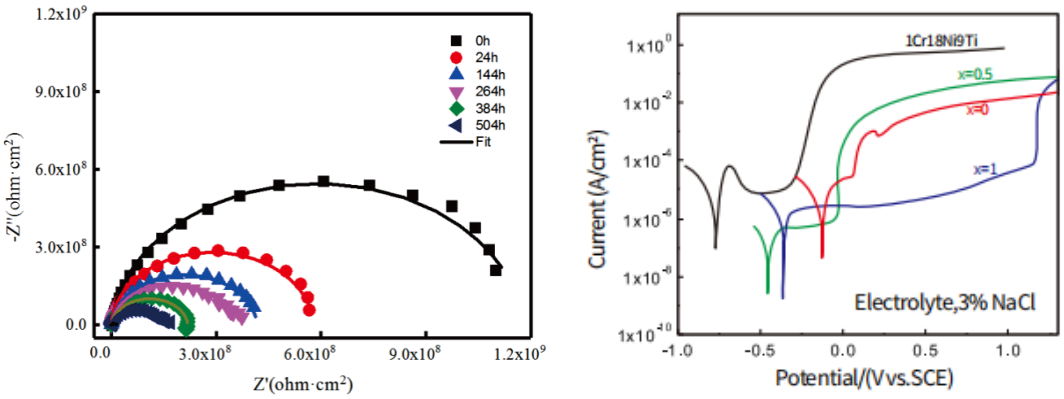
- Data Logger
- Electrochemical Stripping/ Deposition
- Bulk Eletrolysis with Coulometry (BE)
- Rs Measurement

Applications

Corrosion Electrochemistry

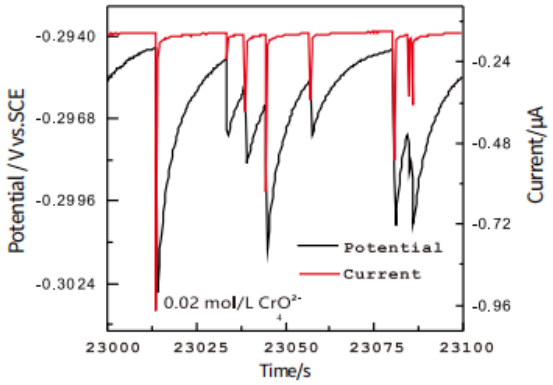
CS potentiostats/galvanostats support a variety of electrochemical techniques for corrosion, such as OCP recorder, potentiodynamic, EIS, cyclic polarization (CPP), LPR, hydrogen diffusion test, zero resistance ammeter (ZRA), electrochemical noise (ECN), etc.

Due to their high input impedance($10^{13}\Omega$), they are especially suitable for EIS measurement of high-impedance systems like coating, concrete, and pure water.



High-impedance coating ageing test in salt spray tests

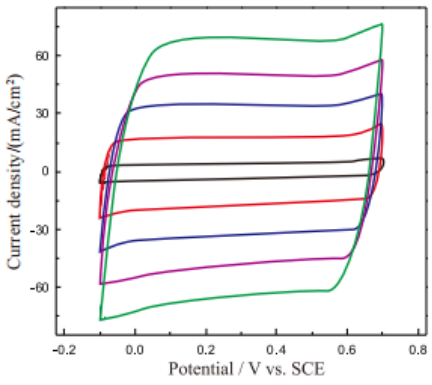
Polarization curves of Ti-alloy& stainless steel in 3%NaCl solution



ECN of low-carbon steel in 0.05mol/L Cl+0.1mol/L $NaHCO_3$

Energy & Battery Testing

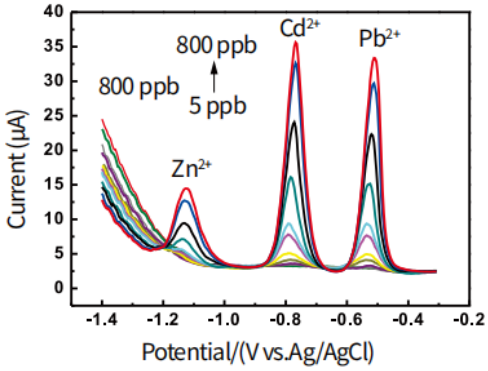
With versatile functions like linear sweep voltammetry (LSV), cyclic voltammetry (CV), galvanostatic charge/discharge (GCD), EIS(including potentiostatic and galvanostatic modes) with precise IR compensation, CS potentiostats are widely used in supercapacitor, Li-ion batteries, Li-S batteries, fuel cell, solar cell, solid-state batteries, flow batteries, and metal-air batteries, *etc*.



CV of PPy supercapacitor in 0.5 mol/L H_2SO_4 solution

Analytical Electrochemistry

CS potentiostats include comprehensive voltammetric methods such as NPV, DPV, DNPV, SWV, and ACV, which make them ideal for quantitative analysis of trace elements via the intrinsic Voltammetry stripping techniques.

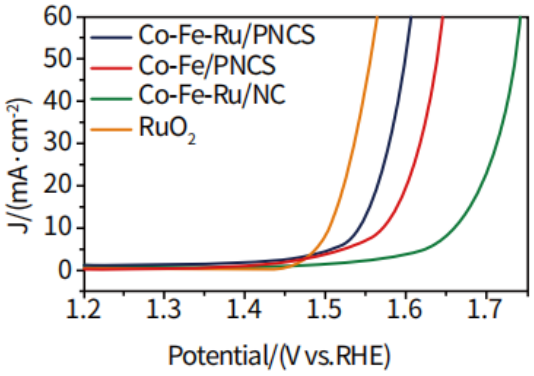


Stripping voltammetric curves in the solution dissolved with Pb^{2+}, Cd^{2+}, and Zn^{2+} ions

Electrocatalysis

Based on CV and LSV techniques, CS potentiostats can carry out long-term tests for ORR, OER, HER, and CO_2 reduction, which is crucial for evaluating catalyst stability. In addition, the CS2350M bi-potentiostat and multichannel potentiostat specialize in Faradaic efficiency synchronous measurement.

CS potentiostats can measure the half-wave potential (ORR) and overpotential (HER, OER) of catalysts and calculate the power density and energy density of Redox peaks.



LSV curves of various catalysts in alkaline solution

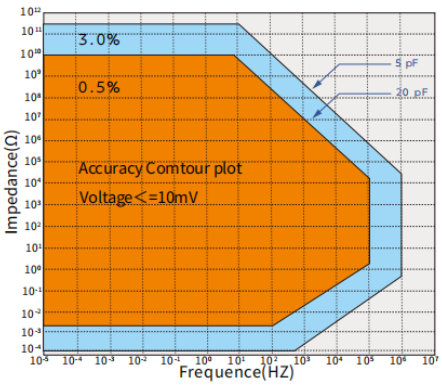
Electrochemical Sensor

Thanks to the high current sensitivity(100fA) and voltage resolution(1 μV), the CS potentiostat can be used for the R&D of biosensors and electrochemical sensors.

Technical Advantages

Switchable floating and earthing mode

All CS potentiostats/galvanostats can switch between the floating and earthing modes, and this strategy is beneficial for studying electrochemical systems in which the working electrodes are intrinsically ground, such as autoclaves, in-site concrete structures and multi-working electrodes requiring isolation, etc.



High-bandwidth EIS

with the help of built-in digital FRA and arbitrary signal generator, as well as the high input impedance (10^{13} Ω), the CS potentiostat is particularly suitable for EIS measurements of high-impedance systems (such as coating, membrane, concrete, etc.)

Based on the DC bias compensation technique, CS potentiostats can conduct EIS tests under different charge/discharge states of batteries, making them suitable for ultra-low resistance systems, such as power batteries, fuel cells, water-splitting equipment, etc.

Multiple electrode configurations

CS potentiostats support 2-, 3-, or 4-electrode configurations and can measure the galvanic current via built-in zero resistance ammeter circuits.

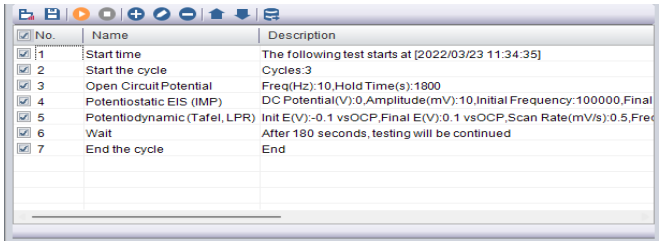
Independent multiple channels

For CS 310X multi-channel potentiostat, each channel is completely independent. It can be used for the electrochemistry measurements of multiple cells or multiple working electrodes in a cell.

CS2350M Bipotentiostat/multi-channel potentiostat can be used for the RRDE test, dual-cell hydrogen diffusion test.

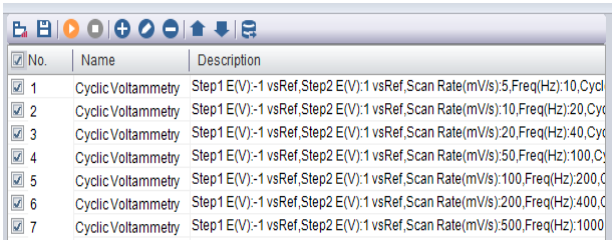
User-defined sequence test

CS Studio 6.0 for Windows software supports user-defined sequence tests ("combination test"), which can facilitate automatic testing according to user-defined experiment sequences.



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

Sequence 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

Sequence Test: Pseudocapacitor tests

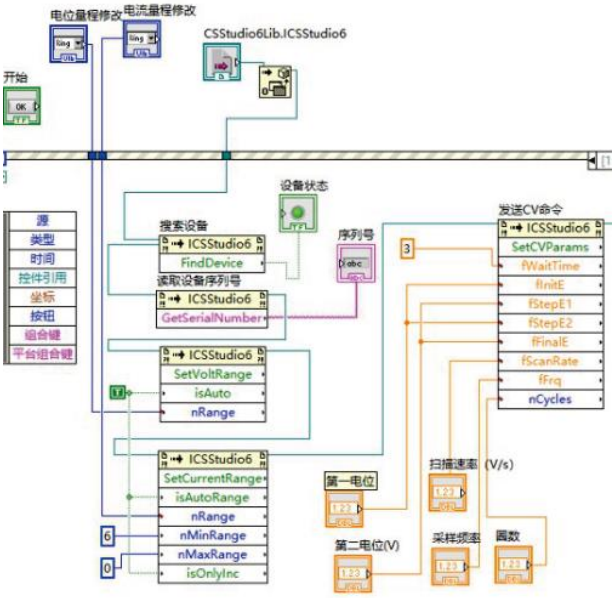
Power booster

Through CS2020B/CS2040B/CS2100B booster, the CS potentiostats can extend their output current up to ±20A/40A/100A, meeting the growing requirements in fuel cells, power batteries, electroplating and

The compliance voltage of single-channel potentiostat can be customized(±30V),suitable for carbon/nitrogen electrochemical reduction.

With a multiplexer, the CS single-channel potentiostats can be extended to 16~32 channels for high throughput testing.

CS potentiostats can work with a CST520 arrayed electrode mapper to study the non-uniform corrosion of metal samples under deposits, coatings and anti-rust oils.



Software development kit (SDK)

All CS potentiostats run under the control of CS Studio 6.0 for Windows (CSS 6.0). The CSS6.0 supports third-party languages, such as LabVIEW, C, C++, C#, VC, Python and others. Some API general interfaces and development examples can be supplied with the CS potentiostats. Through the SDK, customers can implement user-defined test methods.

Real-time data saving

CSS 6.0 saves experimental data timely, even if the experiment is accidentally interrupted by a power failure or computer shutdown. CSS 6.0 supports several data formats compatible with Originpro and Microsoft Excel.

Versatile data analysis functions

CSS 6.0 provides robust functions, including various electrochemical measurements and data analysis. It can complete Tafel plot fitting, CV derivation, integration and peak height analysis, EIS equivalent circuit fitting, etc.

3, 4 parameter polarisation curve fitting.

EIS fitting

Electrochemical noise spectrum analysis

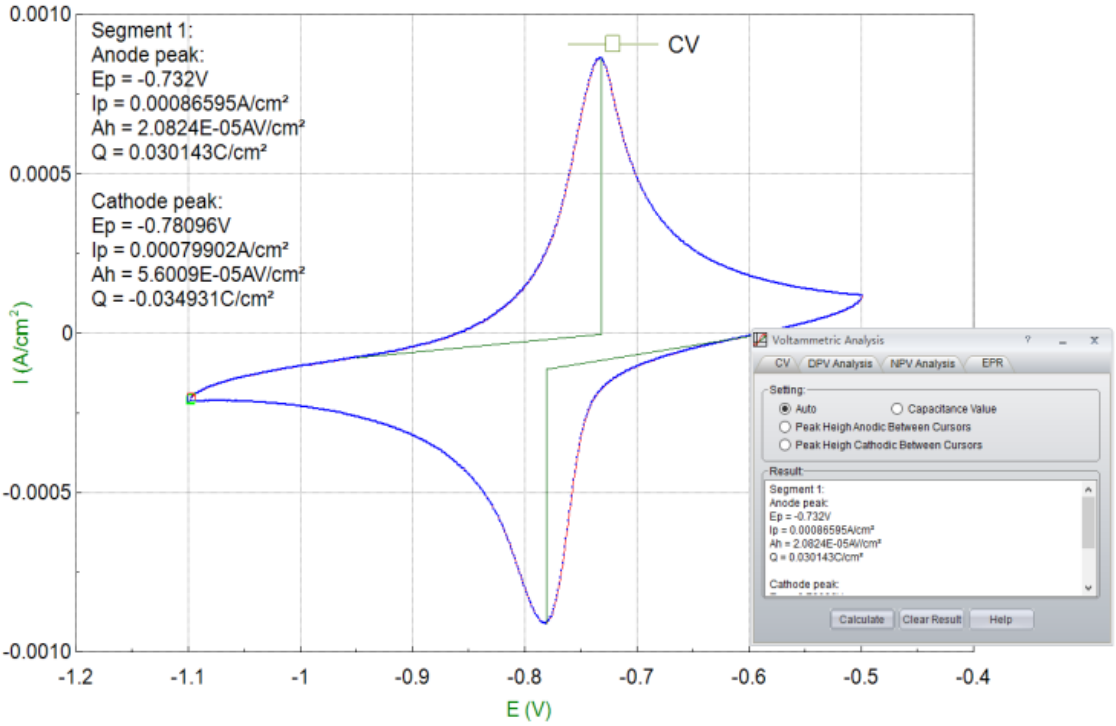
Pseudo-capacitance calculation

GCD-specific capacitance, efficiency calculation

Mott-Schottky analysis

CV curve analysis

Activation/re-passivation curve analysis



BiPotentiostat / BiGalvanostat (2-channel) model CS2350M

Standard supply:

Instrument **CS2350M** x1

CS studio software x1Power cable x1,

Ethernet cable x1,

Electrode cable x 4

Dummy cell (1kΩ||100μF) x2