

## CS series single channel potentiostat/galvanostat

CS series 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.



### Applications:

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

## HARDWARE FEATURES

Dual-channel high-speed 16bit/high-accuracy 24bit AD converter;  
 Built-in frequency response analyzer(FRA), frequency range: 10 $\mu$ Hz~1MHz;  
 High-bandwidth high input impedance amplifier unit  
 Built-in FPGA DDS digital signals synthesizer  
 High-power Potentiostat/Galvanostat/ZRA;  
 Potential control range:  $\pm 10$ V; Compliance voltage:  $\pm 21$ V;  
 Current control range:  $\pm 2$ A ;  
 Potential resolution: 10 $\mu$ V; current resolution 1pA.

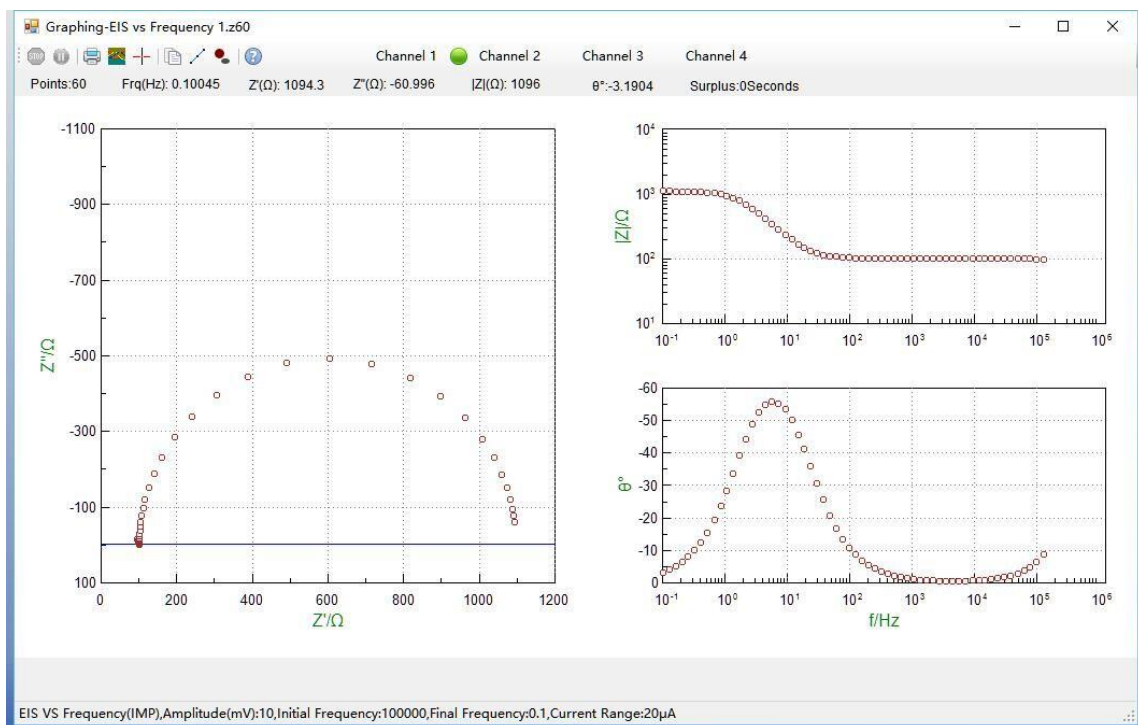
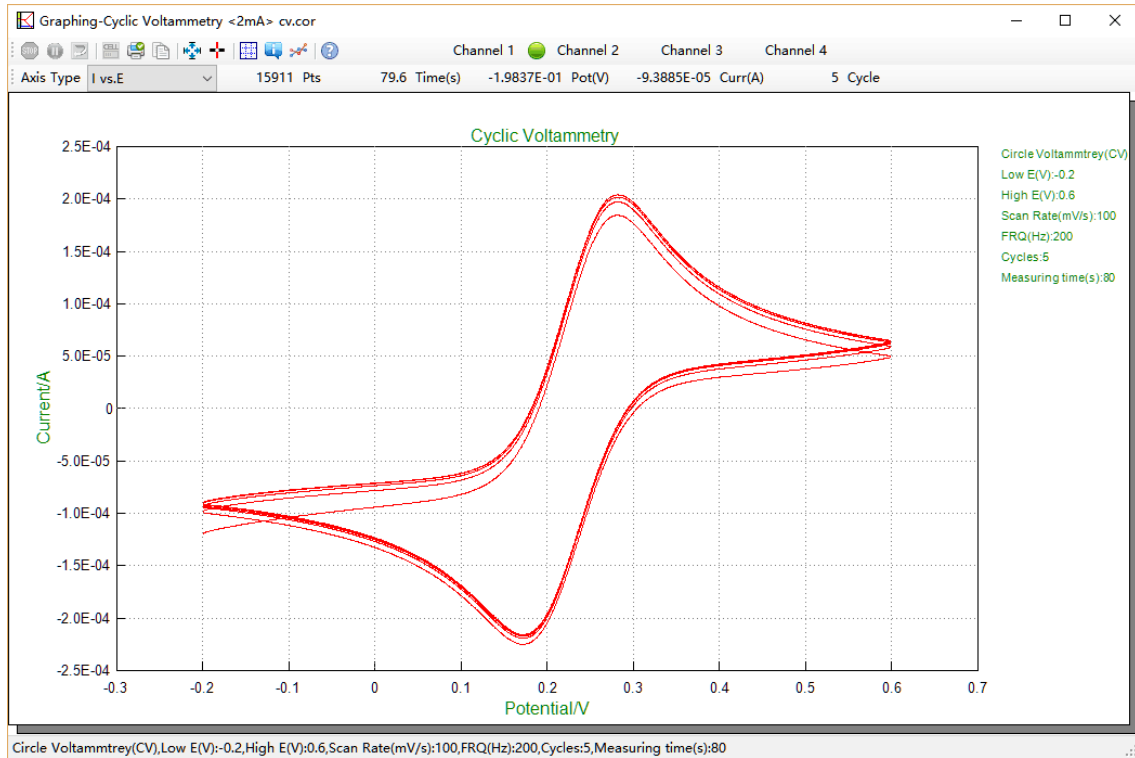
## SOFTWARE FEATURES

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.

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.

CS Studio software can achieve real time saving of the measuring data. The data can be automatically saved even in case of sudden power off.

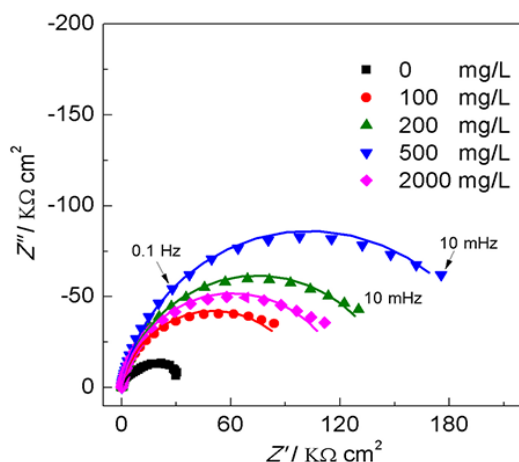
CS studio kit has a built-in versatile timing policy for combined measurements, which can facilitate the automation of experiments and save time.



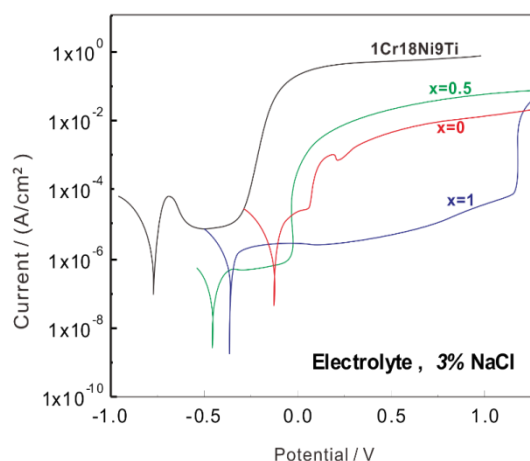
## TECHNICAL ADVANTAGES

### 1. Impedance (EIS)

CS electrochemical workstation 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.). It can also be used to obtain Mott-Schottky curve and differential capacitance curve. During test, the software can display real-time open circuit potential(OCP) without entering.



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



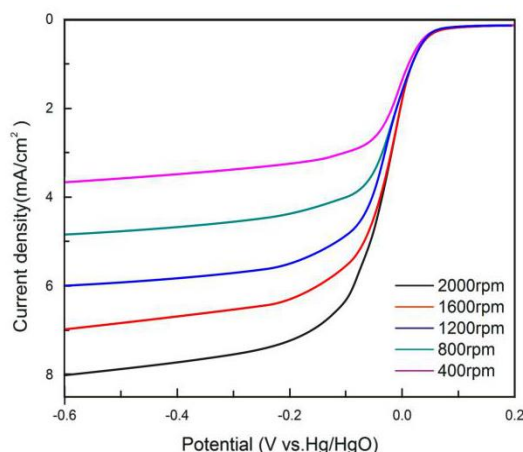
Polarization curve of Ti-based amorphous alloy & stainless steel in 3%NaCl solution

### 2. Polarization curve

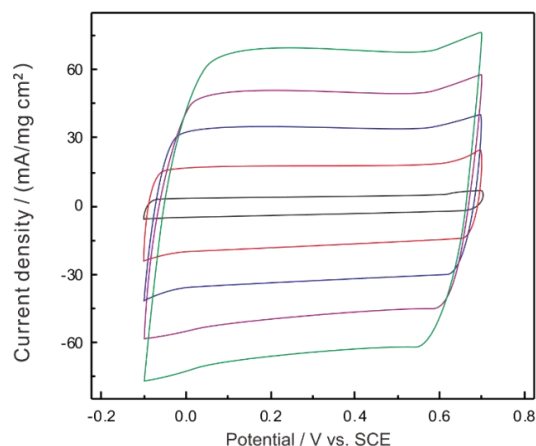
It can complete linear polarization curve and Tafel plot measurements. The user can set the anodic reversal current (passivation film breakdown current) of the cyclic polarization curve to determine material's pitting potential and protection potential and evaluate the its susceptibility to intergranular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

### 3. Voltammetry

It can do the following electroanalysis methods: Linear Sweep Voltammetry(LSV), Cyclic Voltammetry(CV), Staircase Cyclic Voltammetry(SCV), Square wave voltammetry(SWV), Differential Pulse Voltammetry(DPV), Normal Pulse Voltammetry(NPV), AC voltammetry(ACV), Stripping voltammetry etc. It can complete calculation of the integrated peak area, peak current and standard curve analysis.



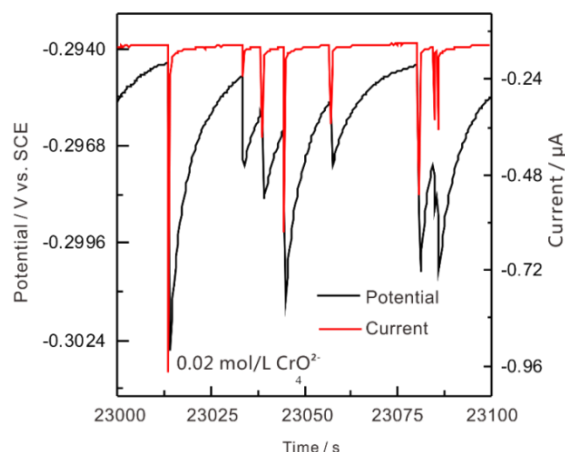
LSV curve: mesoporous carbon material in 0.1M KOH



CV curves of PPy supercapacitor in 0.5 mol/L H<sub>2</sub>SO<sub>4</sub>

#### 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. Through noise spectrum, we can evaluate the inducement, growth and death of metastable pitting and crack. 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<sup>-</sup>+0.1mol/L NaHCO<sub>3</sub>

#### 5. Full floating measurement

CS workstation uses full-floating working electrode. It can be used for autoclave electrochemical measurements, on-line corrosion monitoring of metallic components under the ground (rebar in concrete, etc.)

#### 6. User-defined methods

CS workstation supports user-defined combination measurements. The user can set cyclic timing measurements of an electrochemical method or several methods.

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

## SPECIFICATIONS

Support 2-, 3- or 4-electrode system  
Potential control range:  $\pm 10\text{V}$   
Current control range:  $\pm 2\text{A}$   
Potential control accuracy:  $0.1\% \times \text{full range} \pm 1\text{mV}$   
Current control accuracy:  $0.1\% \times \text{full range}$   
Potential resolution:  $10\mu\text{V}$  ( $>100\text{Hz}$ ),  $3\mu\text{V}$  ( $<10\text{Hz}$ )  
Current sensitivity:  $10\text{pA}$   
Rise time:  $<1\mu\text{s}$  ( $<10\text{mA}$ ),  $<10\mu\text{s}$  ( $<2\text{A}$ )  
Reference electrode input impedance:  $10^{12}\Omega \parallel 20\text{pF}$   
Current range:  $2\text{nA} \sim 2\text{A}$ , 10 ranges  
Compliance voltage:  $\pm 21\text{V}$   
Potential and current range: automatic

Maximum current output:  $2.0\text{A}$   
CV and LSV scan rate:  $0.001\text{mV} \sim 10,000\text{V/s}$   
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:  $0.076\text{mV} @ 1\text{V/ms}$   
SWV frequency:  $0.001 \sim 100\text{kHz}$   
DPV and NPV pulse width:  $0.0001 \sim 1000\text{s}$   
AD data acquisition:  $16\text{bit} @ 1\text{MHz}$ ,  $20\text{bit} @ 1\text{kHz}$   
DA Resolution:  $16\text{bit}$ , setup time:  $1\mu\text{s}$   
Minimum potential increment in CV:  $0.075\text{mV}$   
IMP frequency:  $10\mu\text{Hz} \sim 1\text{MHz}$   
Low-pass filters: covering 8-decade

### Electrochemical Impedance Spectroscopy (EIS)

#### Signal generator:

Frequency range:  $10\mu\text{Hz} \sim 1\text{MHz}$   
Frequency accuracy:  $0.005\%$   
AC signal amplitude:  $1\text{mV} \sim 2500\text{mV}$   
Signal resolution:  $0.1\text{mV RMS}$   
DC Bias:  $-10 \sim +10\text{V}$   
Output impedance:  $50\Omega$   
Waveform: Sine wave, triangular wave and square wave  
Wave distortion:  $<1\%$   
Scan mode: Logarithmic/linear, increase/decrease

#### Signal analyzer:

Integral time: minimum:  $10\text{ms}$  or the longest time of a cycle  
Maximum: 106 cycles or  $105\text{s}$   
Measurement delay:  $0 \sim 105\text{s}$

#### DC offset compensation:

Potential automatic compensation range:  $-10\text{V} \sim +10\text{V}$   
Current compensation range:  $-1\text{A} \sim +1\text{A}$   
Bandwidth: 8-decade frequency range, automatic and manual setting

#### OS Requirement

Communications Interface: isolated Universal Serial Bus (USB 2.0)  
Operating System: Windows 2000/XP/ Win7/Win8/Win10

## Software

Techniques		CS150	CS300	CS310	CS350
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)	✓	✓	✓	✓
	Staircase Voltammetry (SCV) #		✓		✓
	Square wave voltammetry (SWV) #		✓		✓
	Differential Pulse Voltammetry (DPV)#		✓		✓
	Normal Pulse Voltammetry (NPV)#		✓		✓
	Differential Normal Pulse Voltammetry (DNPV)#		✓		✓
	ACvoltammetry (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	Electrochemical Potentiokinetic Reactivation(EPR)	✓	✓	✓	✓
	Electrochemical Noise(EN)	✓	✓	✓	✓
	Zero resistance Ammeter (ZRA)	✓	✓	✓	✓
Battery test	Battery charge and discharge	✓	✓	✓	✓
	Galvanostatic charge and discharge(GCD)	✓	✓	✓	✓
Extensions	Data Logger	✓	✓	✓	✓
	Electrochemical stripping/deposition	✓	✓		✓
	Bulk electrolysis with Coulometry(BE)	✓	✓	✓	✓

# there is the corresponding stripping techniques