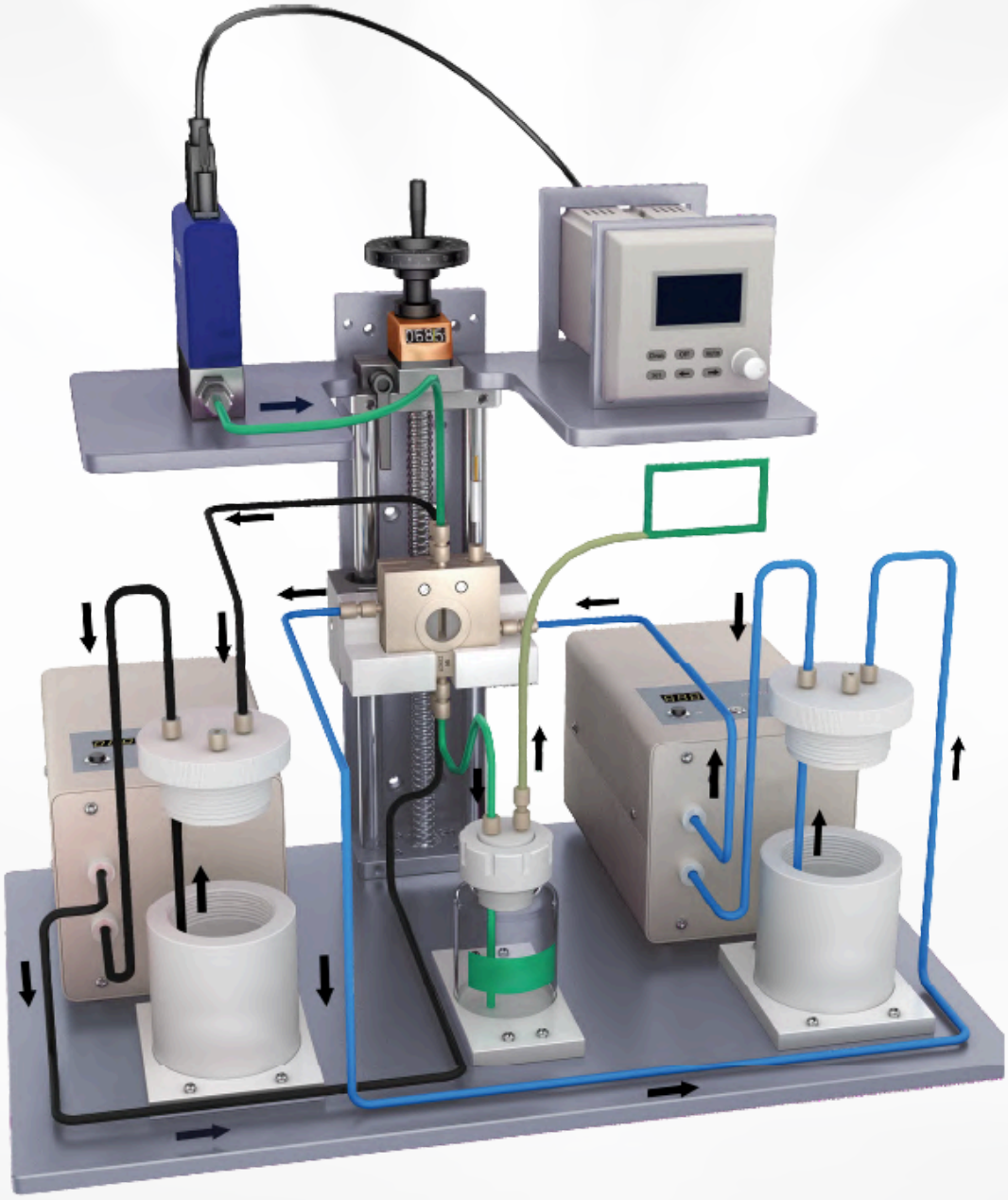
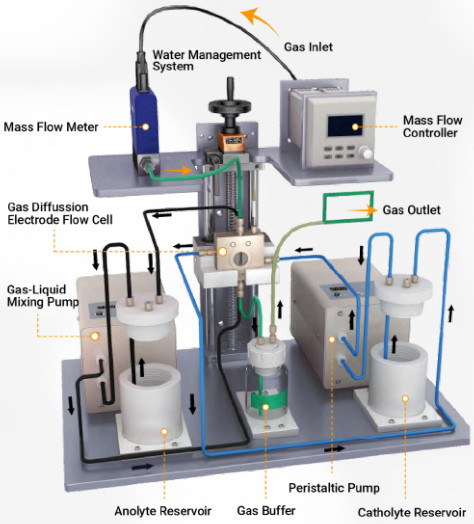
CO_2 Reduction Complete System





System Overview

The CO_2 Reduction Complete System is a turnkey electrochemical platform designed specifically for Gas Diffusion Electrode (GDE) Flow Cell-based CO_2 electrolysis research. The system consists of three integrated modules: Electrolytic Reaction Module, Fluid Transfer & Control Module, and Fluid Storage & Interconnection Module. This integrated design enables reliable, scalable, and highly reproducible CO_2 reduction experiments, covering the full workflow from fundamental catalyst studies to CO_2 reduction reaction (CO_2RR) evaluation at medium-to-high current densities. By establishing an efficient gas-liquid-solid three-phase interface, the GDE Flow Cell enables CO_2RR studies at medium-to-high current densities that are difficult to achieve in conventional H-type Electrochemical Cell (H-Cell) configurations.

GDE Flow Cell vs. Conventional H-Cell

Parameter	GDE Flow Cell	Conventional H-Cell
Current Density	> 200 mA/cm²	5–20 mA/cm²
CO_2 Feed Mode	Direct gas-phase feed to GDE	CO_2 dissolved in electrolyte
Electrolyte Compatibility	Broad pH compatibility (0–14*)	Limited by cell materials
Product Handling	Continuous gas & liquid product collection	Batch operation; product accumulation
Scalability	Modular and scalable architecture	Limited scalability

**Depending on membrane, electrode, sealing and wetted-path materials.*

Primary Applications

- CO_2RR catalyst evaluation and benchmarking at medium-to-high current densities
- GDE characterisation under gas-phase CO_2 feed
- Mechanistic studies of CO_2 electroreduction pathways and reaction intermediates
- Continuous-flow electrosynthesis of C_1/C_2 products (CO, formate, ethylene, ethanol)
- High-purity liquid product generation and recovery from CO_2 electrolysis

System Modules

Module	Key Components	Function
Electrolytic Reaction Module	• GDE flow cell • Working electrode substrates • Counter electrode • Reference electrode • Ion-exchange membrane	Enables electrochemical CO_2 conversion under GDE flow cell operating conditions
Fluid Transfer & Control Module	• Water management system • Peristaltic pump • Gas-liquid mixing pump • Mass flow meter & controller	Responsible for fluid and gas delivery, flow rate control, and pressure/flow management
Fluid Storage & Interconnection Module	• Anolyte / Catholyte reservoir • Gas buffer • PTFE tubing	Provides fluid storage, buffering, and interconnection between modules

Features and Benefits

End-to-End Integration

Pre-validated components for immediate deployment; no piecing together third-party hardware.

Modular Versatility

Multiple interchangeable cell geometries with standardized footprints for cost-effective upgrades.

Industrially Relevant Performance

Designed for CO_2RR studies at medium-to-high current densities.

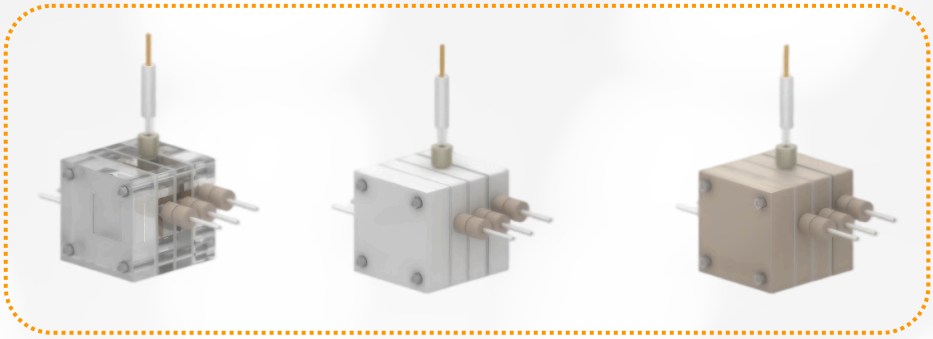
Superior Corrosion Resistance

Carefully selected wetted-path materials, including PMMA, PTFE, PEEK, and titanium, provide excellent chemical resistance and long-term durability across a wide range of acidic and alkaline electrolytes.

Technical Specifications

1.GDE Flow Cell

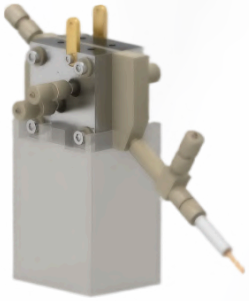
EC-GDE1



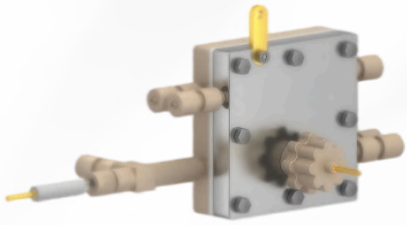
EC-GDE2

EC-GDE3

EC-GDE4



EC-GDE5



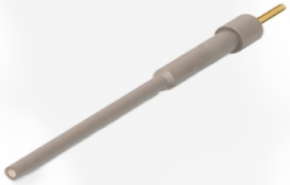
EC-GDE6

Model	EC-GDE1	EC-GDE2	EC-GDE3	EC-GDE4	EC-GDE5	EC-GDE6
Chamber Structure	Three-chamber	Three-chamber	Three-chamber	Three-chamber	Three-chamber (standard)	Three-chamber
Electrode System	Three-electrode	Three-electrode	Three-electrode	Three-electrode	Three-chamber (standard)	Three-electrode
Anode-cathode Gap	25 mm	20 mm	7 mm	3 mm	1.2 mm	0.4 mm
Channel Size	10 × 10 mm	10 × 10 mm	5 × 20 mm	5 × 20 mm	10 × 10 mm	10 × 10 mm
Cell Body Material	PEEK	PMMA / PTFE / PEEK	PEEK	PEEK	Ti + PEEK	Ti + PEEK
Optical Window	No	No	Yes (Quartz)	Yes (Quartz)	No	No
Recommended Use	Entry-level GDE Flow Cell, Basic CO_2RR/NRR Testing, Catalyst Screening, Teaching Demonstration	Cost-Effective GDE Flow Cell, Rapid Feasibility Validation	Visualized Three-Chamber GDE Flow Cell, Mechanistic Studies & Catalyst Evaluation, Graduate-Level Research Platform	High-Performance Three-Chamber GDE Flow Cell, 3 mm Short Electrode Gap, Advanced Catalyst Evaluation Platform	Modular Advanced GDE Flow Cell, 1.2 mm Short Electrode Gap, Four Operating Modes, Solid-Electrolyte Reactor Research	Ultra-Short-Gap GDE Flow Cell, 0.4 mm Electrode Gap, CO_2RR Studies at Medium-to-High Current Densities, and Long-Term Stability Testing

Notes: Custom channel sizes are available upon request. All GDE flow cells are compatible with most commercial potentiostats supporting three-electrode measurements, including CH Instruments (e.g., CHI 660E, CHI 1140C), Bio-Logic systems (e.g., VMP3), and Corrtest Instruments systems (e.g., CS350M).

2.Reference Electrode

R1038



PK-1038

4038

Hg-1038

Model	R1038	PK-1038	4038	Hg-1038
Product Name	Ag/AgCl Electrode (Single Salt Bridge)	Ag/AgCl Electrode (Solid)	Ag/Ag+ Electrode	Hg/HgO Electrode
Electrode Material	Ag/AgCl	Ag/AgCl	Ag	Hg/HgO
Applicable Systems	Neutral & acidic aqueous solutions	Neutral & acidic aqueous or non-aqueous solutions	Non-aqueous organic systems	Alkaline aqueous solutions
Typical Potential vs SHE	0.198 V	0.198 V	0.799 V	0.098 V
Body Diameter	Φ3.8 mm	Φ3.8 mm	Φ3.8 mm	Φ3.8 mm
Body Material	Glass	PEEK	Glass	PEEK
Filling Solution	saturated KCl	N/A	1.0 mol/L $AgNO_3$	1.0 mol/L KOH
Flow Rate of Junction	≥ 1 drop/10 min	N/A	≥ 1 drop/10 min	≥ 1 drop/10 min
Internal Resistance	≤ 10 kΩ	≤ 10 kΩ	≤ 10 kΩ	≤ 10 kΩ

Note: Potentials are typical values at 25 °C and may vary with the electrolyte, filling solution, solvent, and temperature. Calibration is recommended. RHE, Hg/Hg_2SO_4, SCE, and other reference electrode types are available upon request. Dimensions, body materials, and filling solutions are customizable.

3.Counter Electrode

Platinum Wire Electrode

Platinum Sheet Electrode

Platinum Mesh Electrode

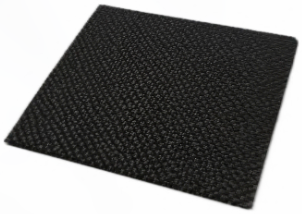
Graphite Rod Electrode

Product Name	Platinum Wire Electrode	Platinum Sheet Electrode	Platinum Mesh Electrode	Graphite Rod Electrode
Electrode Material	Pt (99.99%)	Pt (99.99%)	Pt (99.99%)	Graphite (98%, 99.99%)
Applicable Systems	Acidic, neutral and alkaline aqueous solutions, organic solvents, high temperature and high pressure	Acidic, neutral and alkaline aqueous solutions, organic solvents, high temperature and high pressure	Acidic, neutral and alkaline aqueous solutions, organic solvents, high temperature and high pressure	Alkaline and neutral aqueous solutions; some organic solvents
Standard Dimensions	Φ0.5 × 37 mm, Φ1.0 × 37 mm, Φ0.5 × 230 mm	Thickness: 0.1, 0.2, 0.3 mm, Sizes: 5 × 5, 5 × 10, 10 × 10, 10 × 15, 15 × 15 mm, etc.	Sizes: 10 × 10, 10 × 15, 15 × 15, 20 × 20 mm, etc.	Φ3-6 × 75 mm
Handle Material	PTFE/PEEK/PVDF	PTFE/PEEK/PVDF	PTFE/PEEK/PVDF	PTFE/PEEK/PVDF

Note: Counter electrodes are available in a range of materials for different electrochemical applications. IrO_2-coated titanium mesh, nickel foam/mesh, stainless-steel mesh, graphite felt, gold, and other materials are available upon request. Dimensions and geometries are customizable.

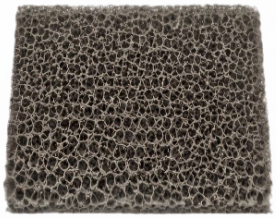
4.Working Electrode Substrates

Carbon Paper



Carbon Cloth

Glassy Carbon



Nickel Foam

Product Name	Carbon Paper	Carbon Cloth	Glassy Carbon	Nickel Foam
Electrode Material	Carbon fiber	Carbon fiber	Glassy carbon	Nickel
Thickness	0.19–0.30 mm	0.30–0.45 mm	1.00–3.00 mm	0.50 mm
Porosity	75–85%	70–80%	Non-porous	95–98%
Electrical Conductivity	100–300 S/cm	80–250 S/cm	800–2000 S/cm	1000–5000 S/cm
Recommended Current Density	50–500 mA/cm²	50–500 mA/cm²	<50 mA/cm²	50–1000 mA/cm²
Applicable Systems	Neutral and alkaline aqueous solutions, and some organic solvents	Neutral and alkaline aqueous solutions, and some organic solvents	Acidic, neutral and alkaline aqueous solutions, organic solvents, high temperature and high pressure	Strongly alkaline aqueous solutions
Standard Dimensions	100 × 100 mm	100 × 100 mm	100 × 100 mm	100 × 100 mm

Note: Working electrodes are available with a range of substrate and catalyst combinations for different electrochemical applications. Substrates including titanium mesh, titanium felt, copper foam, and ePTFE, and catalysts including Ag-, Sn-, Bi_2O_3-, Cu-, and CuO-based materials are available upon request. Dimensions, substrate–catalyst combinations, and other specifications are customizable.

5.Ion Exchange Membrane

Nafion N-117

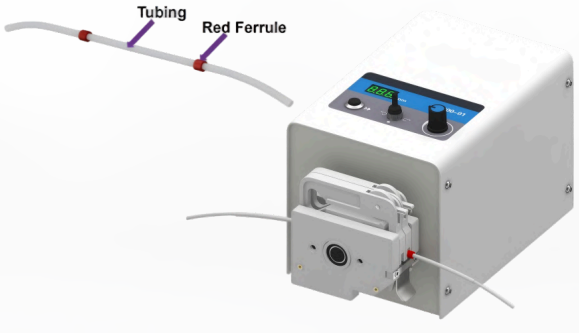
Fumasep FAA-3-50

Model	Nafion N-117	Fumasep FAA-3-50
Membrane Type	Proton Exchange Membrane (PEM)	Anion Exchange Membrane (AEM)
Thickness (Dry)	0.183 mm	0.045–0.055 mm
Ion Conductivity	~0.1 S/cm	~0.03 S/cm
Area Resistance	< 0.3 Ω·cm²	< 1.0 Ω·cm²
Applicable Systems	Acidic aqueous solutions	Acidic, neutral and alkaline aqueous solutions
Color	Transparent / Colorless	Transparent / Brown
Manufacturer	Chemours (USA)	FuMA-Tech (Germany)

Note: Pre-treatment may be required. Nafion N-117 is commonly treated with H_2O_2/H_2SO_4 for cleaning and protonation, while FAA-3-50 is typically conditioned in KOH for hydroxide-form conversion. Refer to the membrane manufacturer's instructions or established laboratory protocols for specific conditions.

6. Peristaltic Pump

Model	PMP-1
Tubing Size	2 mm ID, 4 mm OD
Flow Rate Range	0–35 mL/min
Motor Speed	0–200 rpm
Power Supply	AC 220 V



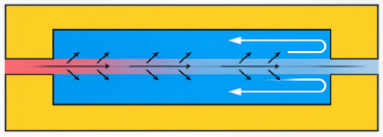
PMP-1

- Precise Flow Control: Utilizes a rotary knob for flexible and rapid speed adjustment, accommodating varying flow rate requirements under different experimental conditions.
- Convenient and Reliable Operation: A toggle switch enables easy control of start/stop and forward/reverse direction switching for intuitive operation.
- One-Button Full-Speed Function: Equipped with a full-speed button for one-touch activation, allowing users to quickly fill or flush fluid lines.
- Application-Specific Design: Specifically developed for the electrochemical testing field, suitable for fluid transfer applications in electrochemical experiments.

7.Gas-Liquid Mixing Pump

Model	PMP-2
Flow Rate Range	140–170 mL/min
Operating Pressure	90 kPa
Input Power Supply	AC 220 V
Rated Operating Voltage	AC 24 V
Load Current	150 mA
Tubing Compatibility	3 mm PTFE tubing
Dimensions	145 × 95 × 90 mm

PMP-2



Shear Force Diagram

- Efficient Gas Bubble Removal: Enables rapid removal of large gas bubble volumes to maintain stable reaction conditions, especially in anodic gas evolution processes.
- High Shear Mixing: Quick-connect fittings generate strong shear force, breaking gas into fine dispersed phases for improved mass transfer and experimental reproducibility.

8.Mass Flow Meter and Controller

Model	EC-MFM+EC-MFC
Flow Range	0-500 SCCM, 0-30 SLM
Control Range	2-100% of F.S.
Accuracy	±1% F.S.
Repeatability	±0.2% F.S.
Response Time	≤ 2 s
Max. Working Pressure	1 MPa
Communication Interface	RS485 / RS232 (Modbus RTU)
Dimensions	L108 × W35 × H108 mm
Weight	0.95 kg

EC-MFM

EC-MFC

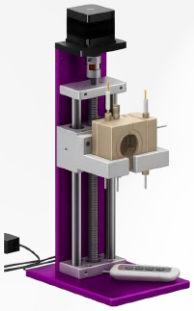
Note: SCCM = standard cubic centimeters per minute; SLM = standard liters per minute. The mass flow meter/controller is configured for CO_2 operation but can also be used to measure other gases using appropriate conversion factors.

- Intuitive Display: LCD screen provides real-time display of signal type, flow rate, setpoint, unit, and communication status.
- Flexible Flow Settings: Digital rotary encoder supports both step and continuous flow setting modes to meet diverse experimental needs.
- Power-Off Memory: Parameters are automatically saved and retained after power loss, ensuring operational continuity.

- Versatile Communication: Equipped with RS485/RS232 interfaces supporting Modbus RTU protocol; compatible with host computer software for parameter configuration and calibration.
- Backward Compatible: Signal interface and operation are fully compatible with the original EC-MFC, facilitating seamless upgrades.
- Power Connection: Please confirm the required input voltage and plug type when ordering.

9.Water Management System

Model	EC-WM
Effective Stroke	260 mm
Material	Aluminum alloy
Dimensions	L190 × W150 × H350 mm



EC-WM

- Pressure Balance Management: Adjusts the relative height of the GDE flow cell to balance liquid and gas pressures, helping prevent electrolyte flooding or gas breakthrough and maintaining a stable gas-liquid-solid three-phase reaction interface.
- Precision Adjustment: Equipped with a graduated fine-adjustment display, allowing users to precisely control the GDE flow cell height.
- Robust and Durable: Constructed from aluminum alloy, providing structural stability and corrosion resistance for long-term experimental use.
- Optional Electric Remote Control: An electric remote-controlled version is available, enabling convenient remote height adjustment for enhanced operational flexibility.

Application Notes

1.CO_2RR Evaluation at Industrially Relevant Current Densities: Gas-phase CO_2 is directly supplied to a GDE flow cell to establish an efficient gas-liquid-solid three-phase reaction interface. This configuration enables catalyst evaluation under industrially relevant current density conditions, allowing researchers to investigate Faradaic efficiency, overpotential, product distribution, and operational stability in realistic CO_2 electrolysis environments.
Reference: *Qing et al. "Protonation pathway for CO_2 reduction mediated by coordinated H_2O on active sites", Nature Communications, 2025.*

2.CO_2-to-Ethylene Electrosynthesis Using Surface N-Coordinated Cu Catalysts: The GDE flow cell platform enables the evaluation of advanced copper-based catalysts for selective CO_2 conversion to ethylene. Surface nitrogen coordination modifies the local catalytic environment, promoting C–C coupling and enhancing ethylene selectivity while suppressing competing hydrogen evolution. This application demonstrates the system's suitability for catalyst screening and mechanistic studies of multicarbon product formation.
Reference: *Tao et al. "Surface N-coordinated Cu catalysts for CO_2 electroreduction to ethylene at industry-level current densities", Sustainable Energy & Fuels, 2023.*

3.CO_2-to-Ethanol Electrosynthesis Using Multivalent Cu Catalysts: The system supports the investigation of multivalent copper catalysts for selective ethanol production from CO_2. Stable Cu^{2+}/Cu^{+} active sites facilitate asymmetric C–C coupling and promote the formation of oxygenated C_2 intermediates, improving ethanol selectivity. This application highlights the platform's capability for studying catalyst structure–performance relationships and liquid-product electrosynthesis.
Reference: *Chen et al. "Multivalent Cu sites synergistically adjust carbonaceous intermediates adsorption for electrocatalytic ethanol production", Nature Communications, 2024.*

Ordering Information

Product ID	Description
	GDE Flow Cell
EC-GDE1	Three-chamber PEEK GDE Flow Cell, 25 mm Electrode Gap
EC-GDE2	Three-chamber GDE Flow Cell, 20 mm Electrode Gap
EC-GDE3	Quartz-window Three-chamber GDE Flow Cell, 7 mm Electrode Gap
EC-GDE4	Quartz-window Three-chamber GDE Flow Cell, 3 mm Electrode Gap
EC-GDE5	Modular Three-chamber GDE Flow Cell, 1.2 mm Electrode Gap
EC-GDE6	Three-chamber GDE Flow Cell, 0.4 mm Electrode Gap
	Reference Electrode
R1038	Ag/AgCl Reference Electrode, Glass Body
PK-1038	Solid Ag/AgCl Reference Electrode, PEEK Body
4038	Ag/Ag^+ Reference Electrode, Glass Body
Hg-1038	Hg/HgO Reference Electrode, PEEK Body
	Counter Electrode
Pt Wire Series	Platinum Wire Electrode
Pt Sheet Series	Platinum Sheet Electrode
Pt Mesh Series	Platinum Mesh Electrode
GR Series	Graphite Rod Electrode
	Working Electrode Substrates
CP Series	Carbon Paper Electrode
CC Series	Carbon Cloth Electrode
GC Series	Glassy Carbon Electrode
NF Series	Nickel Foam Electrode
	Ion Exchange Membrane
Nafion N-117	Proton Exchange Membrane
FAA-3-50	Anion Exchange Membrane

Ordering Information (Continued)

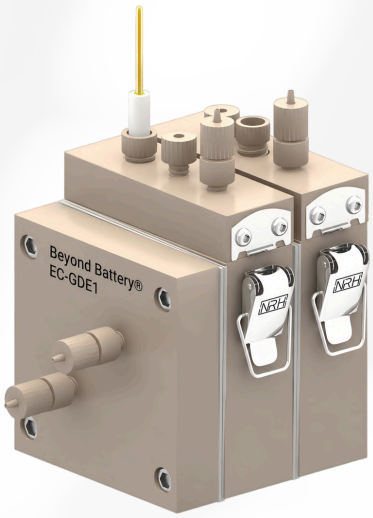
Fluid Transfer & Control Module	
PMP-1	Peristaltic Pump
PMP-2	Gas-Liquid Mixing Pump
EC-MFM+EC-MFC	Mass Flow Meter & Controller
EC-WM	Water Management System
Fluid Storage & Interconnection Module	
Anolyte Reservoir	Electrolyte Storage Reservoir for Anode Compartment
Catholyte Reservoir	Electrolyte Storage Reservoir for Cathode Compartment
Gas Buffer	Gas Pressure Buffer and Flow Stabilization Unit
PTFE Tubing	Chemical-resistant PTFE Tubing & Connectors

Electrochemical Cells Series

EC-GDE1

Gas Diffusion Electrochemical Cell

A quick-opening, three-electrode gas diffusion cell for entry-level electrochemical experiments.



Product Overview

The EC-GDE1 is an entry-level gas diffusion electrochemical cell designed for introductory electrochemical experiments. It features a PEEK three-chamber body and a three-electrode configuration. Quick-opening lids simplify assembly and access, while gas inlet and outlet ports on both electrode sides and dedicated sampling ports support flexible experimental configurations.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Anode-cathode gap	25 mm
Active area	1 cm² (10 x 10 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type electrode
Counter electrode	Rod-type electrode
Cell body material	PEEK

Key Features

Quick-Opening Design

Quick-opening lids simplify cell assembly, access and disassembly.

Three-Chamber Configuration

A three-chamber, three-electrode design supports entry-level electrochemical experiments.

Flexible Port Arrangement

Gas inlet and outlet ports on both electrode sides, together with dedicated sampling ports, support flexible experimental configurations.

Typical Applications

Gas-Diffusion Electrode Studies

Evaluating sheet-type GDEs under static-electrolyte conditions.

Gas-Fed Electrocatalysis

Suitable for CO_2RR, ORR, and NRR experiments.

Electrocatalyst Screening

Comparing catalyst loading, activity, and product selectivity.

Electrode Stability Testing

Monitoring early-stage GDE performance changes during electrolysis.

Instrument Compatibility

Gas Supply Compatibility

Compatible with regulated laboratory gas supply systems equipped with pressure regulators, mass flow controllers or gas flow meters for stable and controlled gas delivery during electrochemical experiments.

Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), and Corrtest Instruments (CS350M).

Related Published Application

Static Gas-Fed CO_2 Electroreduction to Formate

A commercial static, gas-fed, three-electrode cell was used to evaluate SnO_2-coated gas diffusion electrodes for CO_2 electroreduction to formate. Using a static electrolyte and controlled CO_2 supply, the setup enabled systematic investigation of catalyst loading, current-density response and early-stage electrode stability. This comparable cell architecture illustrates the intended role of the EC-GDE1 in laboratory-scale GDE screening and gas-fed electrochemical studies.

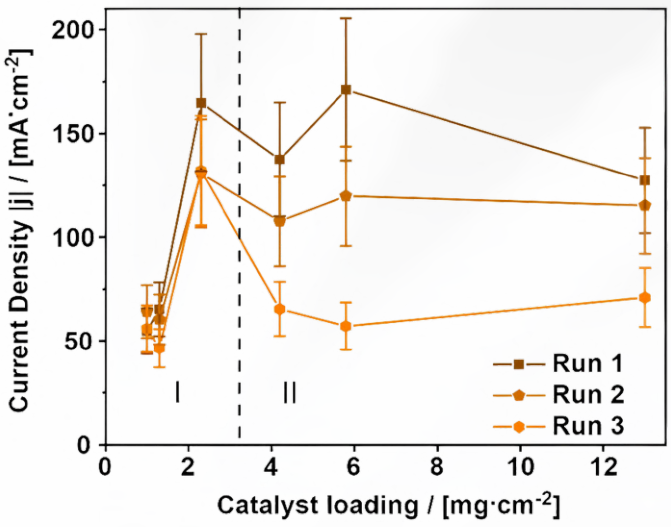
Capabilities Relevant to the EC-GDE1

- Supports laboratory testing of sheet-type gas diffusion electrodes under static-electrolyte conditions.
- Enables comparison of catalyst loading, electrochemical response, and product selectivity.
- Suitable for investigating early-stage electrode performance changes during gas-fed electrolysis.

Application Studies

Application studies using this model are currently underway.

Note: The referenced study used a Gaskatel FlexCell® PTFE cell with a configuration comparable to the EC-GDE1 and is included solely as a related application example.



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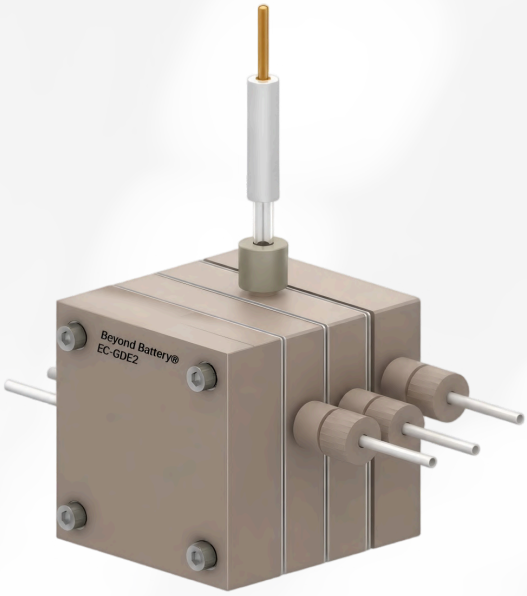
Electrochemical Cells Series

EC-GDE2

Gas Diffusion Electrochemical Cell

A cost-effective, three-chamber GDE flow cell for rapid feasibility validation and catalyst screening.



Product Overview

The EC-GDE2 is a cost-effective gas diffusion electrochemical flow cell designed for rapid feasibility validation and electrocatalyst screening. Its three-chamber, three-electrode architecture supports direct reactant-gas delivery to a sheet-type gas diffusion electrode and controlled electrolyte circulation, providing a flexible laboratory platform for gas-fed electrochemical research.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Anode-cathode gap	20 mm
Active area	1 or 4 cm² (10 x 10 mm or 20 x 20 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type electrode
Counter electrode	Sheet-type electrode
Cell body material	PMMA / PTFE / PEEK

Key Features

Cost-Effective Flow-Cell Platform

Supports rapid feasibility validation and routine gas-diffusion electrode screening.

Controlled Three-Chamber Operation

Separates gas, catholyte, and anolyte pathways for controlled three-electrode testing.

Flexible Cell-Body Options

PMMA, PTFE and PEEK configurations support selection for different experimental requirements.

Typical Applications

Gas-Diffusion Electrode Studies

Evaluating sheet-type GDEs under controlled electrolyte-flow conditions.

CO_2 Electroreduction Research

Investigating catalytic activity and selectivity toward C_1 and C_{2+} products.

Electrocatalyst Screening

Comparing catalyst structures, electrochemical activity and current-density response.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated laboratory gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters and peristaltic pumps.

Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Published Application Example

High-Rate CO_2 Electroreduction to Multicarbon Products

A three-chamber flow cell was used to evaluate Cu(100)-rich gas-diffusion electrodes for CO_2 electroreduction to ethylene and C_{2+} products. Direct CO_2 delivery to the catalyst layer, continuous 2 M KOH circulation and three-electrode control enabled investigation of catalyst-facet effects, current-density response, product selectivity and short-term stability. The study demonstrates the role of this cell architecture in rapid laboratory-scale CO_2RR validation.

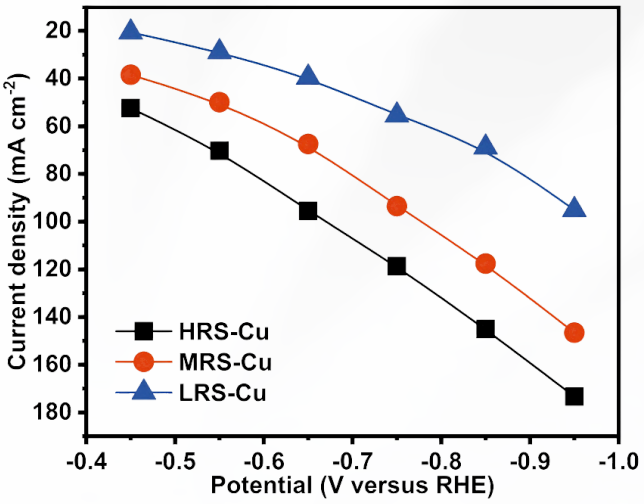
Demonstrated EC-GDE2 Capabilities

- Supports direct reactant-gas delivery to sheet-type GDEs under continuous electrolyte-flow conditions.
- Enables controlled three-electrode evaluation of catalyst activity, product selectivity and current-density response.
- Suitable for rapid feasibility testing and short-term stability studies in CO_2 electroreduction.

Additional Published Applications

- Lin, Y. et al. Nat. Commun. 2023, 14, 3575.

Product Identification Note: EC-GDE2 is the Beyond Battery product code for the same cell reported in the cited publications. The original articles use a different product designation.



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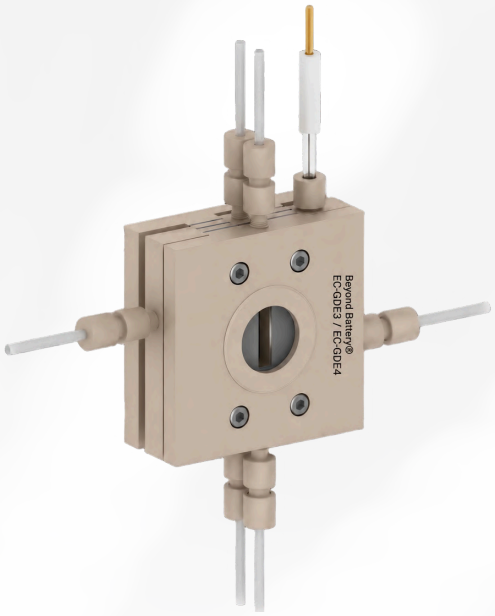
Electrochemical Cells Series

EC-GDE3 / EC-GDE4

Gas Diffusion Electrochemical Cell

Three-chamber PEEK gas diffusion electrochemical cells featuring an optical observation window for direct process viewing, with 7 mm or 3 mm electrode spacing.



Product Overview

The EC-GDE3 / EC-GDE4 gas diffusion electrochemical flow cells are designed for advanced catalyst evaluation and medium-to-high-current-density testing. Their three-chamber, three-electrode configuration enables direct gas delivery to a sheet-type gas diffusion electrode together with controlled electrolyte circulation. A high-purity quartz observation window provides direct visualization of flooding, bubble formation, and salt deposition during operation.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Anode-cathode gap	7 mm (EC-GDE3); 3 mm (EC-GDE4)
Active area	1 cm² (10 x 10 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type electrode
Counter electrode	Sheet-type electrode
Cell body material	PEEK
Optical window material	Quartz

Key Features

Visualized Flow-Cell Platform

The high-purity quartz optical window enables direct observation of the reaction chamber during gas-diffusion-electrode testing.

Selectable Electrode Gap

Available with a 7 mm gap for general research or a shortened 3 mm gap for medium-to-high-current-density measurements.

Chemically Resistant PEEK Body

The PEEK cell body provides strong chemical resistance for demanding electrochemical reaction conditions.

Typical Applications

Gas-Diffusion Electrode Studies

Evaluating sheet-type GDEs under controlled gas and electrolyte-flow conditions.

CO_2 Electroreduction Research

Investigating catalytic activity, product selectivity, and performance at medium-to-high current densities.

Visualized Electrocatalyst Testing

Observing flooding, bubble accumulation and salt deposition during electrolysis.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated laboratory gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters and peristaltic pumps.

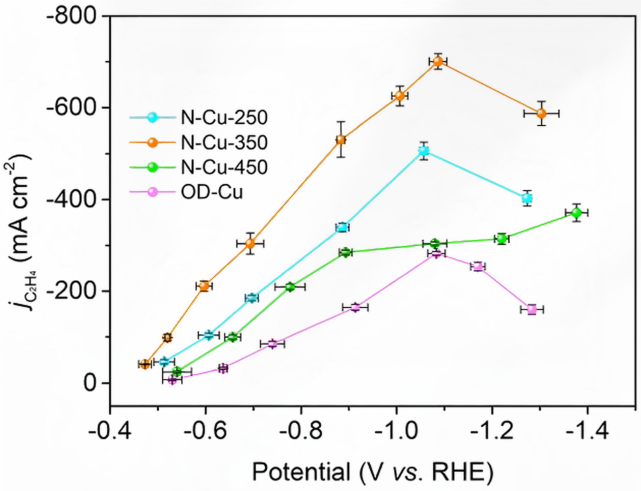
Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Published Application Example

High-Rate CO_2 Electroreduction to Ethylene

A three-chamber flow cell was used to evaluate surface N-coordinated Cu gas-diffusion electrodes for CO_2 electroreduction. Continuous 1.0 M KOH circulation, controlled CO_2 delivery and three-electrode operation enabled evaluation of product selectivity, impedance, stability and medium-to-high-current-density performance. The optimized catalyst achieved an ethylene Faradaic efficiency of 73.2% and an ethylene partial current density of −700.8 mA cm^{-2}.



Reproduced from Tao, H. et al. Sustainable Energy & Fuels 2023, 7, 2991–2996. CC BY 4.0.

Demonstrated EC-GDE3 / EC-GDE4 Capabilities

- Supports direct CO_2 delivery to sheet-type GDEs under continuous electrolyte-flow conditions.
- Enables controlled evaluation of activity, selectivity, impedance, and electrochemical response at medium-to-high current densities.
- Supports visual investigation of flooding and salt precipitation during extended electrolysis.

Additional Published Applications

- Chen, X. et al. Nat. Commun. 2024, 15, 7691.
- Qing, H. et al. Nat. Commun. 2025, 16, 11263.
- Bai, Y. et al. Sci. China Mater. 2026, 69, 2747–2756.

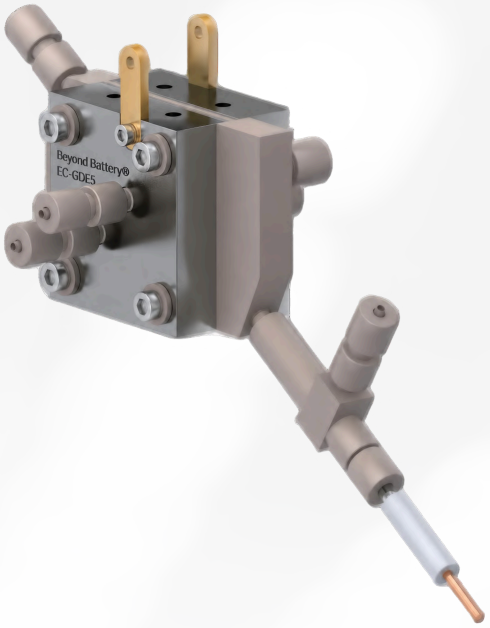
Product Identification Note: EC-GDE3 and EC-GDE4 are the Beyond Battery product codes for the corresponding cell configurations reported in the cited publications. The original articles use different product designations.

Electrochemical Cells Series

EC-GDE5

Gas Diffusion Electrochemical Cell

A modular multifunctional gas diffusion electrochemical cell with four configurable operating modes.



Product Overview

The EC-GDE5 is a modular electrochemical platform designed for gas-fed electrocatalysis and advanced reactor studies. Its sandwich architecture can be reconfigured for gas-diffusion, solid-electrolyte, membrane-electrode-assembly and metal-air operation. A compact 1.2 mm anode-cathode gap shortens the ionic transport path, supporting reduced cell resistance, controlled mass transport and medium-to-high-current-density testing.

Technical Specifications

Chamber structure	Three-chamber (standard); mode-dependent configuration
Electrode system	Three-electrode (standard); two-electrode in MEA and metal–air modes
Anode-cathode gap	1.2 mm
Active area	1 cm² (10 x 10 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type Ag/AgCl electrode
Counter electrode	Sheet-type electrode
Cell body material	Ti + PEEK

Key Features

Four-Mode Modular Architecture

Interchangeable sandwich components support four configurable operating modes within a single platform, enabling rapid reconfiguration for diverse electrochemical studies while reducing the need for multiple dedicated reactors.

Compact 1.2 mm Electrode Gap

The shortened ionic transport path helps reduce ohmic loss and supports controlled medium-to-high-current-density testing.

Robust Titanium-PEEK Construction

High-purity titanium and chemically resistant PEEK provide durable construction for repeated assembly and operation across different electrolyte environments.

Typical Applications

Gas-Fed Electrocatalysis

Evaluating gas-diffusion electrodes for CO_2 reduction and other gas-involved electrochemical reactions at medium-to-high current densities.

Multimode Electrochemical Reactor Studies

Investigating catalyst performance, mass transport, product collection and operational stability across configurable reactor architectures.

Metal–Air Battery Research

Supporting zinc–air and lithium–air studies, including electrode activity, charge–discharge performance and cycling stability.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters, peristaltic pumps and gas-liquid mixing pumps.

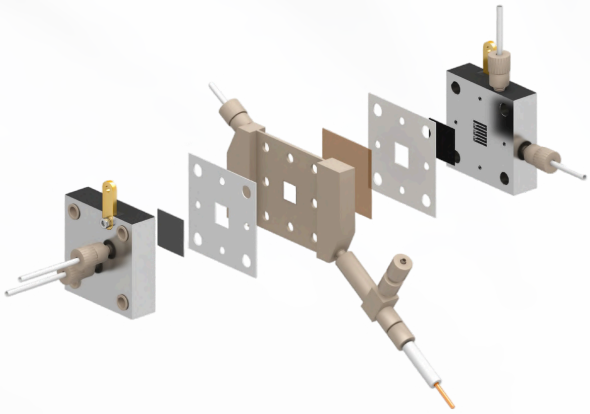
Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Configurable Operating Modes

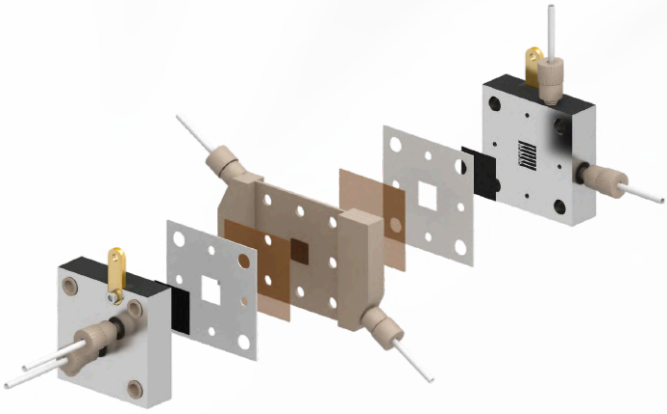
CO_2-Reduction Gas-Diffusion Mode

Humidified CO_2 is supplied directly to the gas diffusion electrode, while catholyte and anolyte circulate through separated chambers. A 45° reference-electrode port facilitates bubble release, supporting stable three-electrode measurements with reduced bubble interference.



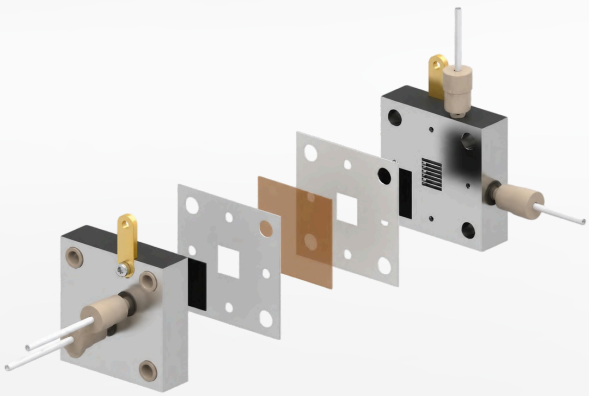
Solid-Electrolyte Mode

Ion-exchange resin replaces the conventional liquid electrolyte in the central chamber, while paired membranes separate the gas-fed cathode and anode. Serpentine channels increase gas residence time, and pure water carries liquid products out of the reactor for direct collection with minimal supporting-electrolyte contamination.



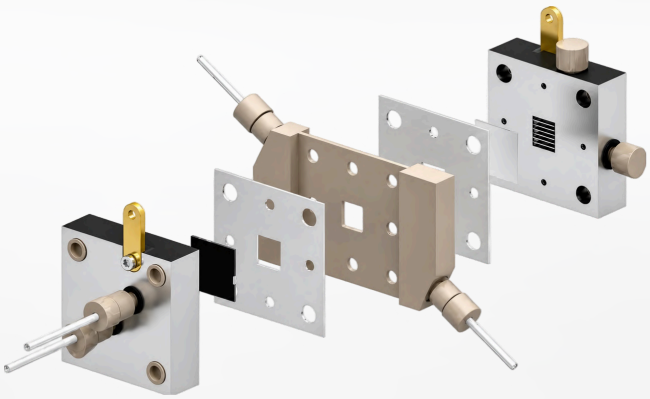
Membrane-Electrode-Assembly Mode

Removing the central catholyte and reference-electrode sections creates a compact two-plate MEA configuration. The gas diffusion electrode, ion-exchange membrane and porous anode form a close-contact assembly, while serpentine channels extend gas residence time for controlled, long-duration electrolysis.



Metal-Air Battery Mode

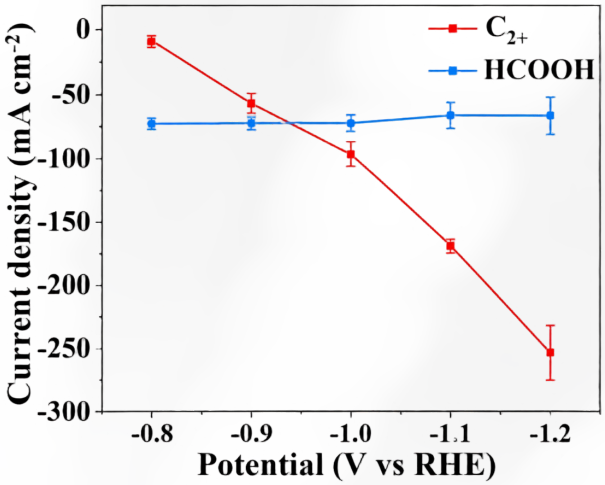
Carbon paper is positioned between the gas and electrolyte plates, while zinc or lithium metal is installed in the adjacent compartment. Separate gas and liquid pathways reproduce a classic metal-air architecture for configurable zinc-air and lithium-air testing.



Published Application Example

Potential-Controlled CO_2 Electroreduction to C_1 and C_{2+} Products

The EC-GDE5 provided controlled CO_2 delivery and electrolyte circulation for evaluating $Al(OH)_3$/CuS gas-diffusion electrodes across different potentials and during extended electrolysis. The platform captured a selectivity shift from HCOOH at −0.8 V versus RHE to C_{2+} products at −1.2 V versus RHE. The catalyst achieved a maximum C_{2+} Faradaic efficiency of 54%, a C_{2+} partial current density of 254 mA cm^{-2} and stable operation for 14,400 s.



Reproduced from Zhou, S. et al. Surfaces and Interfaces 2025, 69, 106779. CC BY 4.0.

Demonstrated EC-GDE5 Capabilities

- Supports controlled CO_2 delivery and continuous electrolyte circulation for gas-diffusion-electrode evaluation.
- Enables potential-dependent comparison of product selectivity and partial current density.
- Suitable for medium-to-high-current-density measurements and extended stability testing.

Additional Published Applications

Application studies using this model are currently underway.

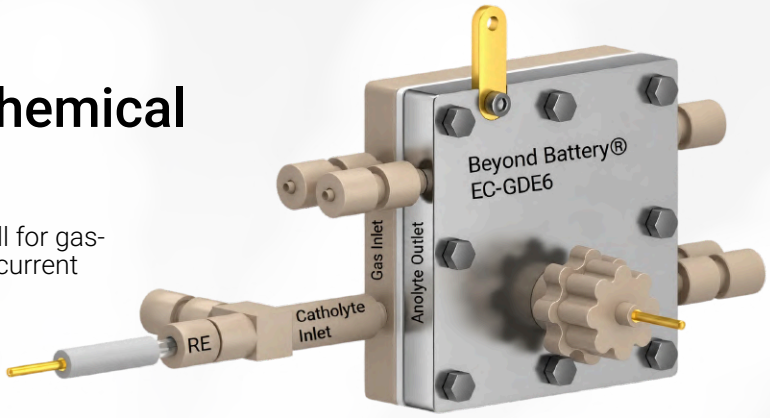
Product Identification Note: EC-GDE5 is the Beyond Battery product code for the same cell reported in the cited publications. The original articles use a different product designation.

Electrochemical Cells Series

EC-GDE6

Gas Diffusion Electrochemical Cell

An ultra-short-gap, three-electrode GDE flow cell for gas-fed electrochemical testing at medium-to-high current densities and long-duration stability studies.



Product Overview

The EC-GDE6 is an advanced gas diffusion electrochemical cell designed for gas-fed electrochemical testing at medium-to-high current densities and long-duration stability studies. Its three-chamber, three-electrode architecture combines high-purity titanium plates with a PEEK cell body. A serpentine gas flow field increases gas contact with the cathode, while the redesigned catholyte pathway reduces the working-to-counter-electrode gap to 0.4 mm.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Anode-cathode gap	0.4 mm
Active area	1 or 4 cm² (10 x 10 mm or 20 x 20 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode (customer-supplied)
Reference electrode	Rod-type Ag/AgCl electrode
Counter electrode	Sheet-type IrO_2 mesh electrode (customer-supplied)
Cell body material	Ti + PEEK
Gas flow field	Serpentine (customizable)

Key Features

0.4 mm Ultra-Short Electrode Gap

The redesigned catholyte pathway minimizes the distance between the working and counter electrodes.

Serpentine Gas Flow Field

The standard serpentine channel extends gas contact with the cathode; custom flow patterns are available.

Designed for Demanding Operation

Supports medium-to-high current densities and extended stability testing.

Typical Applications

Gas-Fed Electrocatalysis

Evaluation of GDE-based reactions under controlled gas and electrolyte flow.

Medium-to-High Current Testing

Investigation of electrode performance under demanding current-density conditions.

Flow-Field Evaluation

Assessment of serpentine and customised gas-distribution patterns.

Long-Duration Stability Studies

Monitoring electrode and cell performance during extended electrolysis.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters, peristaltic pumps and gas-liquid mixing pumps.

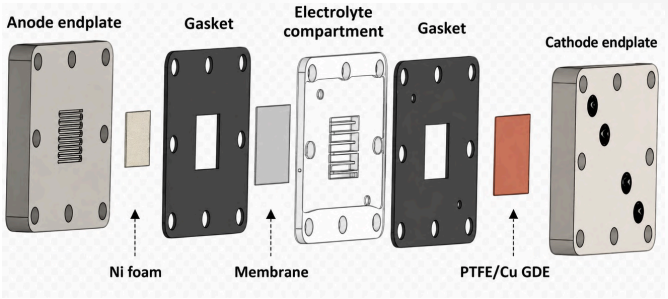
Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Related Published Application

Effects of Catholyte Flow Design on CO_2 Electrolysis

Filippi et al. evaluated four 3D-printed PEEK catholyte compartments—Linear-wide, Shifted, Serpentine and Linear—in a 5 cm^2 CO_2 flow electrolyzer. The system incorporated a PTFE/CuO gas diffusion cathode, an Ag/AgCl reference electrode, a Ni-foam anode and an anion-exchange membrane. All configurations used a gasket-defined 0.2 mm catholyte gap and were tested from 50 to 700 mA cm^{-2}. Experiments and CFD simulations demonstrated that catholyte hydrodynamics govern bubble removal, local pH and product selectivity, with balanced flow velocities of 0.01–0.1 m s^{-1} favouring C_{2+} production.



Reproduced from M. Filippi et al., Energy Environ. Sci. 2023, 16, 5265–5273. CC BY 4.0.

Capabilities Relevant to the EC-GDE6

- Illustrates CO_2 electroreduction at 50–700 mA cm^{-2} in a custom-built thin-gap, three-electrode flow cell.
- Demonstrates the use of thin catholyte gaps for medium-to-high-current-density GDE testing.
- Highlights the effects of catholyte flow and bubble removal on activity and product selectivity.

Application Studies

Application studies using this model are currently underway.

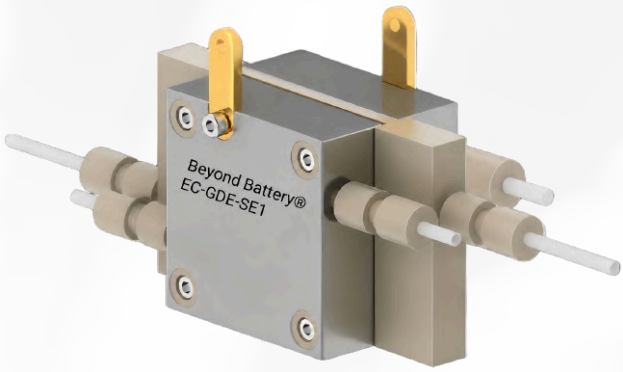
Note: The referenced study used a custom-built 5 cm^2 CO_2 flow electrolyzer with a 0.2 mm catholyte gap and a configuration comparable to the EC-GDE6. It is included solely as a related application example and does not indicate that the EC-GDE6 was used in the study.

Electrochemical Cells Series

EC-GDE-SE Series

Gas Diffusion Electrochemical Cell

A three-chamber solid-electrolyte cell series for high-purity liquid production, potential studies, flow-field development, and optical observation.



Product Overview

The EC-GDE-SE Series comprises four three-chamber solid-electrolyte electrochemical cells for high-purity aqueous liquid-product generation. Their sandwich architecture combines gas-fed electrode chambers, ion-exchange membranes and a central solid-electrolyte chamber, where ionic products recombine and are collected by flowing pure water. Available configurations support two- or three-electrode measurements, central flow-field development, optical observation, and photo-assisted reaction studies.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Two-electrode (EC-GDE-SE1, -3 and -4); three-electrode (EC-GDE-SE2)
Anode-cathode gap	3 mm
Active area	4 cm² (20 x 20 mm, customizable)
Anode and cathode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type electrode (EC-GDE-SE2 only)
Central-chamber design	Open chamber (EC-GDE-SE1 and -2); serpentine flow field (EC-GDE-SE3 and -4)
Cell body material	Ti + PEEK
Gas flow field	Serpentine (customizable)
Optical window material	Quartz (EC-GDE-SE4 only)

Key Features

Solid-Electrolyte Product Recovery

A pure-water stream collects high-purity aqueous products from the central solid-electrolyte chamber with minimal electrolyte contamination.

Three-Chamber Gas-Solid Architecture

Gas-fed chambers, ion-exchange membranes, and catalyst-loaded gas-diffusion layers create controlled gas-solid reaction interfaces.

Research-Specific Configurations

Models support two- or three-electrode testing, central flow-field development, optical observation, and photo-assisted reactions.

Typical Applications

High-Purity Liquid-Product Generation

High-purity aqueous product collection for solid-electrolyte electrolysis research.

Electrode-Potential & Mechanistic Studies

Three-electrode measurements for catalyst evaluation and reaction-mechanism studies.

Flow-Field Development & Mass-Transfer Studies

Central flow-field design for mass-transfer analysis and device optimization.

In Situ Optical & Photo-Assisted Studies

Optical access for in situ observation, photocatalysis, and photoelectrochemical studies.

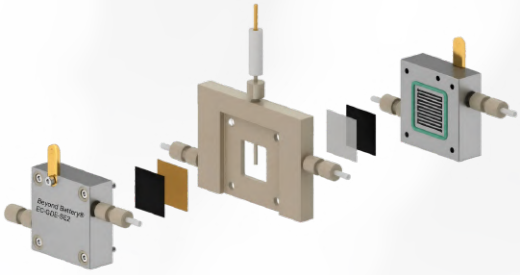
Model Selection Guide

EC-GDE-SE1

The standard configuration for high-purity liquid-product generation and routine solid-electrolyte research. Its two-electrode design and open central chamber are suitable for electrolyte evaluation and device testing.

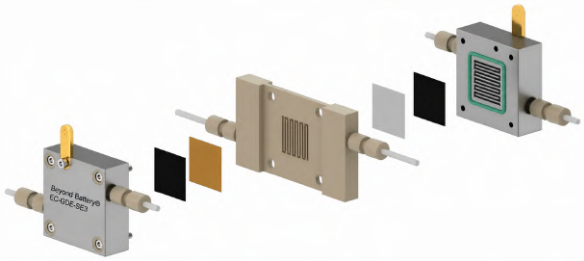
EC-GDE-SE2

For experiments requiring individual electrode-potential monitoring. A dedicated reference-electrode chamber enables three-electrode measurements for catalyst evaluation and mechanistic studies.



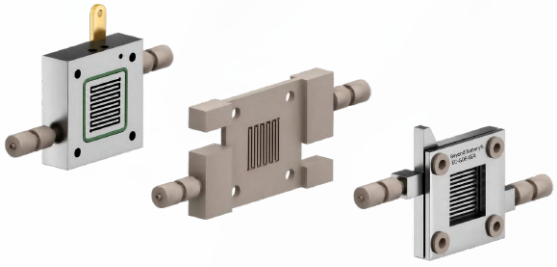
EC-GDE-SE3

For flow-field development and mass-transfer studies. A serpentine flow field in the central chamber supports device optimization and technology validation.



EC-GDE-SE4

For experiments requiring optical access to the cathode chamber. It combines a central serpentine flow field with a high-transmittance quartz window for in situ observation, photocatalytic studies, and photoelectrochemical experiments.



Related Published Application

High-Efficiency H_2O_2 Electrosynthesis in a Solid-Electrolyte Cell

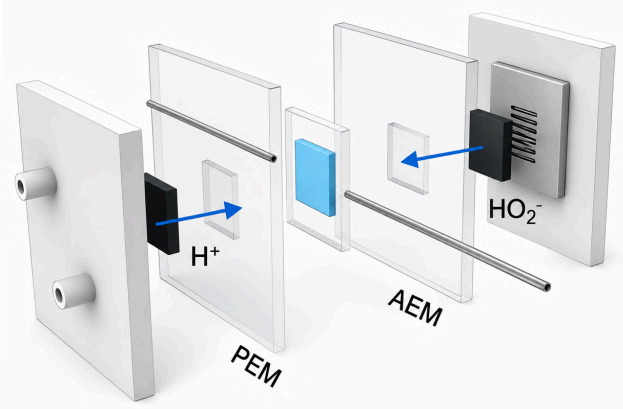
Dong et al. used a two-electrode, three-chamber solid-electrolyte flow cell to investigate direct H_2O_2 electrosynthesis via O_2 reduction. At 2.5 V, the system operated at approximately 100 mA cm-2 for 8 h, producing a 3400 ppm H_2O_2 solution with approximately 85% Faradaic efficiency.

Capabilities Relevant to the EC-GDE-SE Series

- Separates anode, solid-electrolyte, and cathode regions with ion-exchange membranes for selective ion transport.
- Collects central-chamber aqueous products directly via a flowing pure-water stream.
- Supports continuous electrolysis with gas-flow channels and central water flow.

Application Studies

Application studies using this series are currently underway.



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Note: The referenced study used a two-electrode, three-chamber solid-electrolyte cell with a configuration comparable to the EC-GDE-SE Series. It is included solely as a related application example and does not confirm that any EC-GDE-SE Series model was used.

Electrochemical Cells Series

EC-GDE-1LC / EC-GDE-2LC

Gas Diffusion Electrochemical Cell

A series of large-liquid-chamber, three-electrode gas diffusion electrochemical cells with serpentine gas flow fields for flow-phase electrochemical studies.

Product Overview

Designed for flow-phase electrochemical studies with gas diffusion electrodes, the Series combines a serpentine gas flow field with a large liquid chamber for controlled gas delivery and stable reaction conditions. The enlarged chamber improves electrolyte buffering and tolerance to flow and bubble disturbances. EC-GDE-1LC uses a single liquid chamber for general testing, while EC-GDE-2LC features dual membrane-separated chambers for independent electrolyte control on the working/reference and counter-electrode sides.

Technical Specifications

Chamber structure	Twoe-chamber (EC-GDE-1LC only), Three-chamber (EC-GDE-2LC only)
Electrode system	Three-electrode
Active area	4 cm² (20 x 20 mm, customizable)
Gas flow field	Serpentine
Working electrode	Sheet-type gas diffusion electrode
Reference electrode	Rod-type electrode (customer-supplied)
Counter electrode	Sheet-type Pt mesh electrode (customer-supplied)
Cell body material	Ti + PEEK

Key Features

Large Liquid-phase Buffering

Enlarged liquid chambers improve electrolyte buffering and reduce sensitivity to short-term flow disturbances.

Controlled Gas Delivery

A serpentine gas flow field provides a defined pathway for reactant gas delivery to the gas diffusion electrode.

Flexible Chamber Configuration

EC-GDE-1LC uses a single liquid chamber, while EC-GDE-2LC adds membrane-separated dual liquid compartments.

Typical Applications

Gas-Diffusion Electrode Studies

Evaluating GDEs under controlled gas delivery and flow-phase electrochemical conditions.

Gas-Phase Electrocatalysis

Studying CO_2 reduction and other gas-involved electrochemical reactions under continuous-flow conditions.

Steady-State Electrolysis

Supporting long-duration testing with enhanced liquid-phase buffering and membrane-separated electrolyte environments (EC-GDE-2LC only).

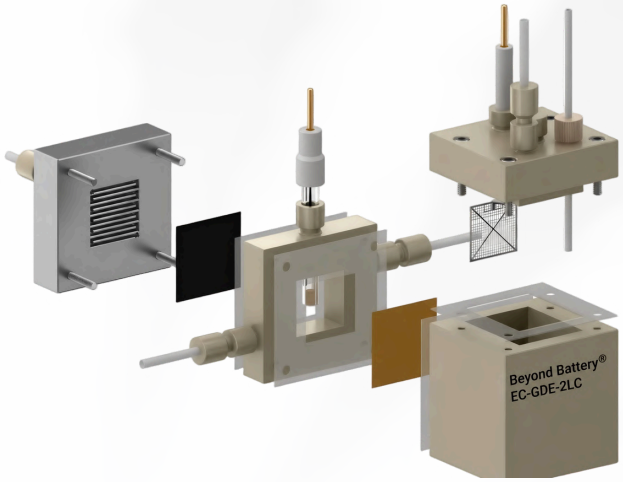
Model Selection Guide

EC-GDE-1LC

The standard single-liquid-chamber configuration, combining a large liquid chamber with a serpentine gas flow field. Suitable for general gas diffusion electrode testing, flow-phase electrochemical studies, and experiments requiring a stable bulk electrolyte environment.

EC-GDE-2LC

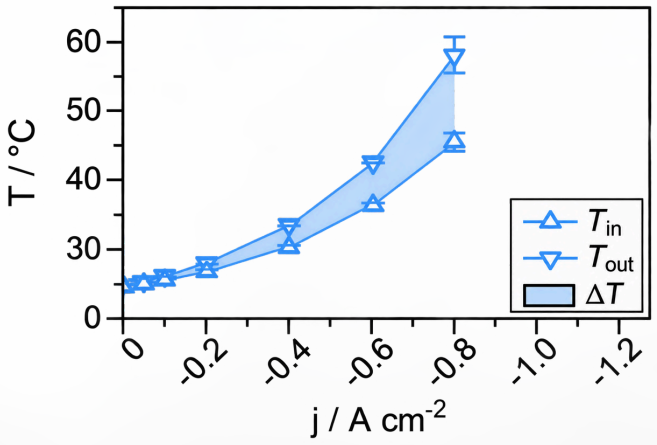
A membrane-separated dual-liquid-chamber configuration that isolates the working/reference electrode side from the counter-electrode side. Suitable for experiments requiring independent catholyte and anolyte environments, membrane studies, and separated electrode reaction conditions.



Related Published Application

Liquid-Phase Buffering in CO_2 Flow Electrolysis

Martens et al. investigated a 10 cm^2 GDE CO_2 flow cell with a ~3 mL catholyte compartment and current densities up to −1.2 A cm^{-2}. The limited in-cell electrolyte volume amplified heat and gas-evolution effects: at −0.8 A cm^{-2}, the catholyte temperature difference across the cell reached ~20 K, while bubble accumulation reduced electrode–electrolyte contact and increased cell resistance. Improving electrolyte conductivity and cooling reduced catholyte temperature by 8–12 K and extended the stable operating range, highlighting the importance of sufficient liquid-phase buffering and effective thermal/gas management in GDE flow electrolysis.



Reproduced from Martens et al., Green Chem., 2023, 25, 7794–7806. CC BY 4.0.

Capabilities Relevant to this Series

- Gas diffusion electrode evaluation under controlled gas delivery and flow-phase electrochemical conditions.
- Large-liquid-chamber operation with enhanced electrolyte buffering for more stable steady-state testing.
- Membrane-separated electrochemical studies with independent electrode-side electrolyte environments (EC-GDE-2LC only).

Application Studies

Application studies using this Series are currently underway.

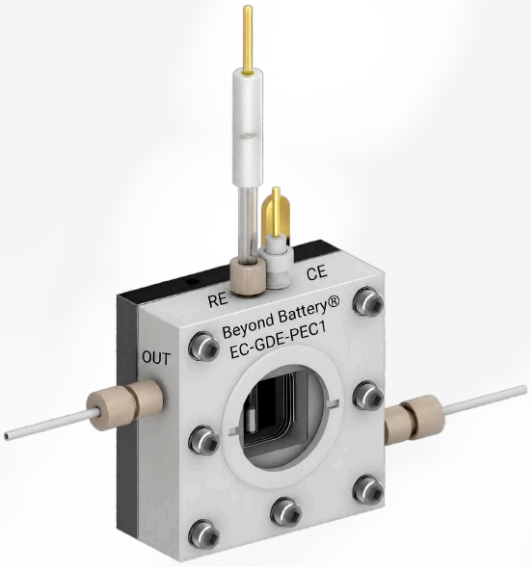
Note: The referenced study used a modified ElectroCell micro-flow cell with a configuration comparable to the this Series and is included solely as a related application example.

Electrochemical Cells Series

EC-GDE-PEC1

Gas Diffusion Electrochemical Cell

An optically accessible photoelectrochemical cell for illuminated gas-diffusion-electrode studies with serpentine gas delivery.



Product Overview

The EC-GDE-PEC1 is a three-compartment, three-electrode photoelectrochemical cell for studying gas diffusion electrodes under illumination. Its serpentine gas-flow design enhances contact between the reactant gas and catalyst, while a quartz optical window enables operando observation of electrode interfaces and supports investigation of charge-transfer processes in photoelectrochemical research.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Active area	4 cm² (20 x 20 mm, customizable)
Working electrode	Hydrophobic sheet-type gas diffusion electrode
Reference electrode	Ag/AgCl electrode
Counter electrode	Platinum wire, Ø0.5 mm × 230 mm
Optical window material	Quartz
Cell body material	Ti + PTFE

Key Features

Operando Optical Access

Provides optical access to the electrode interface for operando monitoring during photoelectrochemical reactions.

Serpentine Gas Distribution

Directs reactant gas across the catalyst surface to enhance gas-catalyst contact.

Gas Diffusion Electrode Testing

Supports photoelectrochemical testing of hydrophobic gas diffusion electrodes under illuminated operating conditions.

Typical Applications

Gas-Diffusion Electrode Studies

Evaluating hydrophobic sheet-type gas diffusion electrodes under illuminated photoelectrochemical conditions.

Photoelectrochemical Gas Conversion

Investigating light-assisted conversion of gaseous reactants at electrode interfaces.

Gas-Liquid-Solid Interface Studies

Examining mass transfer and reaction behaviour at triphase interfaces.

Operando Interface Observation

Monitoring illuminated electrode interfaces through the quartz optical window during operation.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters, peristaltic pumps and gas-liquid mixing pumps.

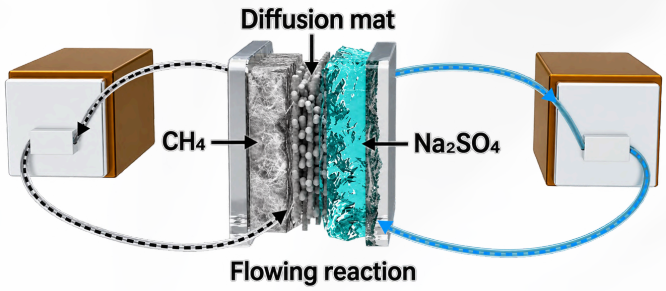
Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Related Published Application

Continuous Photoelectrochemical Methane Conversion in a Flow Cell

Meng et al. evaluated methane conversion using a triphase R-TiO_2/$ZnWO_4$ fibrous photoanode in a sealed three-electrode flow cell with a Nafion 117 separator and front illumination. Compared with batch operation, the system achieved 16.6-fold higher production rate and 4.0-fold higher C_2-product selectivity, while operating stably for at least 100 h.



Reproduced from Meng, X. et al. Nat. Commun. 2023, 14, 2643. CC BY 4.0.

Capabilities Relevant to the EC-GDE-PEC1

- Front-illuminated testing of gas diffusion photoelectrodes
- Gas-liquid-solid triphase reaction interface studies
- Three-electrode operation with operando optical access.

Application Studies

Application studies using this model are currently underway.

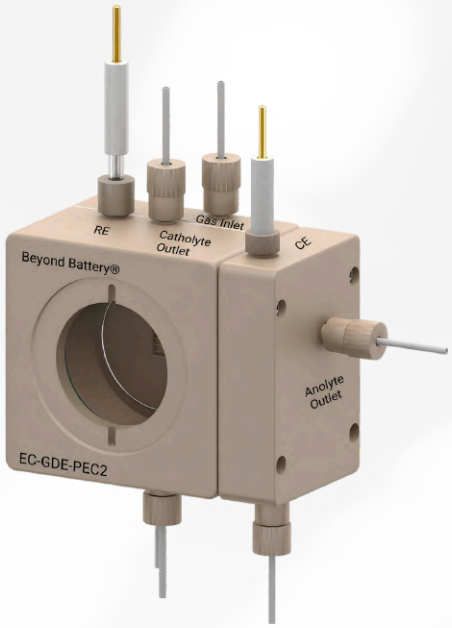
Note: The referenced study used a sealed photoelectrochemical flow cell with a configuration comparable to the EC-GDE-PEC1. The commercial cell model was not identified, and the study is included solely as a related application example.

Electrochemical Cells Series

EC-GDE-PEC2

Gas Diffusion Electrochemical Cell

A continuous-flow PEC platform enabling direct illumination of the catalyst-coated side of gas diffusion photoelectrodes.



Product Overview

The EC-GDE-PEC2 is a three-compartment photoelectrochemical flow cell designed for gas diffusion electrode research under illumination. Its optical-access geometry directs light toward the catalyst-coated side of the working electrode, addressing the light-blocking limitation of conventional GDE flow cells. The cell is intended for continuous-flow photoelectrochemical testing, including CO_2 reduction and nitrogen reduction studies.

Technical Specifications

Chamber structure	Three-chamber
Electrode system	Three-electrode
Active area	4 cm² (20 x 20 mm, customizable)
Working electrode	Sheet-type gas diffusion electrode (customer-supplied)
Reference electrode	Ag/AgCl electrode
Counter electrode	Graphite rod electrode
Optical window material	Quartz
Cell body material	PTFE

Key Features

Direct Illumination of the Catalyst-Coated Side

Directs light through a quartz window toward the catalyst-coated side of opaque gas diffusion electrodes.

Continuous-Flow Photoelectrochemical Testing

Supports gas-fed continuous-flow testing for photoelectrochemical reactions such as CO_2RR and NRR.

Flexible Gas Diffusion Electrode Integration

Accommodates user-supplied gas diffusion electrodes for evaluating different catalyst and electrode-substrate systems.

Typical Applications

Gas Diffusion Photoelectrode Studies

Evaluating gas diffusion electrodes with direct illumination of the catalyst-coated side.

Photoelectrochemical CO_2 Reduction

Investigating light-assisted conversion of gaseous reactants at electrode interfaces.

Photoelectrochemical Nitrogen Reduction

Investigating N_2-fed NRR systems using gas diffusion photoelectrodes.

Gas–Liquid–Solid Interface Studies

Examining mass transport and reaction behaviour under controlled gas and electrolyte flow.

Instrument Compatibility

Gas and Electrolyte Flow Compatibility

Compatible with regulated gas supplies and electrolyte-circulation systems equipped with mass flow controllers, gas flow meters, peristaltic pumps and gas-liquid mixing pumps.

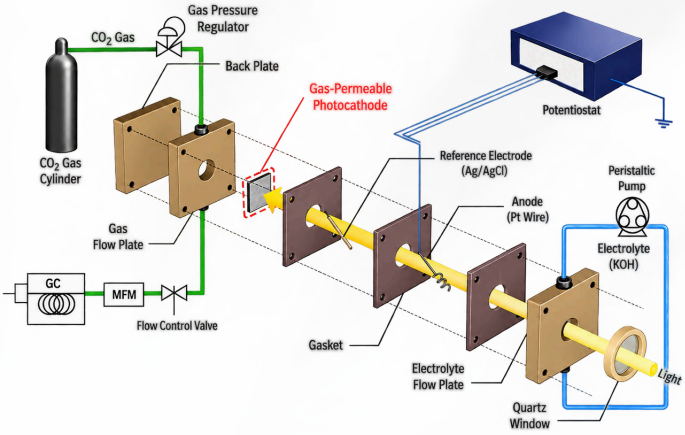
Potentiostat Compatibility

Compatible with commercial potentiostats supporting three-electrode measurements, including CH Instruments (CHI660E, CHI760E, CHI1140C), Bio-Logic (VMP3), Corrtest Instruments (CS350M), Ivium Technologies (CompactStat.e20250), and Metrohm Autolab (PGSTAT204).

Related Published Application

Continuous-Flow Photoelectrochemical CO_2 Reduction

Jung et al. demonstrated CO_2 reduction using an Ag–TiO_2 gas-permeable photocathode in a custom-built continuous-flow PEC reactor. CO_2 was supplied to the non-illuminated side of the photocathode, while light reached the catalyst-coated side through flowing electrolyte and a quartz window. At −0.4 V vs RHE, CO production reached 262.6 μmol cm^{-2} h-1—approximately 33.3 times the H-cell rate. In a separate stability test, CO Faradaic efficiency remained 71 ± 8% for approximately 16 h.



Reproduced from Jung, H. et al. Adv. Sci. 2025, 12, 2411348. CC BY 4.0.

Capabilities Relevant to the EC-GDE-PEC2

- Direct illumination of the catalyst-coated side of opaque GDE photocathodes.
- Continuous delivery of reactant gas and flowing electrolyte.
- Investigation of gas–liquid–solid interfaces under controlled flow conditions.

Application Studies

Application studies using this model are currently underway.

Note: The referenced study used a custom-built PEC-GDE flow reactor with a configuration comparable to the EC-GDE-PEC2. The commercial cell model was not identified, and the study is included solely as a related application example.