

Single-channel potentiostat/galvanostat with EIS Model CS350pro consists of a DDS arbitrary function generator, a potentiostat/galvanostat and an FRA. With the help of built-in dual 24-bit Delta-sigma AD converters, it achieves excellent stability and high potential ($1\mu\text{V}$) and current(1pA) resolutions. With 40+ electrochemical techniques, CS350pro has been widely applied in corrosion, energy, material and analysis electrochemistry.

CS350Pro is an upgraded version of the conventional single-channel electrochemical workstation with outstanding stability and accuracy, advanced hardware, and fully functional software. EIS frequency can be as high as 5MHz.



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Applications

- Energy materials (Li-ion battery, solar cell, fuel cell, supercapacitors, etc);
- Reactive mechanisms of electrosynthesis, electrodeposition (electroplating), anodic oxidation, electrolysis;
- Metallic corrosion; corrosion inhibitor, coating and cathodic protection efficiency;
- Electrocatalysis (HER, OER, ORR, CO_2RR , NRR, water splitting).

Specifications	
Support 2-, 3- or 4-electrode system	
Potential control range: $\pm 10\text{V}$	Maximum current : $\pm 2\text{A}$
Potential control accuracy: $0.1\% \times \text{full range} \pm 1\text{mV}$	Current control accuracy: $0.1\% \times \text{full range}$
Potential resolution: $1\mu\text{V}$	Current sensitivity: 1pA
Rise time: $< 1\mu\text{s}$ ($< 10\text{mA}$), $< 10\mu\text{s}$ ($< 2\text{A}$)	Reference electrode input impedance: $10^{13}\Omega 5\text{pF}$
Current range: $200\text{pA} \sim 2\text{A}$, 11 ranges	Potential range: $\pm 200\text{mV}$, $\pm 2.5\text{V}$, $\pm 5\text{V}$, $\pm 10\text{V}$, 4 ranges
Compliance voltage: $\pm 30\text{V}$	CV and LSV scan rate: $0.001\text{mV} \sim 10\text{kV/s}$
CA and CC pulse width: $0.0001 \sim 65,000\text{s}$	Current increment during scan: $1\text{mA} @ 1\text{A/ms}$
Potential increment during scan: $0.02\text{mV} @ 1\text{V/mS}$	SWV frequency: $0.001 \sim 100\text{kHz}$
DPV and NPV pulse width: $0.001 \sim 100\text{s}$	AD data acquisition: $16\text{bit} @ 1\text{MHz}$, $20\text{bit} @ 1\text{kHz}$
DA Resolution: 20bit	Minimum potential increment in CV: 0.02mV
Current/potential range setting: Auto/ Manual	Low-pass filters: covering 7-decade
Ground mode: Floating / Earthing, support ZRA	Interface: Ethernet & USB
Operating System: Windows 10/11	Power: $90 \sim 240\text{V AC } 50/60\text{Hz}$
Weight / Measurements: 6.5kg , $36 \times 30 \times 16\text{ cm}$	
EIS (Electrochemical Impedance Spectroscopy)	
Signal generator	
Frequency range: $10\mu\text{Hz} \sim 5\text{MHz}$	Signal resolution: 0.1mV RMS
Frequency accuracy: 0.1%	AC amplitude: $1\text{mV} \sim 2500\text{mV}$

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:	Maximum: 10 ⁶ cycles or 10 ⁵ s	
minimum: 10ms or the longest time of a cycle		
Measurement delay: 0~10 ⁵ s		
DC offset compensation		
Potential automatic compensation range: -10V~+10V		Current compensation range: -2A~+2A
Bandwidth: 8-decade frequency range, automatic and manual setting		

Techniques - CS350pro

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), Chronoamperometry (CA), Chronocoulometry (CC)

Voltammetry: Linear Sweep Voltammetry (LSV), Cyclic 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: Potentiostatic EIS (Nyquist, Bode), Galvanostatic EIS, Potentiostatic EIS (Optional freq.), Galvanostatic EIS (Optional freq.), Mott-Schottky, Potentiostatic EIS vs. Time (Single freq.), Galvanostatic EIS vs. Time (Single freq.)

Corrosion Measurements: Cyclic polarization curve (CPP), Linear polarization curve (LPR), Electrochemical Potentiokinetic Reactivation (EPR), Electrochemical Noise (EN), Zero resistance Ammeter (ZRA)

Battery testing: Battery Charge and Discharge, Galvanostatic Charge and Discharge (GCD), Potentiostatic Charging and Discharging (PCD), Potentiostatic Intermittent Titration Technique (PITT), Galvanostatic Intermittent Titration Technique (GITT)

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

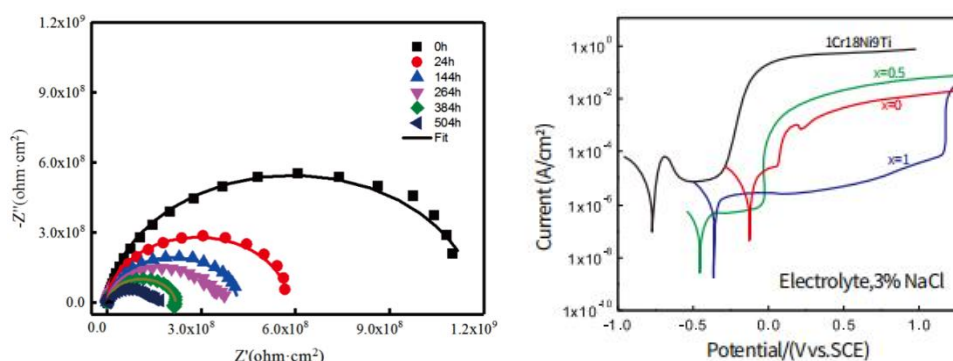
Extensions: Data Logger, Electrochemical Stripping/ Deposition, Bulk Electrolysis with Coulometry (BE), Rs Measurement

Applications

Corrosion Electrochemistry

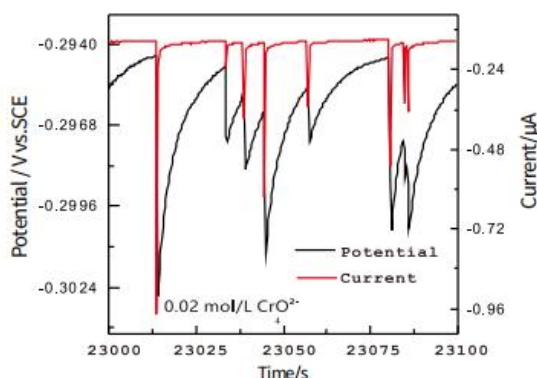
CS potentiostats/galvanostats support a variety of electrochemical techniques for corrosion, such as OCP recorder, potentiodynamic, EIS, cyclic polarization (CPP), LPR, hydrogen diffusion test, zero resistance ammeter (ZRA), electrochemical noise (ECN), etc.

Due to their high input impedance (10¹³Ω), 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

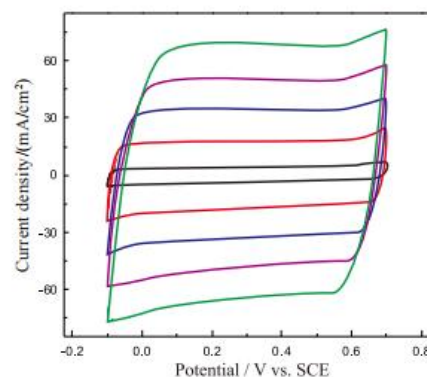
Polarization curves of Ti-alloy& stainless steel in 3%NaCl solution



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 EIS and galvanostatic EIS) with precise IR compensation, CS potentiostats are widely used in supercapacitor, Li-ion batteries, Li-S batteries, Sodium-ion batteries, Zn-ion batteries, fuel cell, solar cell, solid-state batteries, and metal-air batteries, etc.

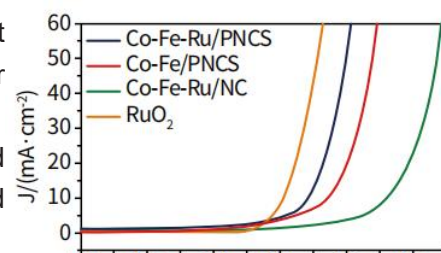


CV of PPY supercapacitor in 0.5 mol/L H $_2$ SO $_4$ solution

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.

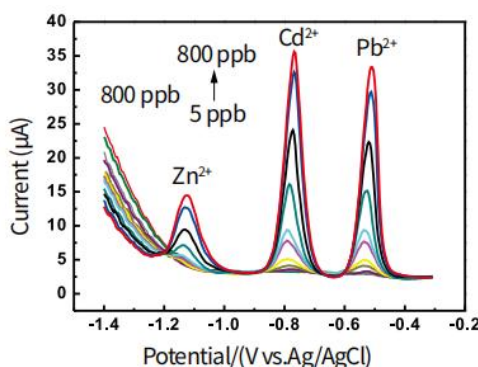
CS potentiostats can measure the half-wave potential (ORR) and overpotential (HER, OER) of catalysts and calculate the power density and energy density of Redox peaks.



LSV curves of various catalysts in alkaline solution

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

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. This strategy is beneficial for studying electrochemical systems where the working electrodes are intrinsically ground, such as autoclaves, in-site concrete structures and multi-working electrodes requiring isolation, etc.

High-bandwidth EIS

With built-in digital FRA and arbitrary signal generator, as well as the high input impedance ($10^{13} \Omega$), 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 charge/discharge state 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.

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 vs OCP, Final E(V): 0.1 vs OCP, Scan Rate(mV/s): 0.5, Freq
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 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 5, Freq(Hz): 10, Cyl
2	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 10, Freq(Hz): 20, Cyl
3	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 20, Freq(Hz): 40, Cyl
4	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 50, Freq(Hz): 100, Cyl
5	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 100, Freq(Hz): 200, Cyl
6	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 200, Freq(Hz): 400, Cyl
7	Cyclic Voltammetry	Step1 E(V): -1 vs Ref, Step2 E(V): 1 vs Ref, Scan Rate(mV/s): 500, Freq(Hz): 1000

Sequence Test: Pseudocapacitor tests

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 polarization curve fitting.

EIS equivalent circuit fitting

Electrochemical noise spectrum analysis

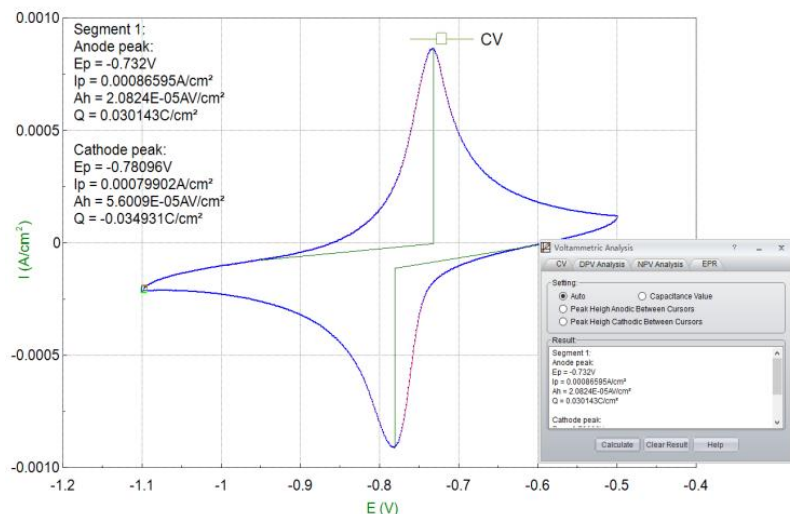
Pseudo-capacitance calculation

GCD - specific capacitance, efficiency calculation

Mott-Schottky analysis

CV curve analysis

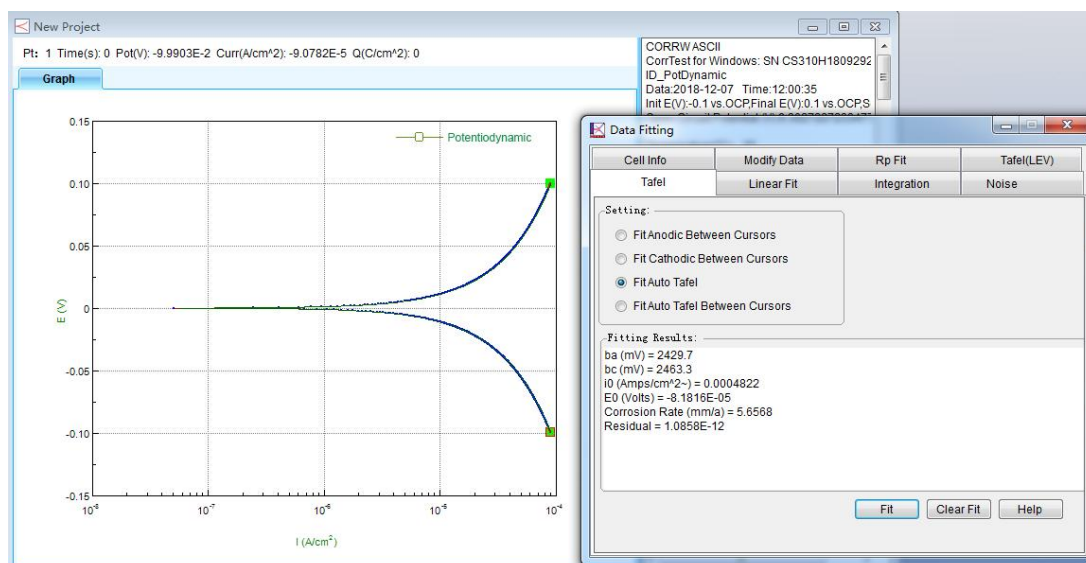
Activation/re-passivation curve analysis



Software Features

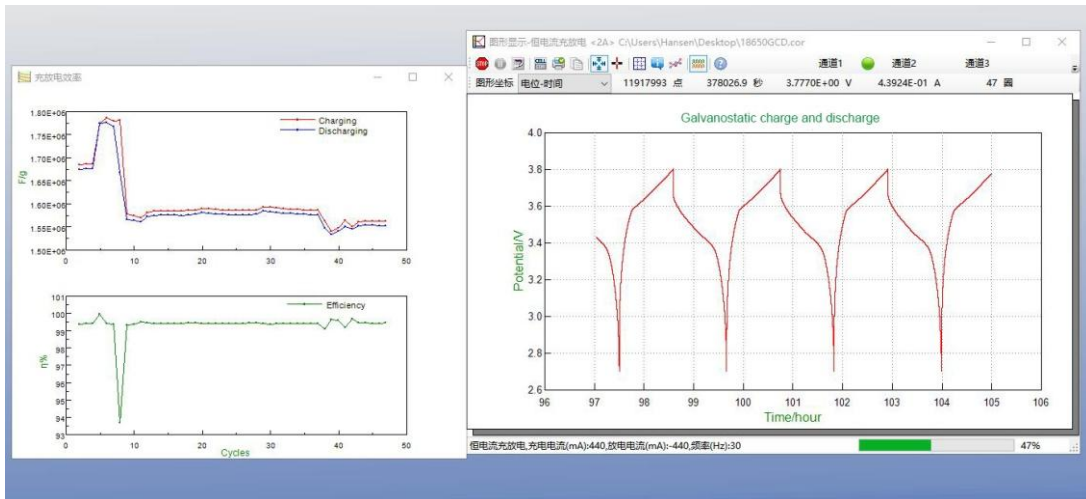
Cyclic voltammetry: CS studio software provides users a versatile smoothing/differential/ integration kit, which can complete the calculation of peak height, peak area and peak potential of CV curves. In CV technique, during the data analysis, there is function of selecting exact cycle(s) to show.

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 ECN measurements.



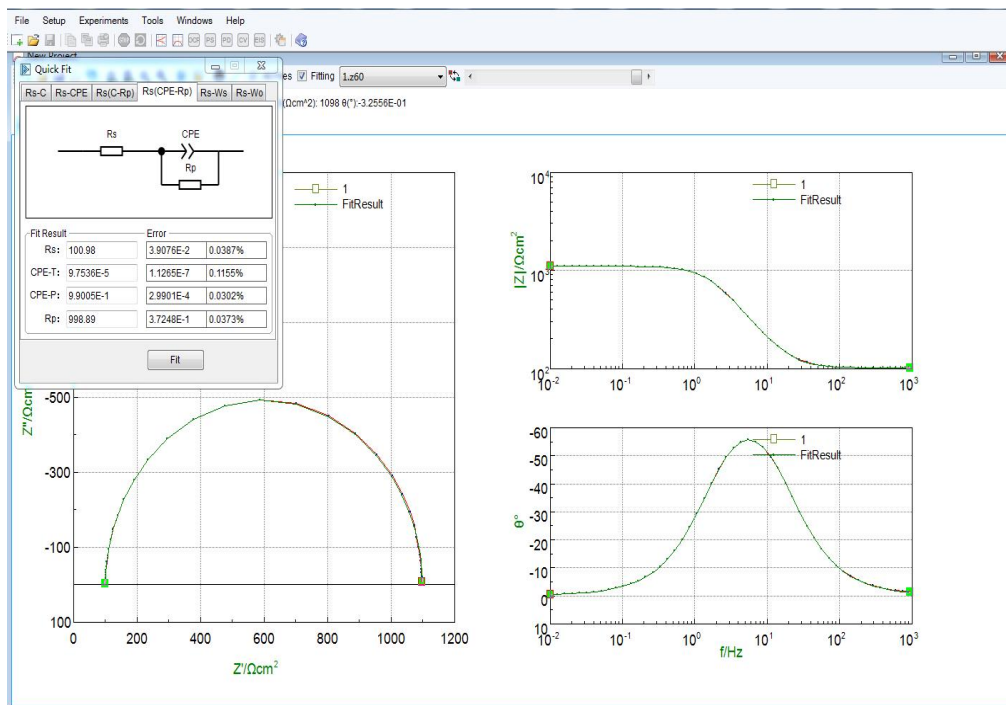
Battery Test and analysis:

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.



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