# Electrochemistry General Catalog

Vol. 020

# TOKYO JAPAN

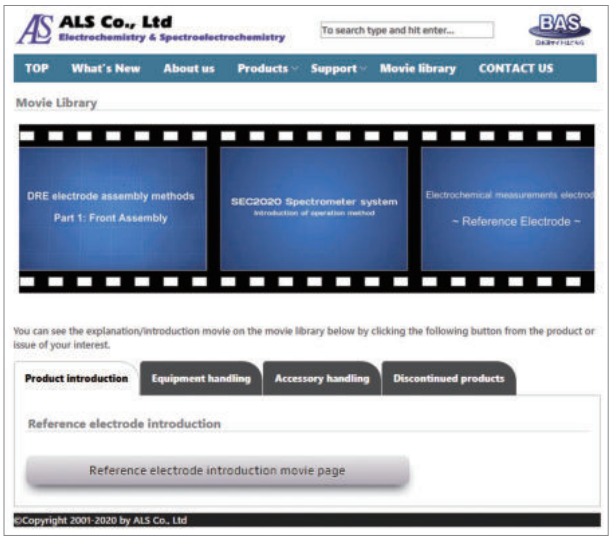
Rotating Ring Disk Electrode **RRDE-3A**
Faraday cage **CS-3A**
Portable Hydrogen Generator **H2G1**
Spectrometer system **SEC2020**

*Variety of products line up for research purposes*

**Electrochemistry & Spectroelectrochemistry**

# Information

## Technical notes and Movie library




**Movie library**
https://www.als-japan.com/1846.html

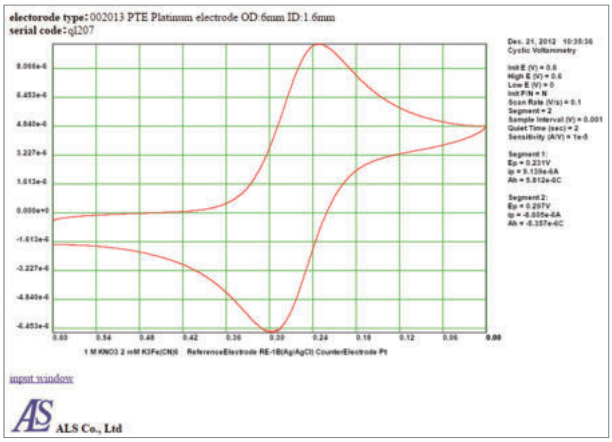
**frontpage --> Movie library**

**Technical note**
https://www.als-japan.com/technical-note.html

**frontpage --> Support --> Technical note**

ALS website has a "Technical note" and "Movie library" section, where you will find useful information and introduction movie of the products.
For the instrument, set up and application movies will help you in the choose of the accessories.
We will be always producing and releasing new movies, attending the demands of spectators.

## Inspection data sheet download service

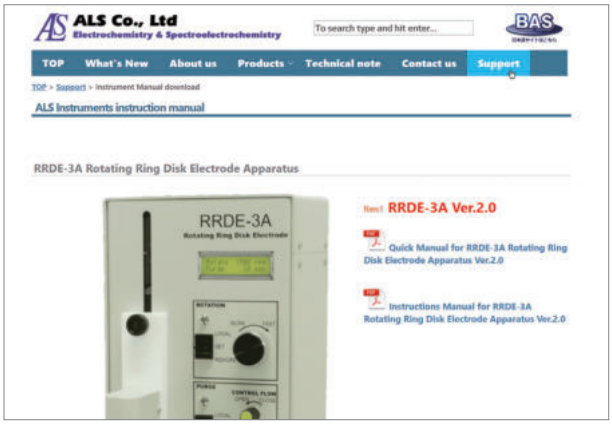



https://www.als-japan.com/dl/
**Inspection data sheet link**

**frontpage --> Support --> Electrode data**

ALS working and reference electrodes are tested and inspected before shipment, and the check data could be confirmed through the website.
In the instruction manual, for the product which the check data is available, you will find the website direction.

## Product manual download service




**Instrumentation**

ALS Instruments instruction manual
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**frontpage --> Support --> Instrument Manual**

**Electrodes**

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ALS product manual is available for download on website.

# 1 Instrumentation

## RRDE-3A Rotating Ring Disk Electrode Apparatus

**Detection of intermediate products by hydrodynamic voltammetry**


ALS Instruments instruction manual
https://www.als-japan.com/support-instrument-manual.html
Manual download link

| Catalog No. | Description |
|---|---|
| 013606 | RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.2.0 |
| Specification | |
| Rotational range | 100 to 8,000 rpm |
| Rotation stability | Error, < 1% at 100 to 1,000 rpm<br>< 0.5% at > 1,001 rpm |
| Ring/Disk insulation resistance | > 10 M ohm |
| Electrode to lead pin contact resistance | 5 ohm |
| Rotator shaft | Stainless steel |
| Motor | 12 V, ironless core, low inertial DC servo |
| Power | 100 - 240 VAC, 50/60 Hz |
| Remote control | One volt corresponds to 1,000 rpm<br>Motor ON/OFF TTL or relay input to back panel |
| Connection | Purge TTL or relay input to back panel connection |
| Operating temperature | 10 to 50 deg C |
| Relative humidity | ≤ 80% |
| Size | 190 x (Base: 230, Body: 120) x 400 mm |
| Weight | 6 kg |

| Accessories | | Qty |
|---|---|---|
| (013580) | Sample vial for alkaline solution (100mL) | 1 |
| 013271 | RRDE-3A Teflon cap V.2 | 1 |
| 012064 | Spin coating adapter | 1 |
| 012065 | Male connector for gas purge (PP) | 1 |
| 013392 | TYGON tubing, OD1/4" x ID1/8" | 1 |
| 012642 | RRDE-3A Sillicon sheet 100 x 180 mm | 1 |
| 012975 | O-ring for RRDE-3A Bearing assembly | 3 |
| | Power supply cable | 1 |
| | Quick manual | 1 |

RRDA-3A is an accurate rotator system for hydrodynamic modulation rotating ring disk voltammmetry. It is precisely controlled by PWM(Pulse Width Modulation). Electrodes are small and rapidly interchangeable. The unit also provides an adjustable valve system for inert gas purging inside the cell vial.

**Feature**

- *Operatable as RDE and RRDE systems*
- *Remote and manual controlled rotation and gas purge*
- *Compact design & Easy operation*
- *Cell lead connects to all potentiostats*
- *Spin coating*
- *"Cleaning" and "Replacement" warning function*

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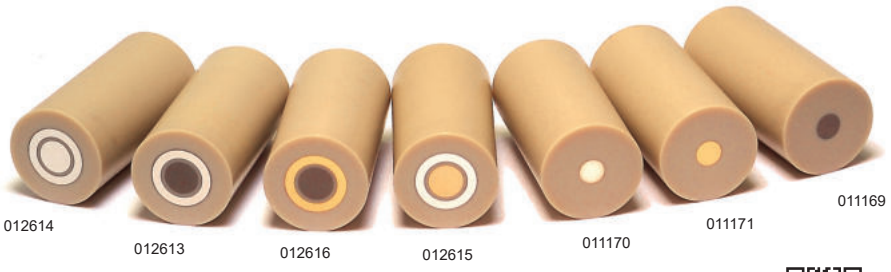
Support Movie link

| Catalog No. | Description |
|---|---|
| 013580 | Sample vial for alkaline solution (100mL) (10 pcs) |
| 013581 | Sample vial for alkaline solution (200mL) (8 pcs) |
| 013582 | RRDE-3A Teflon cap (for 200mL) |
| 012632 | Sample vial (100mL) |
| 012167 | RE-1B Reference electrode (Ag/AgCl) |
| 013613 | RE-1BP Reference electrode (Ag/AgCl) |
| 012171 | RE-7 Non Aqueous reference electrode ($Ag/Ag^+$) |
| 013597 | RHEK Reversible hydrogen electrode kit |
| 012961 | Platinum counter electrode 23 cm |
| 013343 | O-ring for RRDE-3A Teflon cap V.2 |
| 013645 | O-ring for RRDE-3A Shaft (white), 3pcs |
| 012641 | O-ring for RRDE-3A Bearing assembly (10 pcs) |

# Electrodes and accessories

## Disk Electrode & Ring Disk Electrode

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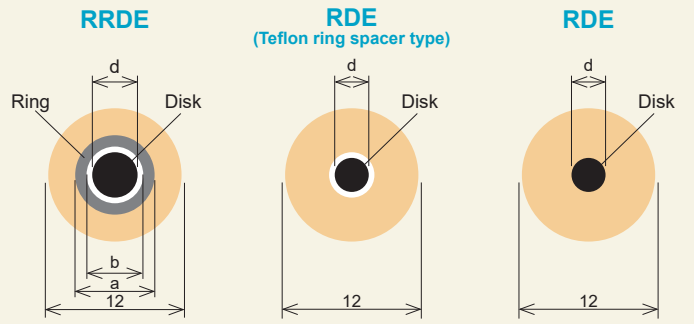
The Ring-Disk and Disk electrodes listed below are working electrodes for RRDE-3A Rotating Ring Disk Electrode Apparatus. Organic solvent resistant resin, PEEK, is used as an insulator, and it can be polished with PK-3 Electrode Polishing kit.

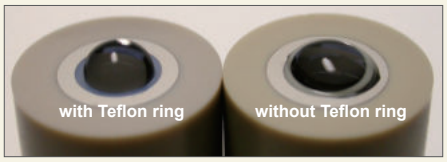
### Size




Teflon ring spacer thickness: 0.5 mm

Unit: mm

### Modification




RRDE Ring disk electrode was improved to facilitate the handling to obtain a chemically modified electrode. Using the RRDE Ring Disk Electrode, a dropped sample is kept on the disk, without spreading the sample to the ring electrode.

| Catalog No. | Description | Electrode size | | Isolation OD | Length |
|---|---|---|---|---|---|
| | | Ring OD(a) / ID(b) | Disk(d) | | |
| **Ring disk electrodes** | | | | | |
| 012613 | RRDE Pt ring/GC disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012614 | RRDE Pt ring/Pt disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012615 | RRDE Pt ring/Au disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012616 | RRDE Au ring/GC disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012617 | RRDE Au ring/Pt disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012653 | RRDE Au ring/Au disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| 012618 | RRDE GC ring/GC disk electrode | 7 mm / 5 mm | 4 mm | 12 mm | 25 mm |
| **Disk electodes** | | | | | |
| 011169 | RDE GCE Glassy carbon disk electrode | - | 3 mm | 12 mm | 25 mm |
| 013490 | RDE GCEt Glassy carbon disk electrode*1 | - | 3 mm | 12 mm | 25 mm |
| 013482 | RDE GCE Glassy carbon disk electrode | - | 5 mm | 12 mm | 25 mm |
| 013491 | RDE GCEt Glassy carbon disk electrode*1 | - | 5 mm | 12 mm | 25 mm |
| 011170 | RDE PTE Platinum disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011171 | RDE AUE Gold disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011966 | RDE ALE Aluminum disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011967 | RDE AGE Silver disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011968 | RDE CUE Copper disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011969 | RDE NIE Nickel disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011970 | RDE TAE Tantalum disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011971 | RDE TIE Titanium disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011972 | RDE WE Tungsten disk electrode | - | 3 mm | 12 mm | 25 mm |
| 011973 | RDE CPE Carbon paste disk electrode*2 | - | 3 mm | 12 mm | 25 mm |

*1. Teflon ring spacer type. It is easier to apply the catalyst than the conventional glassy carbon disk electrode.
*2. 001010 CPO Carbon paste (1 g) is sold separately (p.9). Note that the carbon paste is not filled up.

## DRE Disk Replaceable Electrode


Disk Replaceable Electrode (DRE) has a removable disk electrode. The replacement of the disk electrode is possible from both side, front side and rear side. It makes possible to choose, according to the condition required for your research purpose.

**Feature**

1. *Assessment of the disk electrode using the same ring electrode, could avoid the influence of the ring material and dimension.*
2. *Removable disk and ring assembly make possible modification of the electrode surface and polishing process, separately.*
3. *Disposable disk could be used.*

ALS support product manual
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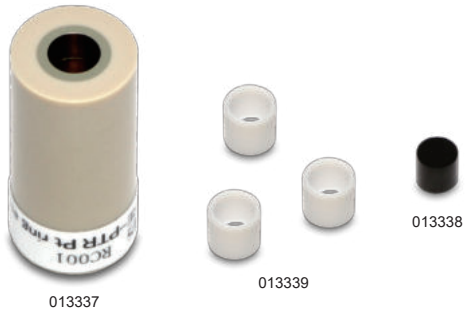
## DRE Disk Replaceable Electrode (RRDE)

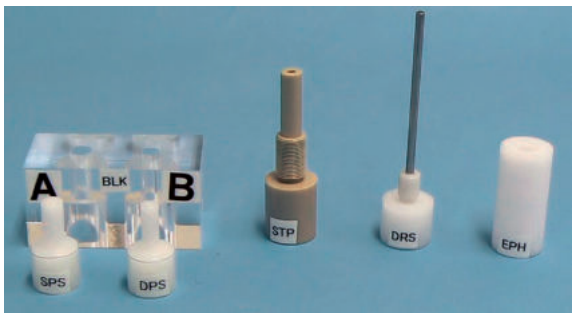



| Catalog No. | Description | Qty |
|---|---|---|
| 013336 | DRE-PGK Pt ring/GC disk replaceable electrode kit | |
| 013641 | DRE-GGK GC ring/GC disk replaceable electrode kit | |
| Contents | | Qty |
| 013337 | DRE-PTR Pt ring assembly | 1 |
| 013642 | DRE-GCR GC ring assembly | 1 |
| 013339 | DRE-SPC Teflon spacer (3 pcs) | 1 |
| 013338 | DRE-GCD GC disk | 1 |
| Optional items | | |
| 013366 | DRE-AUD Au disk | |
| 013367 | DRE-PTD Pt disk | |

## DRE Disk Replaceable Electrode (RDE)


| Catalog No. | Description | Qty |
|---|---|---|
| 013362 | DRE-GCK GC disk replaceable electrode kit | |
| 013364 | DRE-AUK Au disk replaceable electrode kit | |
| 013365 | DRE-PTK Pt disk replaceable electrode kit | |
| Contents common for the kits | | Qty |
| 013361 | DRE-DAS Disk assembly | 1 |
| 013339 | DRE-SPC Teflon spacer (3 pcs) | 1 |
| Optional items | | |
| 013338 | DRE-GCD GC disk | |
| 013366 | DRE-AUD Au disk | |
| 013367 | DRE-PTD Pt disk | |

## DRE-DCP Disk electrode polishing and exchanging tool kit




| Catalog No. | Description | Qty |
|---|---|---|
| 013608 | DRE-DCP Disk electrode polishing and exchanging tool kit | |
| Contents | | Qty |
| | DRE-BLK Base block | 1 |
| | DRE-STP Stopper | 1 |
| | DRE-DRS Disk remove tool | 1 |
| | DRE-SPS Spacer push tool | 1 |
| | DRE-DPS Disk push tool | 1 |
| | DRE-EPH Electrode polishing holder | 1 |

## Handling sketch of the DRE

The DRE-STP Stopper is screwed to the DRE-PTR Pt ring assembly. It works for the adjustment of the height, when the DRE-SPC Teflon spacer and DRE-GCD GC disk are attached. In the DRE-BLK Base block, the “A” side is for the DRE-SPC Teflon spacer attachment, and “B” side is for the DRE-GCD GC disk attachment.

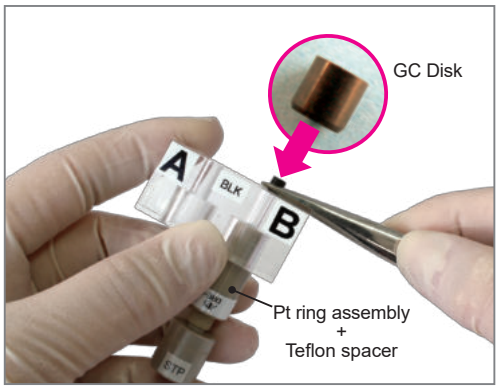



Fig.1-1

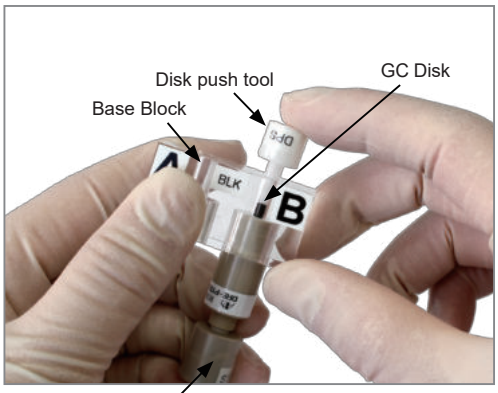



Fig.1-2

Fig.1-3

After fixed and adjusted the height of the DRE-SPC Teflon spacer in to the DRE-PTR Pt ring assembly, in the "A" side, move the DRE-PTR Pt ring assembly to the "B" side, for the setting of the DRE-GCD GC disk from the front side, as shown above.
Put the DRE-GCD GC disk from the front side (Fig.1-1) and adjust it with DRE-DPS Disk push tool (Fig.1-2).
Take out from the DRE-BLK Base block and adjust the height with DRE-STP Stopper and DRE-DRS Disk remove tool, until have the flat surface (Fig.1-3).

ALS support RRDE
https://www.als-japan.com/support-rrde.html
**Support Movie link**

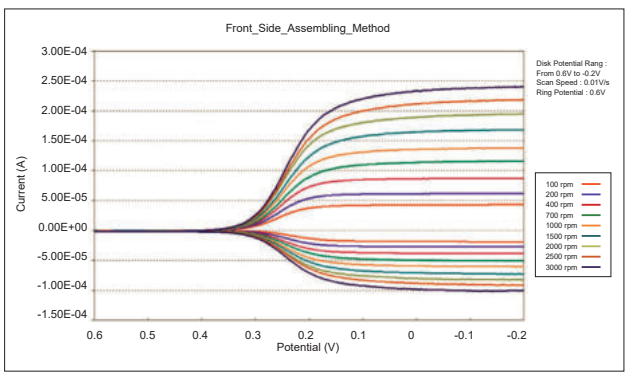
## RRDE Disk replaceable electrode assessment test

The illustration in the section above shows the fitting of the DRE-GCD Glassy carbon disk from the front side, however for the performance test of the electrode, both way, front side and rear side was done.

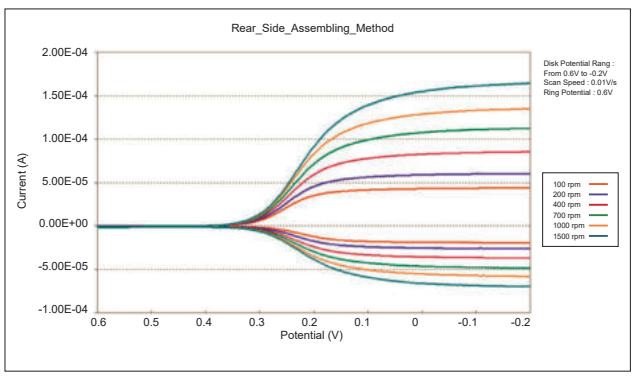
### Typical test parameters are:

Working electrode : DRE-RRDE Pt ring GC disk electrode
Reference electrode: Ag/AgCl
Counter electrode : Platinum wire
Test solution : 2 mM potassium ferricyanide/1 M $KNO_3$
Initial voltage : + 600 mV
Final voltage : - 200 mV
Scan Rate (Volt) : 10 mV/S
Rotation Rate : 100 to 3,000 rpm
Sensitivity : $10^{-5}$ A/V
2nd potential : + 600 mV

### Fitting for the front side:

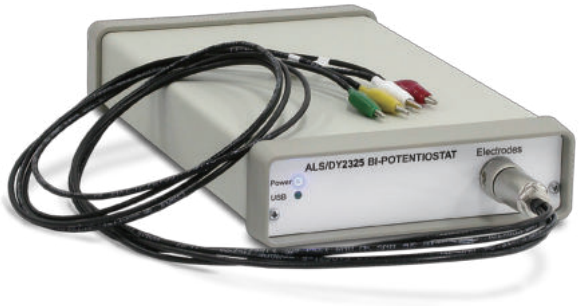



### Fitting for the rear side:



# Model 2325 Bi-Potentiostat for RRDE-3A

## Low-price and high-performance electrochemical analyzer




| Catalog No. | Description |
|---|---|
| 013345 | Model 2325 Bi-Potentiostat |
| 013349 | Model 2325 Software |
| Specification | |
| Potential range | ±4 V |
| Current range | ±50 mA |
| Sensitivity range | $1\times10^{-7}$ - 0.05 A/V |
| Input impedance | $1\times10^{12}\Omega$ |
| Min. Potential Step | 1.0 mV |
| Maximum sampling rate | 10 kHz |
| Maximum data points | 15000 points (65000 depends on the setting) |
| Background current | < 0.2 nA |
| Current Resolution | 3 pA |
| Scan rate (CV) | $1\times10^{-3}$ - 10 V/sec |
| Operating system | Windows™ 8.1 / 10 |
| Dimensions (W×D×H) | 150 × 260 × 50 mm |
| Weight | 1 kg |
| Software Techniques & Measurement range | |
| CV | $1\times10^{-3}$ - 10 V/sec |
| LSV | $1\times10^{-3}$ - 10 V/sec |
| i-t | $1\times10^{-4}$ - 10 sec (sampling interval) |
| OCP-T | $1\times10^{-4}$ - 10 sec (sampling interval) |
| RDE (0-10 V output) | 0 - 10 V output |

### Feature

- *Bi-Potentiostat*
- *High-performance*
- *Compact design*
- *RRDE system control*
- *Wide applications*
- *Repetitive and sequence run*

ALS Instruments instruction manual
https://www.als-japan.com/support-instrument-manual.html
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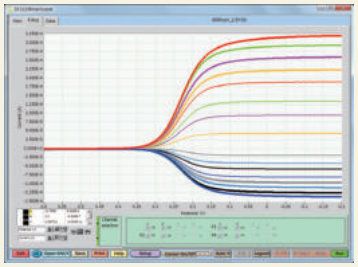
Model 2325 is a very low-price and high-performance Bi-Potentiostat based on modern semiconductor circuitry and advanced software technology. Low noise, high speed and small space measurement were considerate for the development of Model 2325. The user-friendly interface is designed for supporting wide applications. Model 2325 can be applied in various experiments, such as RRDE, sensor development and spectroelectro-chemical measurements, etc. It can be not only applied for research purpose, but also for student experiments and industrial applications due to the low-price and high-performance.

## Configuration for the experimental system

### Fuel cell and corrosion evaluation

Model 2325

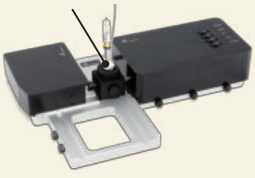

RRDE-3A



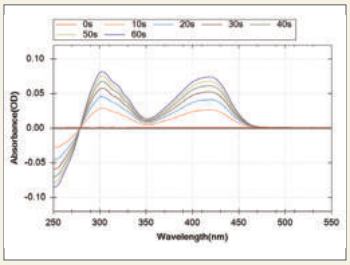
### Spectroelectrochemical measurement

Model 2325

Spectroelectrochemical cell



SEC2020 Spectrometer system



# CS-3A Cell Stand

## Faraday cage for electrochemical measurements


**Feature**

- *Reduction of external electrical interference*
- *Gas purge ON/OFF remote control*
- *Manual and remote ON/OFF control of magnetic stirrer*
- *Reduced corrosion by using stainless steel tray*

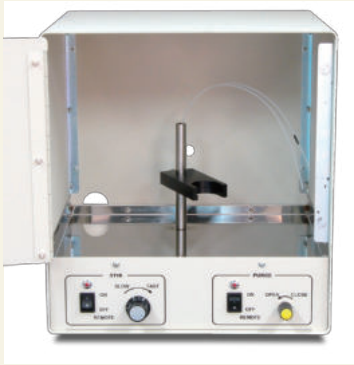
| Catalog No. | Description |
|---|---|
| 012779 | CS-3A Cell Stand Ver.1.1 |
| Specification | |
| Power supply | 100 VAC - 240 VAC, 50/60 Hz |
| Fuse | 1 A |
| Gas pressure | < 34 kPa |
| Temperature | 10 - 50 deg C |
| Size (W x D x H) | 286 x 230 x 320 mm |
| Weight | 3.8 kg |

ALS Instruments instruction manual

https://www.als-japan.com/support-instrument-manual.html

**Manual download link**

CS-3A Cell Stand is specifically designed to use a variety of solid electrodes conveniently and cell accessories available from ALS. The working cell is enclosed in a Faraday cage to reduce external electrical interference. A built-in gas control allows purging of the sample. Manual and remote control of the magnetic stirrer allows for controlling the mixing of the sample for experiments requiring mass transfer of electrolyte or analyte to the electrode surface.



**Point 1**

Stainless steel support setting at the back, to keep space free for sample handling.

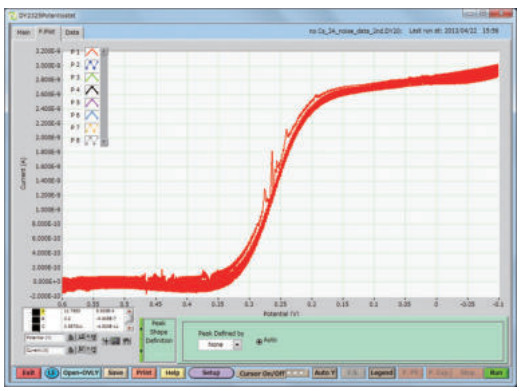
SVC-2/SVC-3 Voltammetry cell can be firmly fixed in the support.

**Point 2**

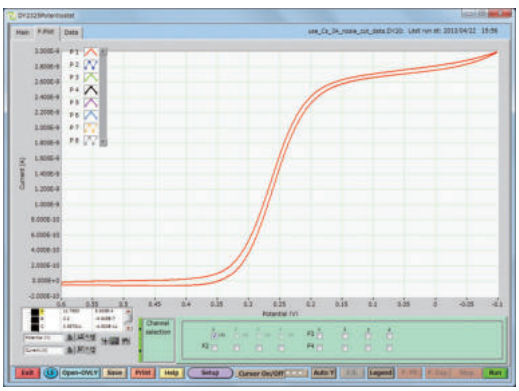
In addition to the cell cable hole, a semicircular cut out with a 15 mm of radius was added to the back panel.

Water-Jacketed glass cell inlet/ outlet tubes can be setting through the back.

## CV measurement performed with Microelectrode



Noise level without CS-3A Cell Stand



Noise level with CS-3A Cell Stand

The measured current value using the Microelectrode is very small, and it becomes vulnerable for external noise. CS-3A could avoid the experimental irregular result, a result caused by the external noise.

# H2G1 Portable Hydrogen Generator NEW

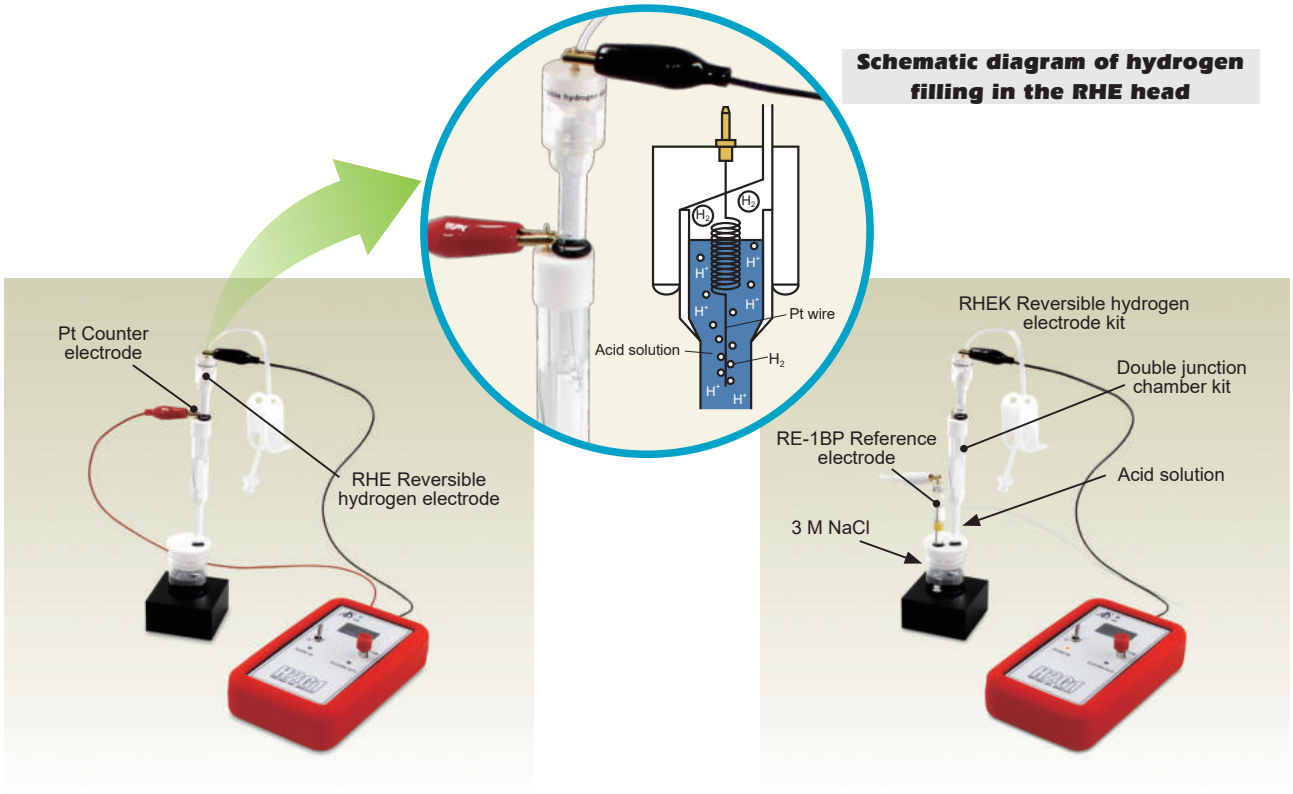

**Feature**

- *Electrolysis and quickly potential measurement*
- *Filling time: about 5 min (for 1.2 mol HCl solution)*
- *Can be used with four AAA batteries*

| Catalog No. | Description |
|---|---|
| 013699 | H2G1 Portable Hydrogen Generator |
| Specification | |
| Output current | 10 mA ± 30% |
| Output Voltage | 28 V |
| Potential measurement range | about 10 - 999 mV |
| Oparating temperature and humidity range | 10 - 50 deg C ≤ 80% RH |
| Power | four AAA batteries |
| Size | about 81 (W) x 32 (H) x 141 (D) mm |
| Weight | about 270 g |
| Acceccories | Calble (red, white, black) 45 cm each |

Portable hydrogen generator is used to generate hydrogen by electrolysis to prepare Reversible Hydrogen Electrode (RHE). The practical and safety reversible hydrogen electrode (RHE) can be prepared by using this instrument for hydrogen gas generation for a RHEK Reversible hydrogen electrode kit. This prepared reversible hydrogen electrode has high accuracy, stability and can be the perfect alternative for the traditional standard hydrogen electrode (SHE).

**Schematic diagram of hydrogen filling in the RHE head**




**1. Electrolytic hydrogen generation function**

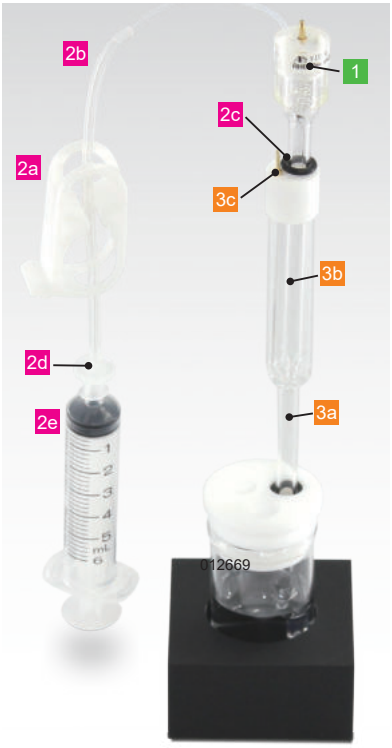
**2. Potential measurement auxiliary Function (*)**

* The potential measurement mode is an auxiliary function, for an accurate electrode potential measurement, an appropriate device is recommended. Also note that the reference electrode using an internal solution with high resistance, such as saturated $K_2SO_4$ solution, will increase the deviation.

# 2 Reference Electrodes

Reference electrodes are widely used for electrochemical measurements (CV, LSV, DPV, etc.) and electrochemical devices (electrochemical detection for HPLC, electrochemical biosensor, etc.). Various kinds of them such as aqueous, non-aqueous, calomel and own-constructing types are available.

## Reversible Hydrogen Electrode




001209

001209 Cell holder for 20 mL vial and 012669 SVC-3 Voltammetry cell are sold separately.

RHE is a reversible electrode kit, in which hydrogen gas is generated by electrolysis of strong acid then stored. It makes unnecessary the complicated and dangerous set-up of the hydrogen cylinder and avoids the large volume of hydrogen gas exhaustion, despite that it has a good potential stability.

| Catalog No. | | Description | |
|---|---|---|---|
| 013597 | | RHEK Reversible hydrogen electrode kit | |
| Contents | | | Qty |
| 1 | 013598 | RHE Reversible hydrogen electrode | 1 |
| 2 | 013378 | RHEK accessories kit | 1 |
| 2a | (Content) | Tubing clamp | 1 |
| 2b | | Silicone tube (10 cm) | 3 |
| 2c | | O-ring | 1 |
| 2d | | Female lure fitting | 1 |
| 2e | | Disposable syringe | 1 |

| Catalog No. | | Description | |
|---|---|---|---|
| 3 | 013375 | Double junction chamber kit | |
| Contents | | | Qty |
| 3a | 013376 | Double junction chamber | 1 |
| 3b | 013377 | PTFE Cap for double junction chamber | 1 |
| 3c | 002222 | Platinum counter electrode 5.7 cm | 1 |

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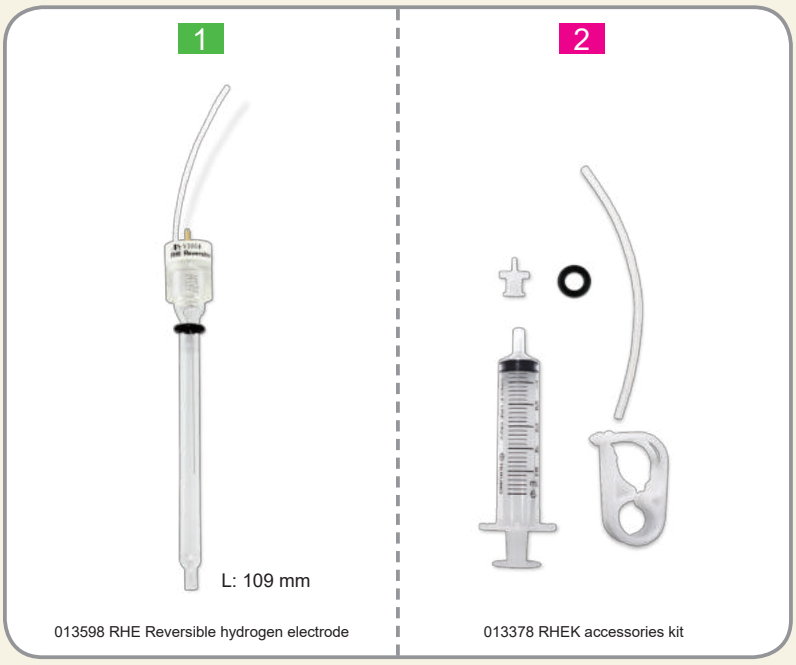
### Contents & structure




013598 RHE Reversible hydrogen electrode

013378 RHEK accessories kit


013375 Double junction chamber kit

013597 RHEK Reversible hydrogen electrode kit

* "L" is an approximately length

# For Aqueous solution

## Ag/AgCl type

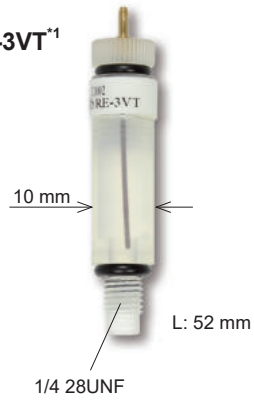
**RE-1B**


**RE-1BP**[*1]


**RE-1S**


**RE-1CP**[*1]


**RE-3VT**[*1]




* "L" is an approximately length

**RE-1B Reference potential**[*2]

$AgCl + e = Ag + Cl^-$

$E^0$ = 195 mV vs RHE (25 deg C)

**Feature**

- *For application in an aqueous solution*
- *Relatively long life time*

**RE-1BP Reference potential**[*2]

$AgCl + e = Ag + Cl^-$

$E^0$ = 196 mV vs RHE (25 deg C)

**RE-1CP Reference potential**[*2]

$AgCl + e = Ag + Cl^-$

$E^0$ = 198 mV vs RHE (25 deg C)

| Catalog No. | Description | Junction | Electrolyte | Purpose |
|---|---|---|---|---|
| 012167 | RE-1B Reference electrode (Ag/AgCl) | IPPG[*3] | 3 M NaCl | SVC-2, SVC-3, VC-4, Bulk electrolysis, RRDE, EQCM |
| 013613 | RE-1BP Reference electrode (Ag/AgCl) | Ceramics | 3 M NaCl | SVC-2, SVC-3, VC-4, Bulk electrolysis, RRDE, EQCM |
| 013393 | RE-1S Reference electrode (Ag/AgCl) | IPPG[*3] | 3 M NaCl | SECM |
| 013691 | RE-1CP Reference electrode (Ag/AgCl/Saturated KCl) | Ceramics | saturated KCl | SVC-2, SVC-3, VC-4, Bulk electrolysis, RRDE, EQCM |
| 013488 | RE-3VT Reference electrode screw type (Ag/AgCl) | Ceramics | 3 M NaCl | For Flow cell (LC, EQCM, SEC-3F) |

*1. Polymethyl pentene
*2. The reference potential mentioned for each reference electrode is the measured value using RHEK reversible hydrogen electrode kit (Cat. No.013597).
*3. IPPG: Ion Permeability Porous Glass

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## Hg type

**RE-2BP**[*1]


**RE-2CP**[*1]


**RE-61AP**[*1]


* "L" is an approximately length

**RE-2BP Reference potential**[*2]

$Hg_2Cl_2 + 2e = 2Hg + 2Cl^-$

$E^0$ = 241 mV vs RHE (25 deg C)

**Feature**

- *Internal solution can be replaced*

**RE-2CP Reference potential**[*2]

$Hg_2SO_4 + 2e = 2Hg + SO_4^{2-}$

$E^0$ = 635 mV vs RHE (25 deg C)

**RE-61AP Reference potential**[*2]

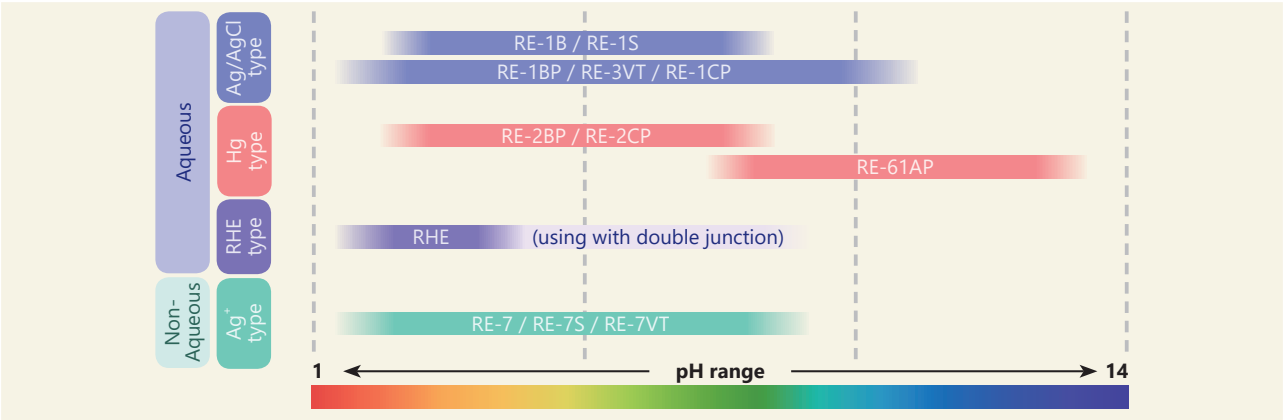
$HgO + H_2O + 2e = Hg + 2OH^-$

$E^0$ = 118 mV vs RHE (25 deg C)

| Catalog No. | Description | Junction | Electrolyte | Purpose |
|---|---|---|---|---|
| 013693 | RE-2BP Calomel reference electrode | Ceramics | Saturated KCl | For application as a standard reference electrode |
| 013692 | RE-2CP Reference electrode | Ceramics | Saturated $K_2SO_4$ | For application as a free from chloride ion measurement |
| 013694 | RE-61AP Reference electrode | Ceramics | - | For application in an alkaline solution |

*1. Polymethyl pentene
*2. The reference potential mentioned for each reference electrode is the measured value using RHEK reversible hydrogen electrode kit (Cat. No.013597).

The reference electrode can be selected depending on the sample to be measured. The following is a table of recommended pH ranges for reference electrode line up.

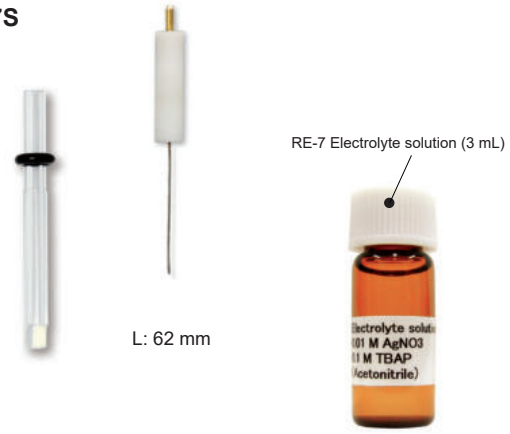


# For Non Aqueous solution

## Ag/Ag$^+$ type

### RE-7


### RE-7S




### RE-7VT[*1]


* "L" is an approximately length

**Feature**

- *For application in an organic solvent based samples*
- *Internal solution can be replaced*

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| Catalog No. | Description | Junction | Electrolyte | Purpose |
|---|---|---|---|---|
| 012171 | RE-7 Non Aqueous reference electrode (Ag/Ag$^+$) | IPPG[*2] | ACN/TBAP[*3] | SVC-2, SVC-3, VC-4, Bulk electrolysis, RRDE, EQCM |
| 013394 | RE-7S Non Aqueous reference electrode (Ag/Ag$^+$) | IPPG[*2] | ACN/TBAP[*3] | SECM |
| 013489 | RE-7VT Non Aqueous reference electrode (Ag/Ag$^+$) | Ceramics | ACN/TBAP[*3] | For Flow cell (LC, EQCM, SEC-3F) |
| Optional items (sold separately) | | | | |
| 012549 | RE-7 Electrolyte solution (10mL) | | ACN/TBAP[*3] | For refill of RE-7 line up (about 15 times) |
| 012108 | RE-PV Preservative vial for reference electrode | | | For preservation of OD 6.0 mm reference electrode |
| 012057 | RE-7 Teflon cap with Ag wire | | | With Ag wire |
| 012058 | RE-7S Teflon cap with Ag wire | | | With Ag wire |
| 012176 | Sample holder dia 6mm (2pcs) | | | For double junction, manufacturing of the electrode |

*1. Polymethyl pentene *2. IPPG: Ion Permeability Porous Glass *3. ACN: acetonitrile
TBAP: tetrabutylammonium perchlorate

## Technical note

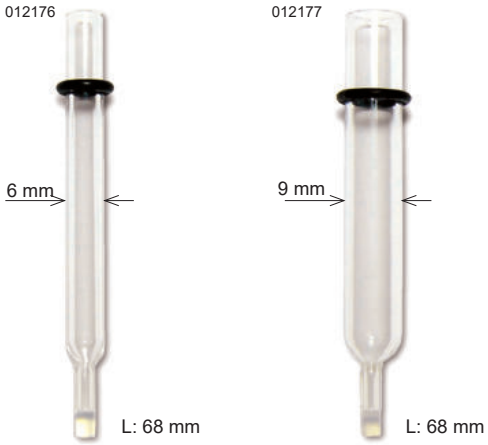
### Supporting electrolyte

If the sample is dissolved in an organic solvent, the supporting electrolyte must be added.
In order to select the supporting electrolyte, it is necessary to consider the following:

1. Solubility in organic solvents
2. Wide potential window
3. No reaction with organic solvent

Typical supporting electrolyte:
TEAP: Tetraethylammonium perchlorate
TBAPF6: Tetrabutylammonium hexafluorophosphate

## Sample Holder & Accessories





These products enable to take electrochemical measurement by only 200 µL sample volume. A IPPG* tip is attached to the end of its glass tube, and ions transmit freely. The sample holder is a multi-purpose accessory.

- 6 mm diameter holders can be used for RE-7 series reference electrode
- 9 mm diameter can be used in SVC-2 voltammetry cell
- Can be used as a salt bridge, in which a reference electrode is installed in order to prevent contamination.

| Catalog No. | Description |
|---|---|
| 012176 | Sample holder dia 6.0 mm (2 pcs) |
| 012306 | Sample holder dia 6.0 mm (22 pcs) |
| 012177 | Sample holder dia 9.0 mm (2 pcs) |
| 012307 | Sample holder dia 9.0 mm (22 pcs) |

*IPPG (Ion Permeability Porous Glass) is a porous glass with 40-200 Å diameter of pores. Chemically stable, operational as high as 800 °C. Also can be cut with a sharp knife.

**Reminder:**
Yellowish discoloration indicates contamination. This is caused by the absorbing of organics into their pores from air.

| Catalog No. | Description |
|---|---|
| 012796 | Repair kit for Sample holder* |

* Contents: Heat shrink Teflon tubing, 150 mm
IPPG Rod, dia 3.2 x 4.0 mm, 10 pcs

## Preservative vial


* Reference electrode is sold separately.

If purchased or self-prepared reference electrode is left in direct contact with air, the inside solution will evaporate and dry up gradually. When it is not in use, a recommended way, in order to maintain the reference electrode capability and life time, is to preserve in a sealed preservative bottle with a solution, similar to the reference electrode internal solution.

For example:
3 M NaCl for the preservation of the RE-1B Reference electrode.

| Catalog No. | Description | |
|---|---|---|
| 012108 | RE-PV Preservative vial for reference electrode | |
| Contents | | Qty |
| 011987 | Teflon cap for RE-PV | 1 |
| ------ | Screw vial 10 mL | 1 |
| Optional item | | |
| 012549 | RE-7 Electrolyte solution (10 mL) | |

## Ag/AgCl Ink for Reference electrode

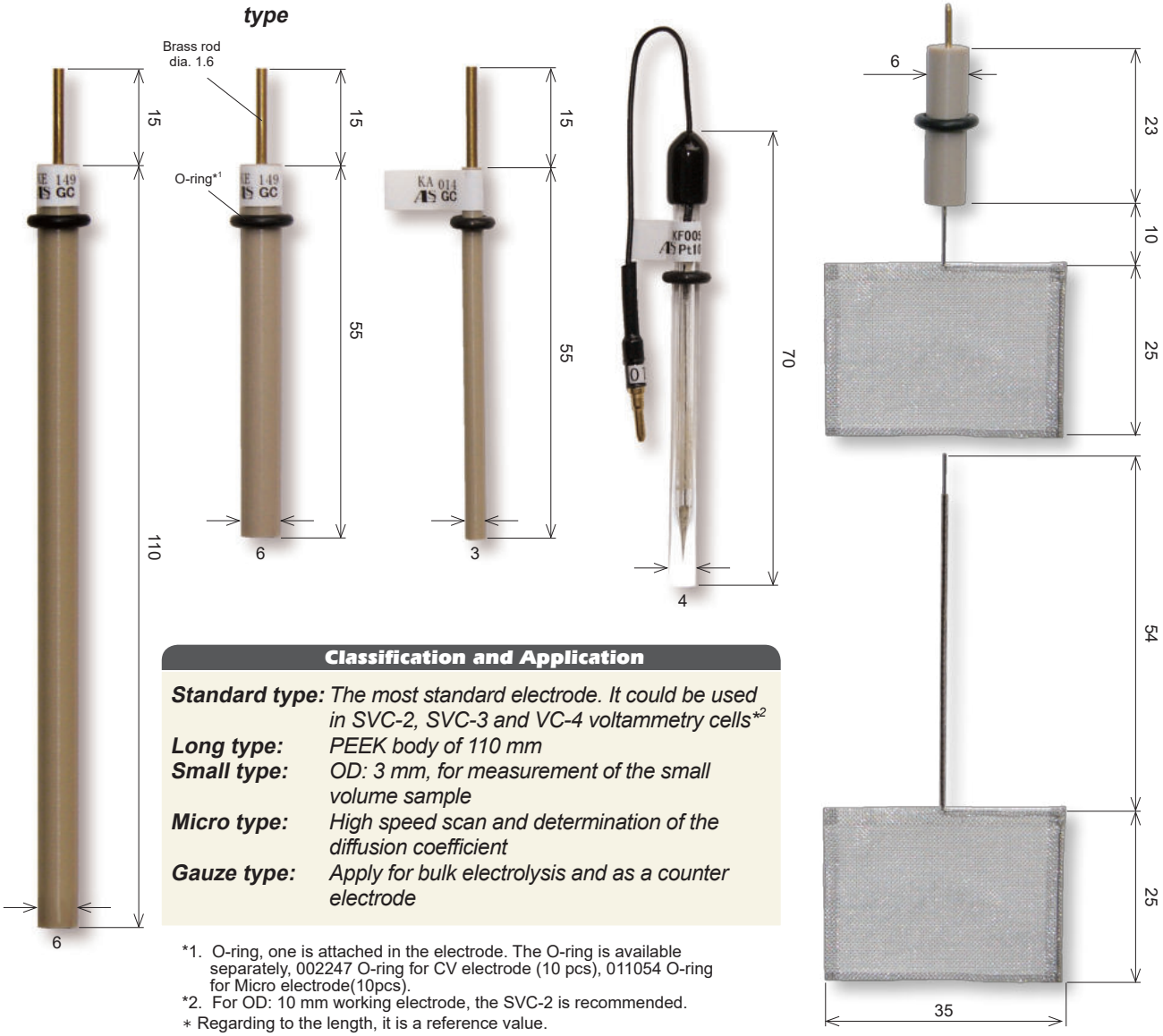

Reference electrodes can be easily prepared by coating Ag/AgCl ink on the metal (Ag, Pt, Au, etc.) surface. The only thing you are required to do is just to deposit the Ag/AgCl ink and wait for dry. The reference electrode prepared by Ag/AgCl ink is quite useful for IDA electrode measurements.

| Catalog No. | Description |
|---|---|
| 011464 | Ag/AgCl Ink for reference electrode (2.0 mL) |
| Specification | |
| Surface resistance | 0.2 Ω/sq/25.4 µm |
| Viscosity | 50 ±10 Pa·s @21.1 deg C |
| Flash point | 82 deg C |

# 3 Working Electrodes

## General Working Electrodes for Voltammetry

Unit: mm




### Classification and Application

***Standard type:*** *The most standard electrode. It could be used in SVC-2, SVC-3 and VC-4 voltammetry cells*2*

***Long type:*** *PEEK body of 110 mm*

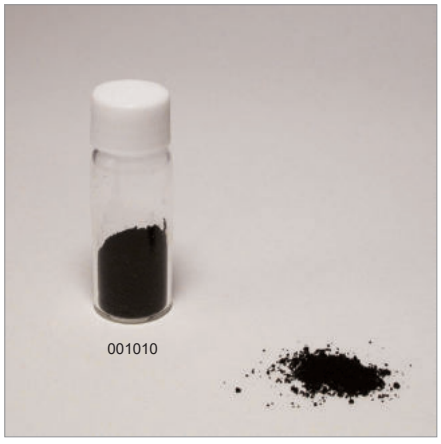
***Small type:*** *OD: 3 mm, for measurement of the small volume sample*

***Micro type:*** *High speed scan and determination of the diffusion coefficient*

***Gauze type:*** *Apply for bulk electrolysis and as a counter electrode*

*1. O-ring, one is attached in the electrode. The O-ring is available separately, 002247 O-ring for CV electrode (10 pcs), 011054 O-ring for Micro electrode(10pcs).
*2. For OD: 10 mm working electrode, the SVC-2 is recommended.
∗ Regarding to the length, it is a reference value.

## CPO Carbon Pasete Oil




Carbon Paste Oil (CPO) is prepared by mixing uniform-sized graphite powder and paraffin oil. This product is applied to Carbon Paste Electrode to have:

1) simple enzyme electrodes
2) chemically modified electrodes

It could not be used in an organic solvent. Keep the container closed to avoid contamination.

### How to prepare carbon paste electrode:

1) Mix and homogenize the compound to be analyzed in the CPO
2) Fill tightly into the electrode hole with a small spatula
3) Remove the excess CPO and polish the surface of the electrode with circular movement on the clean paper

| Catalog No. | Description |
|---|---|
| 001010 | CPO Carbon paste oil base (1 g) |

## Full Listing of Working Electrodes

| Catalog No. | Description | Isolation | Specification | |
|---|---|---|---|---|
| 002250 | Platinum gauze electrode | PEEK | 80 mesh | 35×25 mm |
| 012619 | Platinum gauze electrode, lead wire 54 mm | - | 80 mesh | 35×25 mm |
| 002251 | Gold gauze electrode | PEEK | 100 mesh | 35×25 mm |
| 002417 | GCE Glassy carbon electrode | PEEK | OD: 10 mm | ID: 5 mm |
| 012744 | LGCE Glassy carbon electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002012 | GCE Glassy carbon electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 012297 | GCE Glassy carbon electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002411 | GCE Glassy carbon electrode | PEEK | OD: 6 mm | ID: 1 mm |
| 012298 | SGCE Glassy carbon electrode | PEEK | OD: 3 mm | ID: 1.6 mm |
| 002412 | SGCE Glassy carbon electrode | PEEK | OD: 3 mm | ID: 1 mm |
| 002002 | MCE Micro Carbon fiber electrode | Glass | OD: 4 mm | ID: 33 µm |
| 002007 | MCE Micro Carbon fiber electrode | Glass | OD: 4 mm | ID: 7 µm |
| 002418 | AUE Gold electrode | PEEK | OD: 10 mm | ID: 5 mm |
| 012746 | LAUE Gold electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002421 | AUE Gold electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002014 | AUE Gold electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002314 | SAUE Gold electrode | PEEK | OD: 3 mm | ID: 1.6 mm |
| 002010 | MAUE Micro Gold electrode | Glass | OD: 4 mm | ID: 100 µm |
| 002004 | MAUE Micro Gold electrode | Glass | OD: 4 mm | ID: 25 µm |
| 002006 | MAUE Micro Gold electrode | Glass | OD: 4 mm | ID: 10 µm |
| 002420 | PTE Platinum electrode | PEEK | OD: 10 mm | ID: 5 mm |
| 012745 | LPTE Platinum electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002422 | PTE Platinum electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002013 | PTE Platinum electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002313 | SPTE Platinum electrode | PEEK | OD: 3 mm | ID: 1.6 mm |
| 002009 | MPTE Micro Platinum electrode | Glass | OD: 4 mm | ID: 100 µm |
| 002003 | MPTE Micro Platinum electrode | Glass | OD: 4 mm | ID: 25 µm |
| 002015 | MPTE Micro Platinum electrode | Glass | OD: 4 mm | ID: 15 µm |
| 002005 | MPTE Micro Platinum electrode | Glass | OD: 4 mm | ID: 10 µm |
| 002416 | AGE Silver electrode | PEEK | OD: 10 mm | ID: 5 mm |
| 002419 | AGE Silver electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002011 | AGE Silver electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002315 | SAGE Silver electrode | PEEK | OD: 3 mm | ID: 1.6 mm |
| 002016 | NIE Nickel electrode | PEEK | OD: 6 mm | ID: 1.5 mm |
| 002273 | MNIE Micro Nickel electrode | Glass | OD: 4 mm | ID: 100 µm |
| 002252 | PGBE Pyrolytic graphite electrode (Basal Plane) | PEEK | OD: 6 mm | ID: 3 mm |
| 002253 | PGEE Pyrolytic graphite electrode (Edge Plane) | PEEK | OD: 6 mm | ID: 3 mm |
| 002408 | PFCE 3 Carbon electrode *1 | PEEK | OD: 6 mm | ID: 3 mm |
| 002409 | PFCE 1 Carbon electrode *1 | PEEK | OD: 6 mm | ID: 1 mm |
| 011854 | SPFCE 1 Carbon electrode *1 | PEEK | OD: 3 mm | ID: 1 mm |
| 002019 | PDE Palladium electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002319 | SPDE Palladium electrode | PEEK | OD: 3 mm | ID: 1.6 mm |
| 012585 | FEE Iron electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002018 | FEE Iron electrode | PEEK | OD: 6 mm | ID: 1.5 mm |
| 012584 | CUE Copper electrode | PEEK | OD: 6 mm | ID: 3 mm |
| 002017 | CUE Copper electrode | PEEK | OD: 6 mm | ID: 1.6 mm |
| 002271 | MCUE Micro Copper electrode | Glass | OD: 4 mm | ID: 25 µm |
| 002272 | MWE Micro Tungsten electrode | Glass | OD: 4 mm | ID: 10 µm |
| 002210 | CPE Carbon paste electrode *2 | PEEK | OD: 6 mm | ID: 3 mm |
| 002223 | SCPE Carbon paste electrode *2 | PEEK | OD: 3 mm | ID: 1.6 mm |

**Customized electrode is also available**

*1. Plastic Formed Carbon Electrode (PFCE) is created from a collaboration of MITSUBISHI PENCIL CO., LTD and National Institute of Advanced Industrial Science and Technology (AIST).

*2. 001010 CPO Carbon paste oil base (1 g) is sold separately (p. 9). Note that the carbon paste is not filled up.

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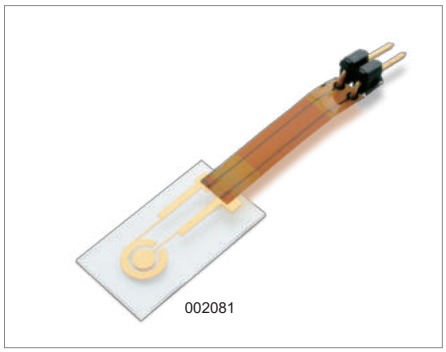
# Lithography / Glass substrate Electrodes

## Ring-Disk electrode

This ring-disk type electrode developed by NTT-AT is one type of printed electrodes. Users can choose Carbon, Gold and Platinum as a working electrode, use for radial flow cells, and achieve complete reduction/oxidation on the center disk at micro flow rate because of its fine coulometric electrolysis efficiency. This also enables to analyze subsequent reaction as well as identification and quantitation of the sample at the same time. Furthermore, this electrode becomes capable of measuring hydrogen peroxide at zero volt by immobilized Osmium Gel / Horse Radish Peroxidase (HRP) (developed by Prof. Adam Heller, Texas Univ.). Thus this Printed electrode comprises FIA (Flow Injection Analysis) system with combinations of various enzymes.

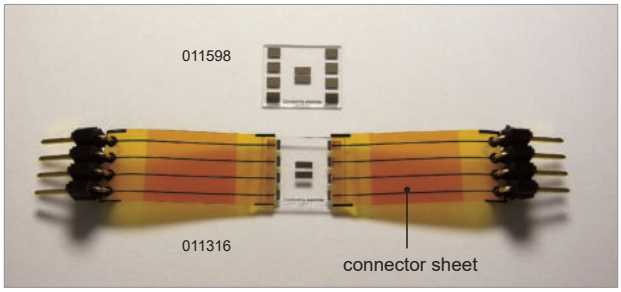
| Catalog No. | Description |
|---|---|
| 002081 | Gold ring disk electrode (3 pcs) |
| 002082 | Platinum ring disk electrode (3 pcs) |
| 002083 | Carbon ring disk electrode (3 pcs) |



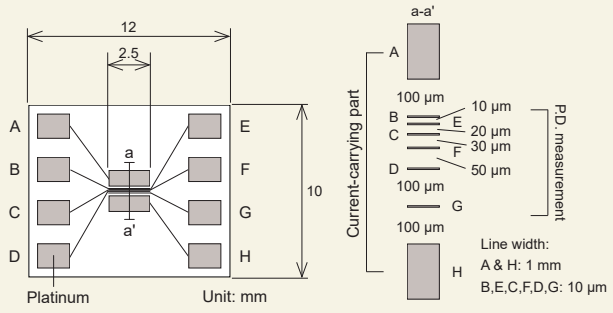

Size: 12.5 x 22 x 0.5 mm

## Conductivity electrode

Platinum terminals are deposited on a fused quartz substrate as current supplying electrodes and potential difference probing electrodes. The distance between electrodes for potential difference are adjustable from 40 µm to 250 µm by changing the connect terminals.




### Figure




### Interval

Unit: µm

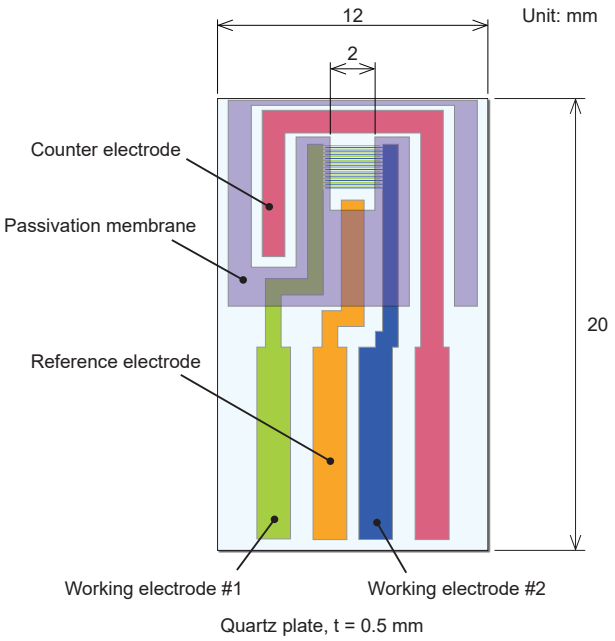
| Point | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| B | | 40 | 140 | 10 | 80 | 250 |
| C | 40 | | 90 | 20 | 30 | 200 |
| D | 140 | 90 | | 120 | 50 | 100 |
| E | 10 | 20 | 120 | | 60 | 230 |
| F | 80 | 30 | 50 | 60 | | 160 |
| G | 250 | 200 | 100 | 230 | 160 | |

| Catalog No. | Description | Specification |
|---|---|---|
| 011316 | Conductivity electrode | With connector sheet* |
| 011598 | Conductivity electrode (3 pcs) | Without connector sheet |

*The following connector is convenient for connection of the electrode with the connector sheet.
- 011839 Connector for printed electrodes
- 011840 IC clip for printed electrodes (4 pcs)

## IDA electrode

Interdigitated Array (IDA) electrode is an electrode developed for electrochemical measurements to be performed in a very small quantity of the sample. IDA electrode could be applied for the detection and reaction analysis of the compounds in a small quantity of the sample. IDA electrode is a microelectrode pattern fabricated by using the lithography technology. The electrodes are composed of 65 pairs. In each one of the pair has a function of the oxidation and reduction electrodes.




### Feature

- *High sensitivity CV measurement*
- *Electrochemical measurements in a small quantity of the sample*
- *Small integration*
- *High-speed response*

### Application

- *Electrochemical measurements*
- *Conductivity measurement*
- *Biosensor/chemical sensor*
- *Chemically modified electrode*
- *Chemical reaction process control*

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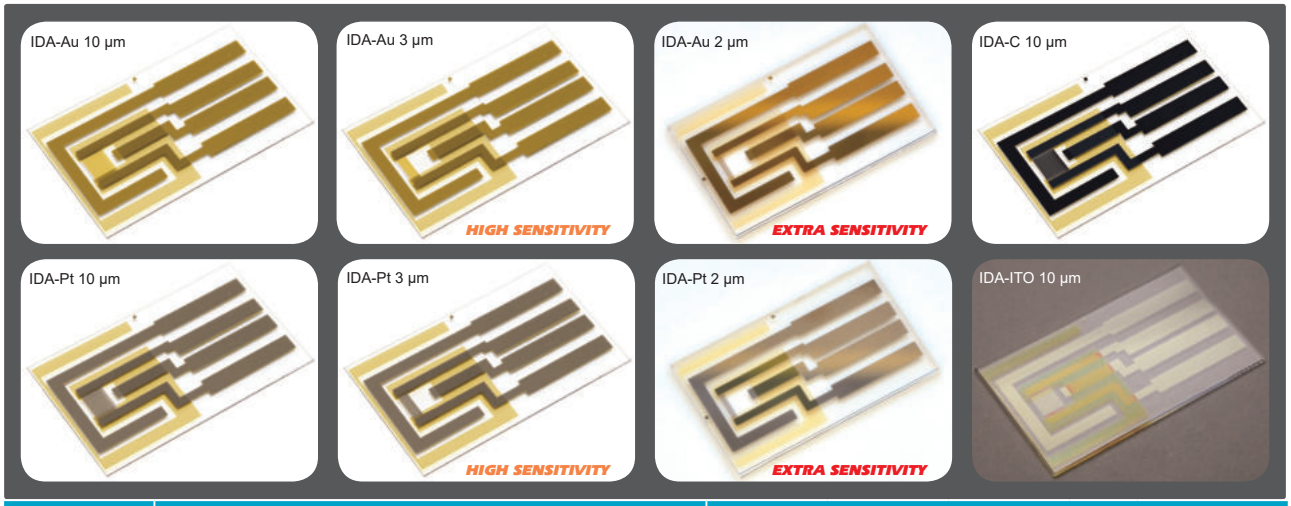


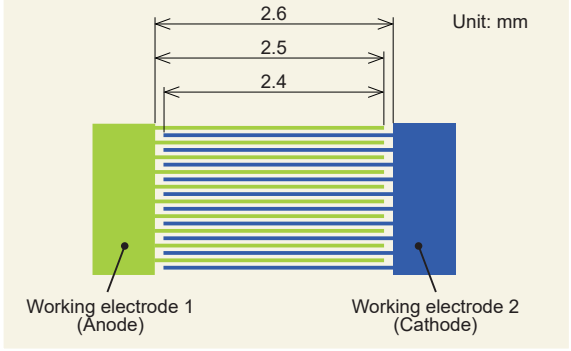

| Catalog No. | Description | Specification | | | | |
|---|---|---|---|---|---|---|
| | | Width (µm) | Interval (µm) | Length (mm) | pairs | Film thickness |
| 012125 | IDA electrode (Au) 10 µm | 10 | 5 | 2 | 65 | 90 nm* |
| 012126 | IDA electrode (Pt) 10 µm | 10 | 5 | 2 | 65 | 90 nm* |
| 012127 | IDA electrode (Carbon) 10 µm | 10 | 5 | 2 | 65 | 1.2 ± 0.1 µm |
| 012128 | IDA electrode (ITO) 10 µm | 10 | 5 | 2 | 65 | 100 ± 20 nm |
| 012129 | IDA electrode (Au) 3 µm | 3 | 3 | 2 | 65 | 90 nm* |
| 012130 | IDA electrode (Pt) 3 µm | 3 | 3 | 2 | 65 | 90 nm* |
| 012257 | IDA electrode (Au) 2 µm | 2 | 2 | 2 | 65 | 90 nm* |
| 012258 | IDA electrode (Pt) 2 µm | 2 | 2 | 2 | 65 | 90 nm* |
| 011066 | Cable kit for IDA electrode | | | | | |
| 011464 | Ag/AgCl Ink for reference electrode (2.0 mL) | | | | | |

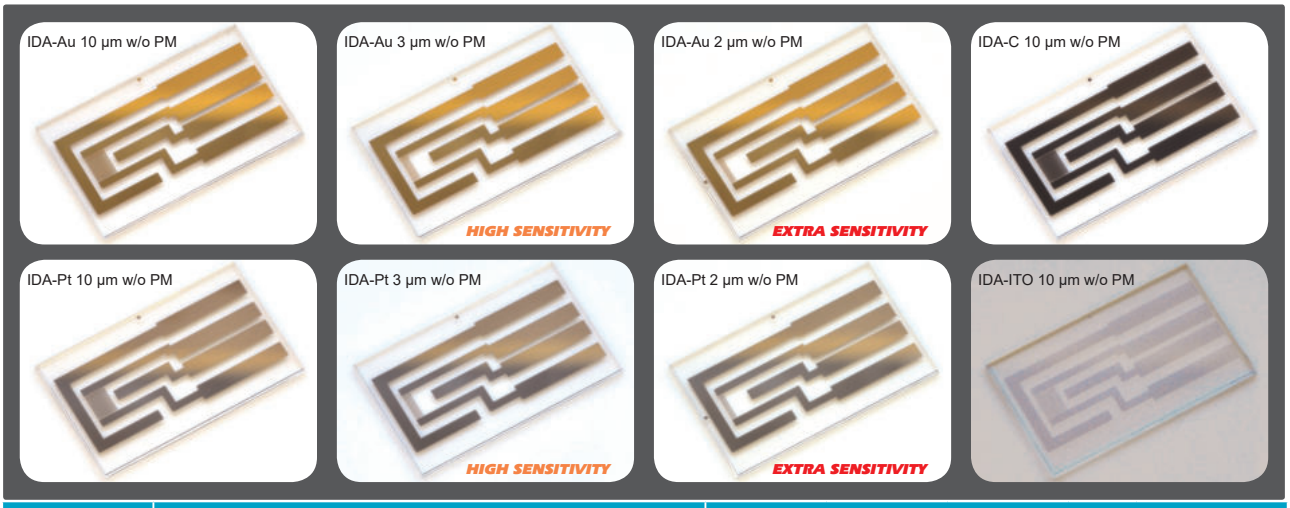
* For Au and Pt, the thickness of the titanium adhesive layer is about 10 nm, resulting in a total thickness of 100 nm.

## IDA electrode w/o passivation membrane

There is a method for the calculation of the dielectric constant from the capacitance measured from the current intensity by the application of the alternative potential through the IDA electrode. However, for an IDA electrode with a passivation membrane, the capacitance of the membrane is also measured, making impossible to obtain the exact measured value. For this purpose, IDA electrode without passivation membrane was added to the product lineup.

**Expanded diagram**




| Catalog No. | Description | Specification | | | | |
|---|---|---|---|---|---|---|
| | | Width (μm) | Interval (μm) | Length (mm) | pairs | Film thickness |
| 012259 | IDA electrode (Au) 10 μm without passivation membrane | 10 | 5 | 2.5 | 65 | 90 nm* |
| 012262 | IDA electrode (Pt) 10 μm without passivation membrane | 10 | 5 | 2.5 | 65 | 90 nm* |
| 012266 | IDA electrode (Carbon) 10 μm without passivation membrane | 10 | 5 | 2.5 | 65 | 1.2 ± 0.1 μm |
| 012265 | IDA electrode (ITO) 10 μm without passivation membrane | 10 | 5 | 2.5 | 65 | 100 ± 20 nm |
| 012260 | IDA electrode (Au) 3 μm without passivation membrane | 3 | 3 | 2.5 | 65 | 90 nm* |
| 012263 | IDA electrode (Pt) 3 μm without passivation membrane | 3 | 3 | 2.5 | 65 | 90 nm* |
| 012261 | IDA electrode (Au) 2 μm without passivation membrane | 2 | 2 | 2.5 | 65 | 90 nm* |
| 012264 | IDA electrode (Pt) 2 μm without passivation membrane | 2 | 2 | 2.5 | 65 | 90 nm* |

* For Au and Pt, the thickness of the titanium adhesive layer is about 10 nm, resulting in a total thickness of 100 nm.

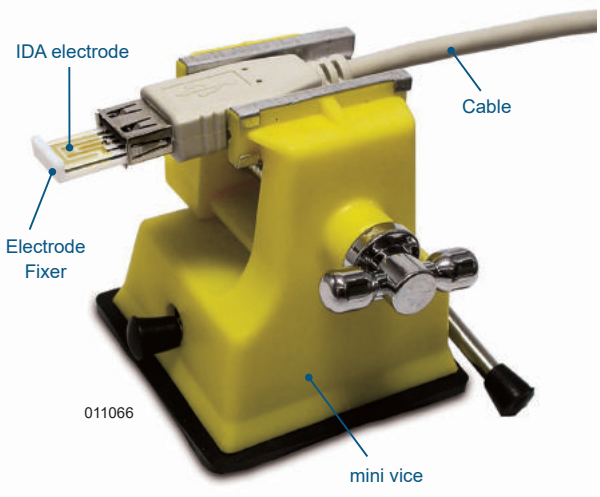
## Cable kit for IDA electrode

The Cable kit is the most suitable connector for IDA electrode.
Be careful when you are inserting or removing the IDA electrode, it consists of quartz glass and it can break easily.

**1) Put the IDA electrode into the connector**
**2) Insert the Teflon fixer into the connector**

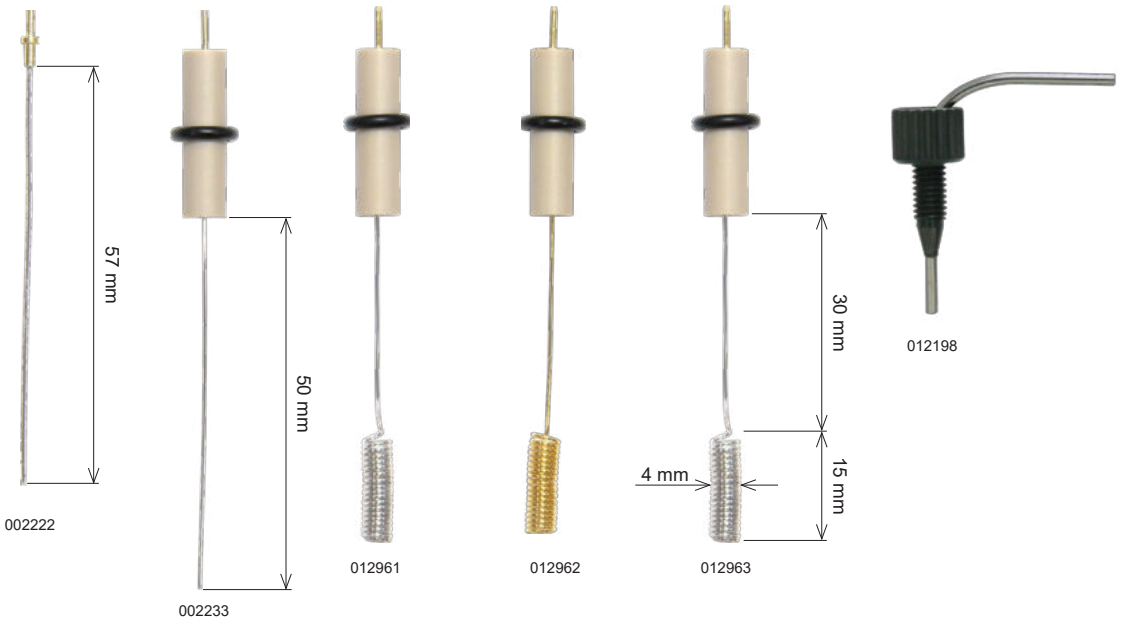
ALS IDA cable kit movie
https://www.als-japan.com/1681.html
Support Movie link

| Catalog No. | Description | |
|---|---|---|
| 011066 | Cable kit for IDA electrode | |
| Contents | | Qty |
| 012970 | Electrode Fixer (Teflon plate) | 1 |
| | Mini vice | 1 |
| | Connecting cable | 1 |



# 4 Counter Electrodes

Four different shapes of the counter electrodes are available. Select the counter electrodes suitable for the experimental conditions. Custom-made counter electrode is also available.




| Catalog No. | Description | Purpose |
|---|---|---|
| 002222 | Platinum counter electrode 5.7 cm | SVC-2, VC-4, Plate Material Evaluating cell |
| 002233 | Platinum counter electrode 5 cm | SVC-3 |
| 012961 | Platinum counter electrode 23 cm | RRDE, Bulk electrolysis, SVC-3 |
| 012962 | Gold counter electrode 23 cm | RRDE, Bulk electrolysis, SVC-3 |
| 012963 | Nickel counter electrode 23 cm | RRDE, Bulk electrolysis, SVC-3 |
| 012198 | Counter electrode for Flow cell | Stainless steel pipe, for Flow cell (LC, EQCM, SEC-3F) |

## Technical note

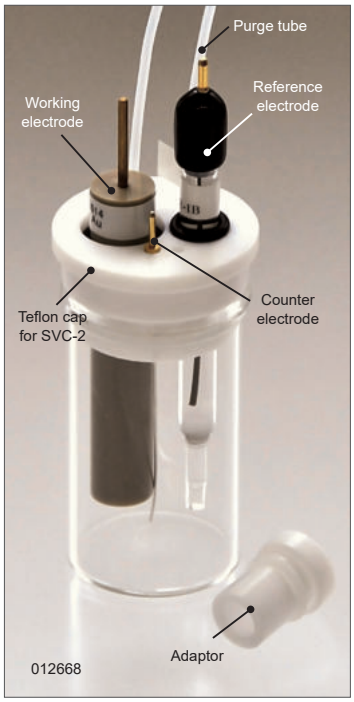
### The role of Counter electrode

For a system using three-electrode potentiostat, we measure current when a potential is applied between the working electrode and the reference electrode. Passage of current through an electrical circuit requires electron transfer reaction between the working electrode and the counter electrode. The main function of the counter electrode is to support a second electron transfer reaction. Important parameter of the counter electrode is the surface area. It is required (area) large enough to support the current generated for the working electrode. For example, the surface area of the platinum electrode of 5 cm length is sufficient to use as a micro-working electrode, such as steady-state cyclic voltammetry experiments. However, for generating a high current measurements such as bulk electrolysis, the counter electrode of a larger area is required, as Catalog No.012961 which the length of platinum is 23 cm. This electrode is used for measurement, such as rotating ring disk.

The cell shape is also an important point. For the electrolysis, to avoid the contamination of the product from the counter electrode, it is arranging separately, isolated in a chamber, from the working electrode. For electrochemical measurements such as cyclic voltammetry, because of the short measurement time, you can ignore the effects of contamination by electrolysis. Therefore, it is not usual the isolation of the counter electrode. In some cases, the separation of the counter electrode in a chamber increases the resistance between counter electrode and reference electrode, under the influence of (sintered glass) fritz. However, in the case of bulk electrolysis, because of long measurement time, the agitation and separation of the working electrode and counter electrode using a chamber is necessary, to prevent the transportation between two electrodes.

# 5 Voltammetry Cells

## SVC-2 Voltammetry cell



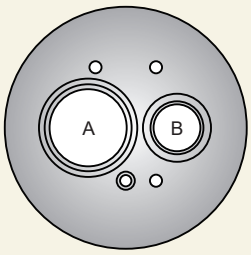

Working electrode and reference electrode are sold separately. Each component could be purchased separately. For acquisition separately, the sample vial of 20 mL is composed for 10 pieces.

### Multi purpose cell - 4 modes setting

SVC-2 Voltammetry cell can be used for 4 modes voltammetry cell setup. Also, it can be applied as an oxygen-free voltammetry cell. Setting the sample holder of 9.0 mm of the diameter, it enable small sample measurement (100 - 200 uL).

**Features and location of Teflon cap holes**

- *For various types of electrodes*
- *Sample volume from 5 to 10 mL*
  *(For very small quantity measurement*, from 100 to 200 µL)*
- *Easy removal of the dissolved oxygen*



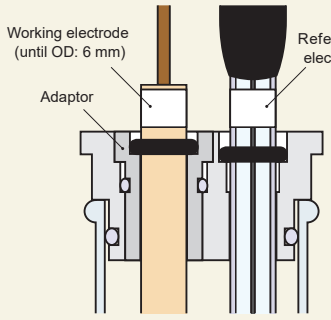

**A** : for OD 9, 10 mm electrode
**B** : for OD 4, 6 mm electrode
**Adaptor** : for OD 6 mm electrode

* 012177 Sample holder dia 9 mm is required separately.

| Catalog No. | Description | |
|---|---|---|
| 012668 | SVC-2 Voltammetry cell | |
| Contents | | Qty |
| (001056) | Sample vial (20 mL) | 7 |
| 002222 | Platinum counter electrode 5.7 cm | 1 |
| 012670 | Teflon cap for SVC-2 | 1 |
| (010537) | Purge tube (ETFE), 30 cm | 1 |
| Optional item | | |
| 012177 | Sample holder dia 9.0 mm (2 pcs) | |

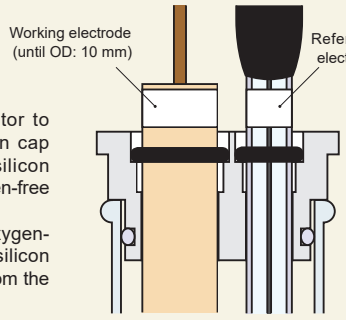
## 4 mode measurement setting

### Standard



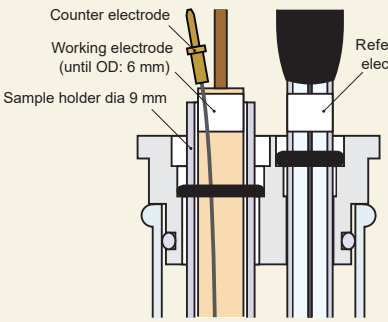

Set the Teflon cap adaptor to the Teflon cap.The Teflon cap adaptor is fixed with a silicon O-ring to work in an oxygen-free condition.
If you do not need the oxygen-free condition, then the silicon O-ring can be taken out from the Teflon cap.

### 10 mm dia WE



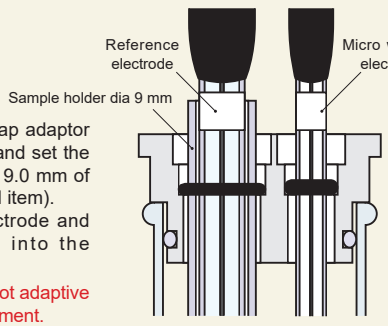

Take out the Teflon cap adaptor from the Teflon cap.Working electrode can be fitted directly to the Teflon cap.
The O-ring will fit perfectly. It permits to have the oxygen-free condition.

### Small sample




Take out the Teflon cap adaptor from the Teflon cap, and set the Sample holder of the 9.0 mm of the diameter (optional item).
Set the working electrode and counter electrode into the Sample holder.
This configuration is not adaptive for oxygen free experiment.

### Low temperature



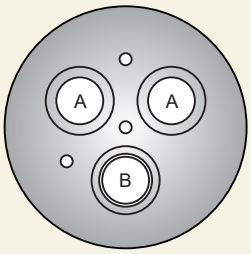

Take out the Teflon cap adaptor, and set the Sample holder of the 9.0 mm diameter (optional item).
Set the reference electrode into the sample holder.

## SVC-3 Voltammetry cell

### Standard voltammetry cell


012669

- *Sample volume from 5 to 10 mL*
- *For various types of electrode*
- *Easy removal of the dissolved oxygen*



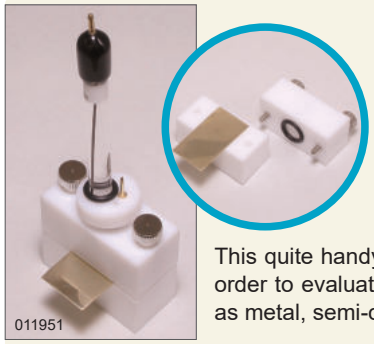

**A** : for OD 6 mm electrode
**B** : for OD 4, 6 mm electrode

Reference electrode is sold separately.

| Catalog No. | Description | |
|---|---|---|
| 012669 | SVC-3 Voltammetry cell | |
| Contents | | Qty |
| (001056) | Sample vial (20 mL) | 7 |
| 002233 | Platinum counter electrode 5 cm | 1 |
| 012671 | Teflon cap for SVC-3 | 1 |
| (010537) | Purge tube (ETFE), 30 cm | 1 |
| Optional item | | |
| 012961 | Platinum counter electrode 23 cm | |
| 012963 | Nickel counter electrode 23 cm | |

## Plate Material Evaluating cell

### Evaluation of plate material


011951

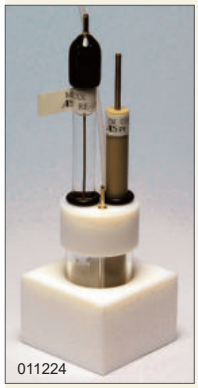
This quite handy cell was developed in order to evaluate a plate material such as metal, semi-conducting plate, etc.

Reference electrode is sold separately.

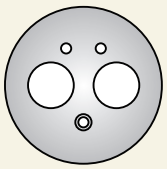
| Catalog No. | Description | |
|---|---|---|
| 011951 | Plate Material Evaluating Cell | |
| Contents | | Qty |
| | Teflon Cell [Body] | 1 |
| | Teflon Cell [Base] | 1 |
| | Teflon cap | 1 |
| | O-ring (Viton) | 1 |
| | Screw 20 mm | 2 |
| 002222 | Platinum counter electrode 5.7 cm | 1 |
| (010537) | Purge tube (ETFE), 30 cm | 1 |

## VC-4 Voltammetry cell

### Small sample measurement cell


011224

- *Sample volume from 1 to 3 mL*
- *Including specific cell holder*
- *Fit the standard type (6 mm)*



Reference electrode is sold separately.

| Catalog No. | Description | |
|---|---|---|
| 011224 | VC-4 Voltammetry cell | |
| Contents | | Qty |
| (011504) | Sample vial (5 mL) | 7 |
| 002222 | Platinum counter electrode 5.7 cm | 1 |
| 011226 | Teflon cap for VC-4 | 1 |
| 011227 | Cell holder for 5 mL vial | 1 |
| (010537) | Purge tube (ETFE), 30 cm | 1 |

## Bulk Electrolysis cell

### High current complete electrolysis of the tagget component


001197

Bulk electrolysis cell is used for complete electrolysis of solution. Typical application includes quantification of mass transfer of the electron per molecule, measurement of absolute quantity of the analyte, electrolytic synthesis of new materials (generally in quantity of milligram).

Reference electrode is sold separately.

| Catalog No. | Description | |
|---|---|---|
| 013647 | SBC Bulk electrolysis cell | |
| Contents | | Qty |
| 012632 | Sample vial (100 mL) | 1 |
| 012961 | Platinum counter electrode 23 cm | 1 |
| 013648 | Teflon cap for SBC | 1 |
| 013616 | PCE Porous carbon electrode | 1 |
| 001198 | Lid for counter electrode | 1 |
| 001196 | Chamber for counter electrode | 1 |
| 001236 | O-ring for counter electrode | 1 |
| 009131 | Port plug | 1 |
| 000178 | Stirrer bar | 1 |
| (010537) | Purge tube (ETFE), 30 cm | 1 |
| Optional item | | |
| 013580 | Sample vial for alkaline solution (100 mL) (10 pcs) | |
| 012652 | Water-Jacketed glass cell (100 mL) | |

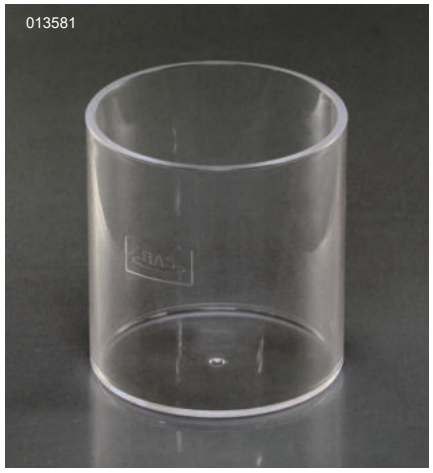
## Cell Vials














● Tolerance of each dimension is approximately ± 0.5 mm. ● The inner diameter (ID) is the size at the top side.

| Catalog No. | Description | Vol (mL) | OD (mm) | ID (mm) | Height (mm) | Qty | Purpose |
|---|---|---|---|---|---|---|---|
| 011504 | Sample vial*1 | 5 | 18 | 15.6 | 30 | 10 | VC-4 |
| 001056 | Sample vial*1 | 20 | 28 | 25.6 | 50 | 10 | SVC-2, SVC-3 |
| 012632 | Sample vial*1 | 100 | 50 | 46.4 | 72 | 1 | RRDE-3A, Bulk Electrolysis Cell |
| 013580 | Sample vial for alkaline solution*2 | 100 | 51.5 | 46.5 | 72 | 10 | RRDE-3A, Bulk Electrolysis Cell |
| 013581 | Sample vial for alkaline solution*2 | 200 | 67 | 62 | 72 | 8 | RRDE-3A, Bulk Electrolysis Cell |
| 012672 | Water-Jacketed glass cell | 5 | 40 | 15.6 | 40 | 1 | VC-4 |
| 001051 | Water-Jacketed glass cell | 20 | 55 | 25.6 | 50 | 1 | SVC-2, SVC-3 |
| 012652 | Water-Jacketed glass cell | 100 | 70 | 46.4 | 80 | 1 | RRDE-3A, Bulk Electrolysis Cell |
| 013596 | Teflon cap for CV (100mL) | | | | | 1 | For 012632, 012652, 013580 |
| 013582 | RRDE-3A Teflon cap (for 200 mL) | | | | | 1 | For 013581 |
| 001209 | Cell holder for 20 mL vial | | | | | 1 | SVC-2, SVC-3 |

*1 Hard glass for scientific rsearch *2 Polymethyl pentene

# 6 Flow Cells

## Electrochemical Flow Cells

Our working electrodes for flow cell are mounted in blocks of PEEK. This resin protects the electrodes from external noise and allows researchers to utilize them regardless the content of mobile phase of HPLC because of their hardness and organic solvent-resistance. Glassy carbon is usually chosen for the redox reaction study on liquid chromatography. Platinum, Gold, Carbon paste and Nickel electrodes are utilized for special purposes.

### Woriking electrodes for Flow cell

001016 009908 001002

**Feature**

- *Excellent chemical resistance*
- *Easy maintenance of the working electrode*
- *Working electrode can be polished with PK-3 Polishing kit*

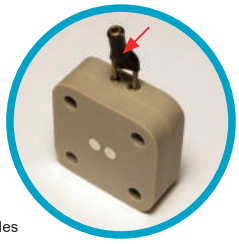
| | Catalog No. | Description | Size | Purpose |
|---|---|---|---|---|
| Dual | 001000 | Glassy carbon electrode (Dual 3 mm) | 25 × 25 mm | For CF, general redox measurements |
| | 001002 | Gold electrode (Dual 3 mm) | 25 × 25 mm | For CF, measurement of thiol-related compounds |
| | 001012 | Platinum electrode (Dual 3 mm) | 25 × 25 mm | For CF, measurement of hydrogen peroxide & oxidized substances |
| | 001008 | Silver electrode (Dual 3 mm) | 25 × 25 mm | For CF, measurement of cyano-sulfide |
| | 001009 | Nickel electrode (Dual 3 mm) | 25 × 25 mm | For CF, amino acids measurement by chemically modified electrode |
| | 001004 | Carbon paste electrode (Dual 3 mm)* | 25 × 25 mm | For CF, modified electrode measurement using carbon paste |
| | 001006 | Glassy carbon / Gold electrode | 25 × 25 mm | For CF, others |
| | 012583 | Glassy carbon / Platinum electrode | 25 × 25 mm | For CF, others |
| Single | 012124 | Glassy carbon electrode (Single 3 mm) | 25 × 25 mm | For RF, general redox measurements |
| | 001016 | Glassy carbon electrode (Single 6 mm) | 25 × 25 mm | For RF, general redox measurements |
| | 000999 | PFCE Carbon electrode (Single 3 mm) | 25 × 25 mm | For RF, general redox measurements |
| | 011155 | Gold electrode (Single 3 mm) | 25 × 25 mm | For RF, measurement of thiol-related compounds |
| | 009908 | Platinum electrode (Single 3 mm) | 25 × 25 mm | For RF, measurement of hydrogen peroxide and oxidized substances |
| | 010251 | Carbon paste electrode (Single 3 mm)* | 25 × 25 mm | For RF, modified electrode measurement using carbon paste |

*001010 CPO Carbon paste oil base (1 g) is sold separately (p. 9). Note that the carbon paste is not filled up.

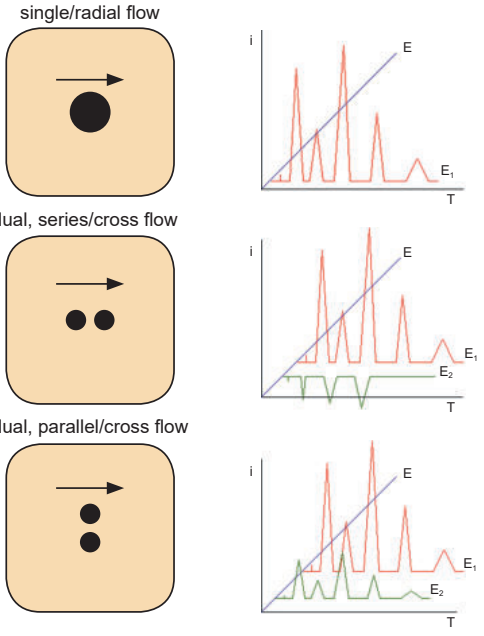
CF: Cross Flow cell RF: Radial Flow cell

### Structure of the working electrode

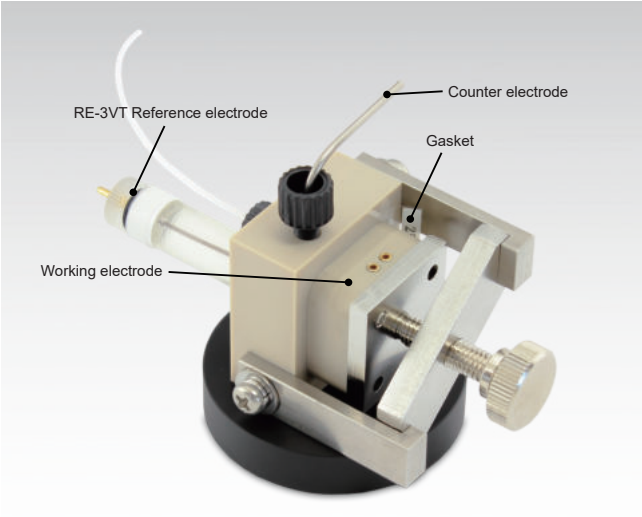
The dual glassy carbon electrode is considered to be a standard working electrode for cross flow cell. It is composed for two glassy carbon electrodes, of 3 mm placed in series. Also it could be rotated 90 degrees and applied as a parallel mode. The selectivity improves with the application of dual series electrode. In the parallel mode, identification of the substance, from the different applied voltage response ratio, is possible.
For the dual electrode, the electrode surface area doubles by using the jumper connector, and high sensitivity analysis becomes possible. For the working electrode, the platinum/gold electrode and others are also available.



002245 Jumper connector for dual electrodes



## Cross Flow Cell

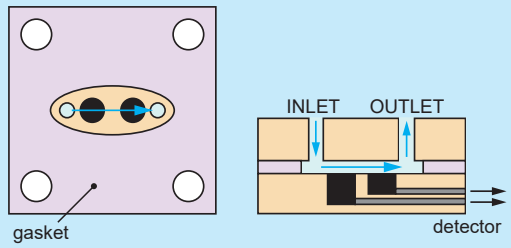



Cross Flow Cell is capable of quantitation up to the level of $10^{-15}$ mol by the flow rate : 1 mL/min - 100 µL/min.

**Feature**

- *Detection electrode for HPLC*
- *for Flow injection analysis*
- *for bio-sensor development*

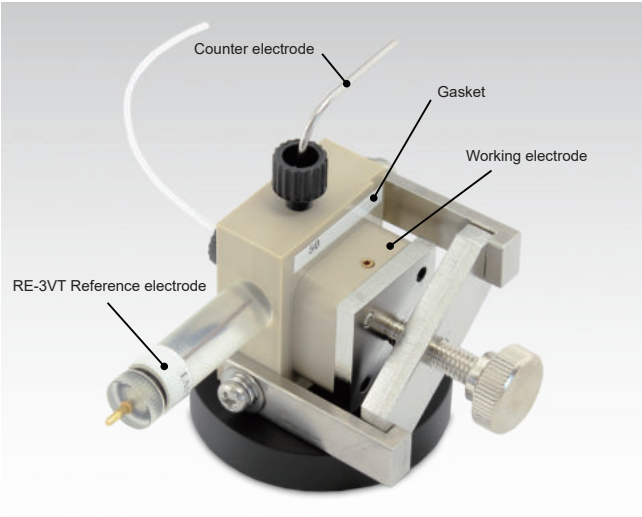
**Schematic diagram of Cross flow cell**




| Catalog No. | Description |
|---|---|
| 012798 | Cross Flow cell |

* Working electrode, Reference electrode and Gasket are sold separately.

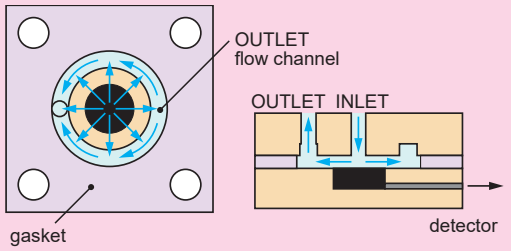
## Radial Flow Cell




Radial Flow Cell is developed for microbore chromatography. Its detecting efficiency will improve when flow rate is 10 µL/min or lower. This flow cell consists of thin layer electrode and symmetric design.

The wall-jet of analyte hits on the surface of electrode, then flows in thin layer and circulated form to the perimeter from the center of the electorde, resulting in enhanced sensitivity.

**Schematic diagram of Radial flow cell**



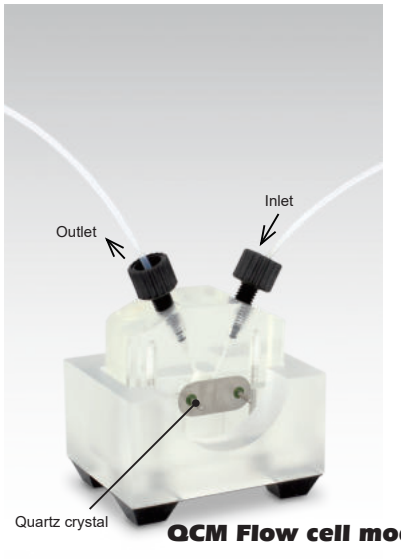

| Catalog No. | Description |
|---|---|
| 012799 | Radial Flow cell |

* Working electrode, Reference electrode and Gasket are sold separately.

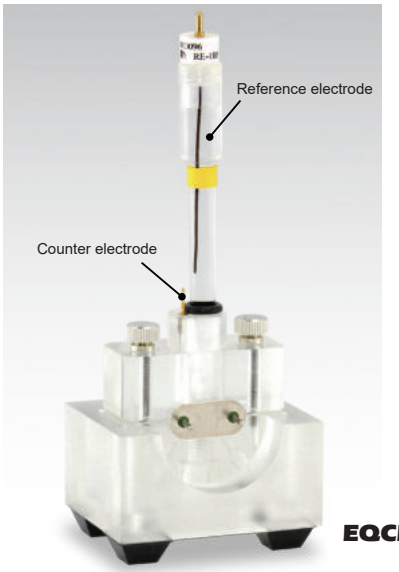
## Optional items

| Catalog No. | Description |
|---|---|
| 013488 | RE-3VT Reference electrode screw type (Ag/AgCl) |
| 013489 | RE-7VT Non Aqueous reference electrode screw type ($Ag/Ag^{+}$) |
| 001046 | TG-2M Teflon Gasket (Cross Flow) / 12 µm (4 pcs) |
| 001047 | TG-5M Teflon Gasket (Cross Flow) / 25 µm (4 pcs) |
| 001048 | TG-6M Teflon Gasket (Cross Flow) / 50 µm (4 pcs) |
| 012801 | TG-8M Teflon Gasket (Cross Flow) / 100 µm (4 pcs) |
| 001146 | TG-2MR Teflon Gasket (Radial Flow) / 12 µm (4 pcs) |
| 001147 | TG-5MR Teflon Gasket (Radial Flow) / 25 µm (4 pcs) |
| 001148 | TG-6MR Teflon Gasket (Radial Flow) / 50 µm (4 pcs) |
| 012802 | TG-8MR Teflon Gasket (Radial Flow) / 100 µm (4 pcs) |
| 002245 | Jumper connector for dual electrodes |
| 012912 | 0.04" Single lead connector (2 pcs) |

# QCM Flow Cells




**QCM Flow cell mode**




**EQCM mode**

### Contents for QCMT Flow cell

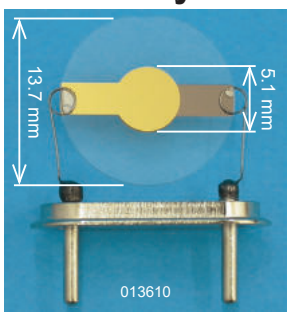
Flow cell; Batch cell; Cap; Flow cell holder; Pt counter electrode; Fitting PEEK; Fixing screw; Silicon O-ring; Teflon tube

The quartz crystal microbalance (QCM) technique under coupling of electrochemistry and crystal oscillation is very useful to determine many compounds such as metal proteins, metal ions and thiol-conjugated oligonucleotides. The Resonance frequency of quartz changes when material attaches to the electrode's surface. This product is capable of super-micro quantitative analysis by using this unique behavior. However, for the best performance, use a degassed sample, to avoid bubbles.
QCMT Flow cell is reversible. With an inverted position of the blocks, it is possible to change from static to flow measurements.

| Catalog No. | Description |
|---|---|
| 013486 | QCMT Flow cell kit |
| | Optional items |
| 013610 | Quartz crystal Au (5 pcs) |
| 013447 | Quartz crystal Pt (3 pcs) |
| 012772 | Blank Crystal with holder (5 pcs) |
| 012167 | RE-1B Reference electrode (Ag/AgCl) |
| 013613 | RE-1BP Reference electrode (Ag/AgCl) |
| 012171 | RE-7 Non Aqueous reference electrode (Ag/Ag$^+$) |

ALS support product manual
https://www.als-japan.com/support-product-manual.html
**Manual download link**

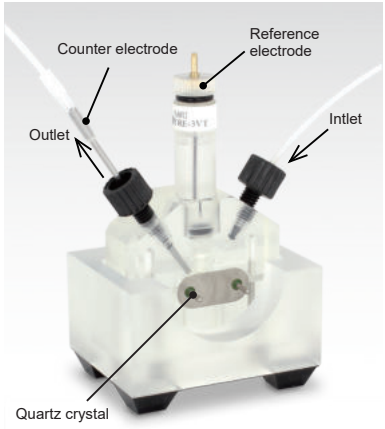
### Quartz crystal




Frequency: 7.995 MHz

# EQCM Flow Cells

**Combination of QCM and electrochemical measurement in an unique flow cell.**




### Contents for EQCMT Flow cell

Flow cell; Batch cell; Cap; Flow cell holder; Pt counter electrode; Stainless tube (Counter electrode for flow cell); Fitting PEEK; Fixing screw; Silicon O-ring; Teflon tube

The two blocks of the EQCMT Flow cell are constructed using Polymethyl pentene. It gives a high resistivity for chemical compounds.
As well as QCMT Flow cell, this cell is reversible. With an inverted position of the blocks, it is possible to change from flow to static measurements.

| Catalog No. | Description |
|---|---|
| 013487 | EQCMT Flow cell kit |
| | Optional items |
| 013610 | Quartz crystal Au (5 pcs) |
| 013447 | Quartz crystal Pt (3 pcs) |
| 012772 | Blank Crystal with holder (5 pcs) |
| 013488 | RE-3VT Reference electrode screw type (Ag/AgCl) |
| 013489 | RE-7VT Non Aqueous reference electrode screw type (Ag/Ag$^+$) |

ALS support product manual
https://www.als-japan.com/support-product-manual.html
**Manual download link**

# 7 Spectroelectrochemistry

Spectroelectrochemistry (SEC) is aimed at the investigation of electrochemical reaction mechanism and the interface structure between electrolyte solution and electrode. Remarkable progress in this field and related technology enables SEC to be applied in wide areas. Nowadays, the relation between absorbance and potential for reversible or quasi-reversible system is theoretically elucidated, on which basis the analysis of electrochemical characteristics becomes possible for the system otherwise difficult with only the result of voltammogram. Typical example is redox enzyme cytochrome c and methylene blue.

**Application**

- *Real-time monitoring of chromatic change by redox reaction*
- *Analysis of the charge transfer at the electrode/liquid interface*
- *Spectrometric measurement of near/surface of electrodes*
- *Absorbing spectrum of the product and intermediate*
- *Parameters: concentration, diffusion coefficient and life time*


## Spectroelectrochemical Batch System

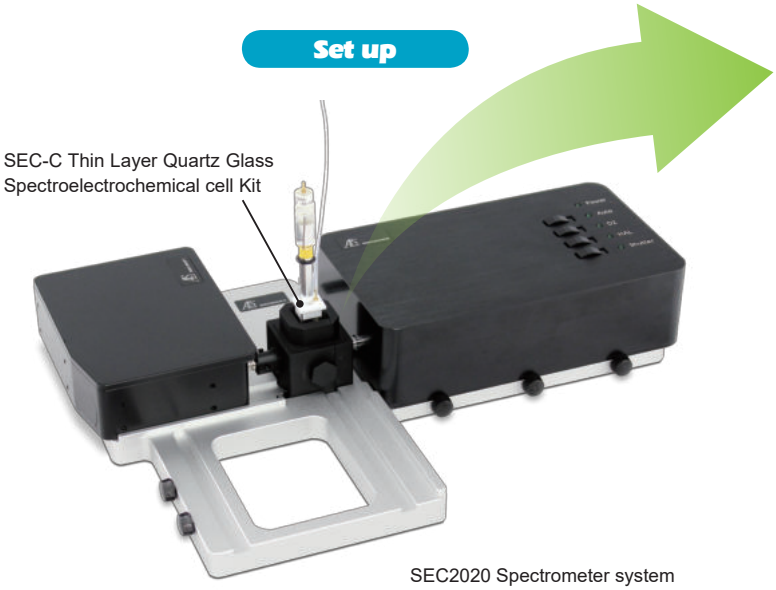
### SEC-C Thin Layer Quartz Glass Spectroelectrochemical cell kit

SEC-C Thin Layer Quartz Glass Spectroelectrochemical cell kit uses platinum or gold mesh electrode as a working electrode. We offer 0.5 and 1.0 mm optical path length cells. After setting the mesh electrode, the activity area for the cell is about 6 mm diameter with a center at 15 mm above of the bottom. For reference electrode, the RE-1B, RE-1BP or RE-7 is recommended.

**Feature**

- *Two variety optical path length (0.5 and 1.0 mm)*
- *Designed to use the 6.0 mm reference electrode*
- *Two variety of working electrodes (Au or Pt)*
- *Be able to use in a standard spectrometer*

**Set up**

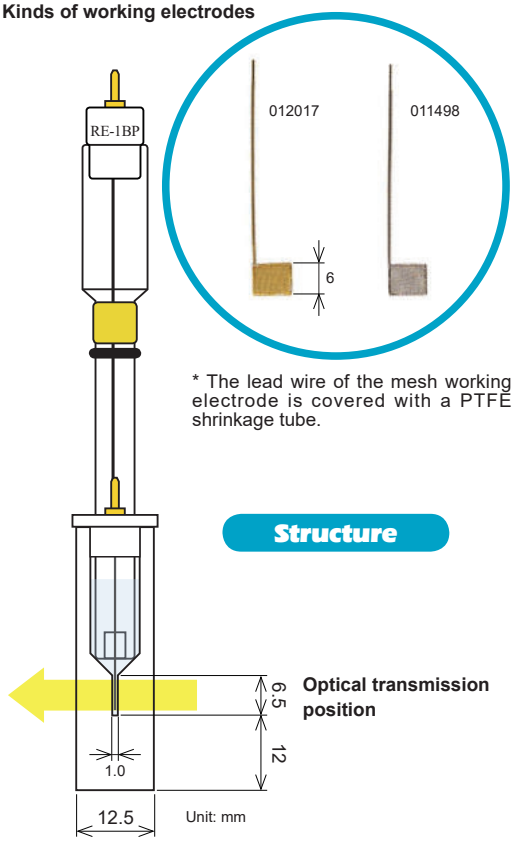



SEC2020 Spectrometer system

ALS Spectroelectrochemical setup
https://www.als-japan.com/1874.html
**Setup introduction link**

## Optical path length 1.0 mm cell

Kinds of working electrodes




* The lead wire of the mesh working electrode is covered with a PTFE shrinkage tube.

**Structure**

**Optical transmission position**

### Optical path length 1.0 mm cell

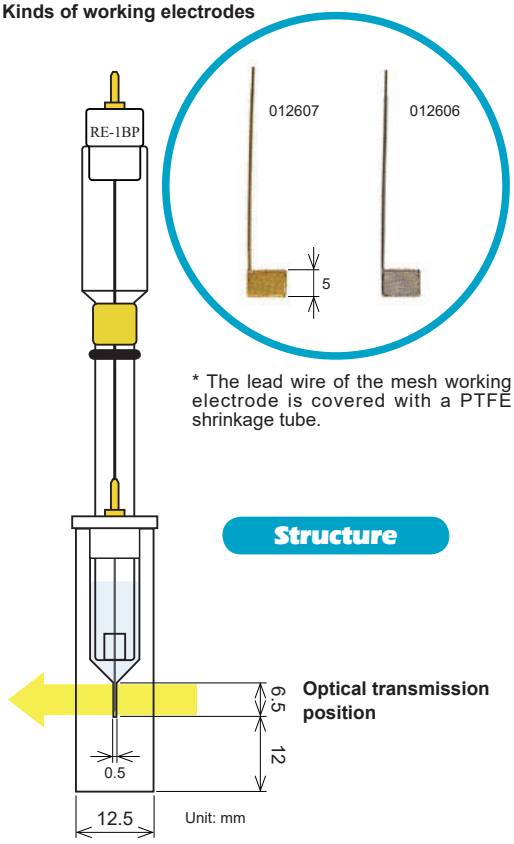
The optical path length 1.0 mm is most suitable for basic spectrum electrochemistry measurements. Theoretically, it is possible to get the same result as for 0.5 mm with a half concentration sample.

ALS support product manual
https://www.als-japan.com/support-product-manual.html
Manual download link

| Catalog No. | Description | | |
|---|---|---|---|
| 013510 | SEC-C Thin Layer Quartz Glass Spectroelectrochemical cell Kit (Pt) | | |
| 013511 | SEC-C Thin Layer Quartz Glass Spectroelectrochemical cell Kit (Au) | | |
| | Contents | | Qty |
| 013703 | SEC-C/C05 Pt counter electrode | | 1 |
| 013512 | SEC-C Thin Layer Quartz Glass cell | | 1 |
| 011501 | SEC-C Teflon cap | | 1 |
| (010537) | Purge tube (ETFE) 10 cm | | 1 |
| | Working Electrodes | | Qty |
| 011498 | SEC-C Pt Gauze working electrode | For 013510 | 1 |
| 012017 | SEC-C Au Gauze working electrode | For 013511 | 1 |
| | Optional items | | |
| 012167 | RE-1B Reference electrode (Ag/AgCl) | | |
| 013613 | RE-1BP Reference electrode (Ag/AgCl) | | |
| 012171 | RE-7 Non Aqueous reference electrode ($Ag/Ag^+$) | | |

## Optical path length 0.5 mm cell

Kinds of working electrodes




* The lead wire of the mesh working electrode is covered with a PTFE shrinkage tube.

**Structure**

**Optical transmission position**

### Optical path length 0.5 mm cell

The optical path length 0.5 mm has an electrolysis time shorter than 1.0 mm cell. The short time for the electrolysis makes possible to have a stable result as for, measurement of the high volatile organic solvent, detection of the unstable electrolysis products, and others.

* There is a specific working electrode for 0.5 mm optical path length. The working electrode for 1.0 mm optical path length can not be used in 0.5 mm optical path length quartz cell.

ALS support product manual
https://www.als-japan.com/support-product-manual.html
Manual download link

| Catalog No. | Description | | |
|---|---|---|---|
| 013700 | SEC-C05T Thin Layer Quartz Glass Spectroelectrochemical cell Kit (Pt) | | |
| 013701 | SEC-C05T Thin Layer Quartz Glass Spectroelectrochemical cell Kit (Au) | | |
| | Contents | | Qty |
| 013703 | SEC-C/C05 Pt counter electrode | | 1 |
| 013702 | SEC-C05T Thin Layer Quartz Glass cell | | 1 |
| 011501 | SEC-C Teflon cap | | 1 |
| (010537) | Purge tube (ETFE) 10 cm | | 1 |
| | Working Electrodes | | Qty |
| 012606 | SEC-C05 Pt Gauze working electrode | For 012813 | 1 |
| 012607 | SEC-C05 Au Gauze working electrode | For 012814 | 1 |
| | Optional items | | |
| 012167 | RE-1B Reference electrode (Ag/AgCl) | | |
| 013613 | RE-1BP Reference electrode (Ag/AgCl) | | |
| 012171 | RE-7 Non Aqueous reference electrode ($Ag/Ag^+$) | | |

## Comparison of 0.5 and 1.0 optical path length cell

The electrolysis time for the 0.5 mm optical path length cell is theoretically a half, compared with the 1.0 mm cell. It is the opposite, for the concentration, when the same result for the 1.0 mm cell is possible for a half of the concentration compared with the 0.5 mm cell. You could select the optical path length and the working electrode appropriate for your research purpose.

For the comparison of 0.5 and 1.0 optical path length cell, sometimes a difference between theoretical and experimental value may occur due to experimental conditions and so on.

| Optical path length | Merit | Demerit |
|---|---|---|
| 0.5 mm | High electrolytic speed | Difficult maintenance |
| 1.0 mm | Easy maintenance | Slow electrolytic speed |

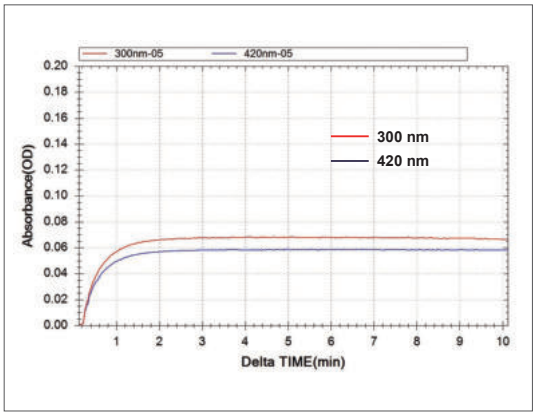



**Fig.2-1. Absorbance for electrolysis performed with 0.5 mm optical path length cell**

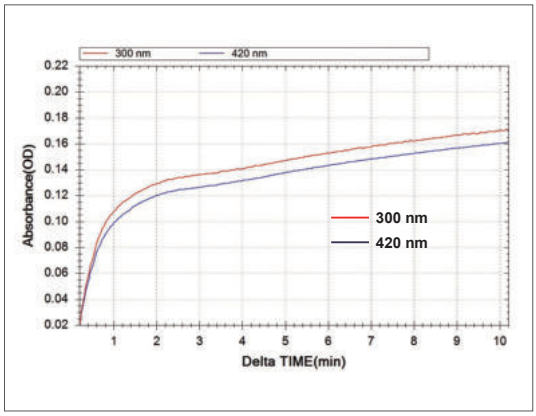



**Fig.2-2. Absorbance for electrolysis performed with 1.0 mm optical path length cell**

A 2 mM potassium ferrocyanide ($K_4[Fe(CN)_6]$) was subjected to an electrolysis reaction at 0.6 V until its equilibrium, and 1 M $KNO_3$ solution was used as a reference. The oxidation reaction was monitored by the comparison of the absorbance change in function of the time at wavelengths of 300 and 420 nm.

## Measurement example using cuvette type spectroelectrochemical cell

UV-visible absorption spectrum can be obtained by measuring the absorbance of substances involved in the redox reaction by using SEC-C Spectroelectrochemical cell (1.0 mm optical path length). The CV of 2 mM potassium ferrocyanide aqueous solution is taken to confirm the redox potential. The Fig. 3-2 shows the time domain of the differential absorption spectrum at constant potential electrolysis at 0.25 V, where the oxidation reaction occurs.

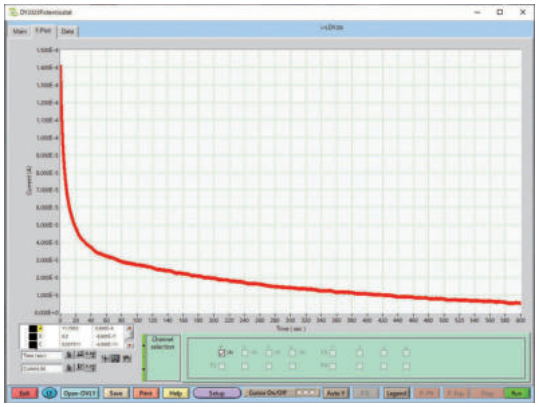


**Fig. 3-1. Constant potential electrolysis for 2 mM potassium ferrocyanide.**

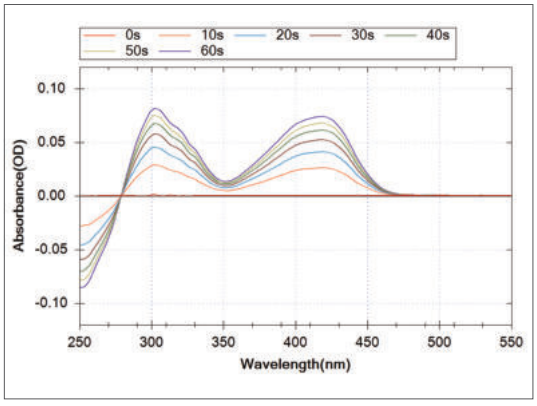
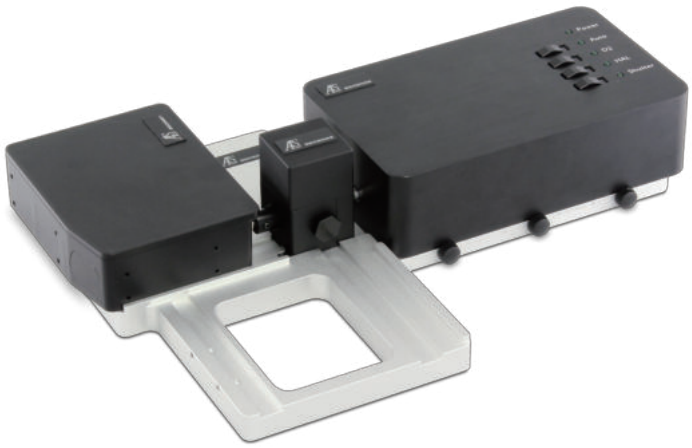


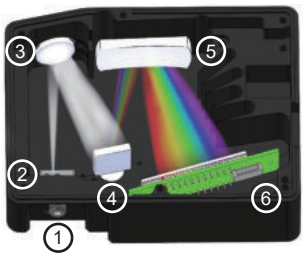

**Fig. 3-2. Absorbance measurement for 2 mM potassium ferrocyanide.**

# SEC2020 Spectrometer system

## Wide wavelength range spectrometer



### Spectrometer structure




1. SMA905 connector
2. Slit
3. Collimating mirror
4. Grating
5. Focus mirror
6. 2048 element CCD array

The SEC 2020 spectrometer system is a spectrometer that enables various spectrometric measurements, focusing on spectroelectrochemical measurements. The high-performance grating and optical design, makes possible to measure with high sensitivity in a wide wavelength range, from ultraviolet to near infrared (UV/VIS/NIR), with a single unit.

For the light source, a compact modularized deuterium halogen lamp is used, which is fixed to the cell holder on the accessory platform for the measurement.

Furthermore, the spectrometer and the light source come with SMA905 connector, which makes possible to connect various optical fibers and probes, to construct the original measurement system.

### Feature

- *Wide wavelength UV/VIS/NIR*
- *High sensitivity, resolutions and quality*
- *Deuterium halogen light source*
- *Measuring platform and analysis software included*
- *SMA 905 connection terminal*
- *Exclusive storage box*

### Application

- *Spectroelectrochemical measurements*
- *Analysis of solution properties*
- *Film thickness/composition*
- *Fluorescence detection**
- *Environmental (water and soil) analysis*

* For fluorescence detection a high power light source, as high power LED is required.

| Catalog No. | | Description |
|---|---|---|
| 013609 | | SEC2020 Spectrometer system |
| Specification | | |
| Spectrometer | Description | SEC2021-025-DUVN |
| | Detector | 2048 element linear silicon CCD array |
| | Wavelength range | 200 - 1025 nm |
| | Grating | Blaze wavelength (300 nm) |
| | Slit | 25 µm |
| | Wavelength resolution | 1.3 nm |
| | Fiber connector | SMA905 Core diameter: 600 µm NA=0.22 |
| | Interface | USB 2.0 |
| | Operating system | Windows™ 8.1 / 10, 32/64 bit |
| | Size (W x D x H) | 86 x 110 x 32 mm |
| Light source | Description | SEC2022 |
| | Light type | Deuterium halogen light source |
| | Wavelength range | 200 - 1700 nm |
| | Stability | < 0.1 % |
| | Drift | < 0.25 %/h |
| | Bulb life | > 1000 h (D2 lamp)<br>> 2000 h (halogen lamp) |
| | Fiber connector | SMA905 |
| | Size (W x D x H) | 100 x 165 x 46 mm |
| Cuvette holder description | | SEC2023 |
| Platform desctiption | | SEC2024 |
| Software | | SpectraSmart |

SEC2021

SEC2023

Colimating lens

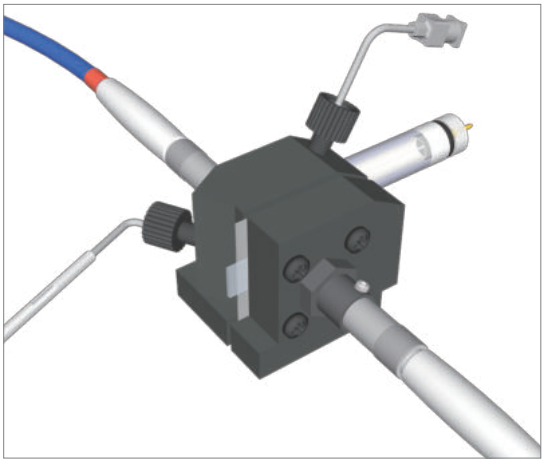
SEC2022

Plug

SEC2024

# Spectroelectrochemical Flow System

## SEC-3F Spectroelectrochemical flow cell



### Feature

- *Thin-layer cell measurement*
- *Variety of working electrode*
- *Connection to a variety of the optical fiber type spectrometer*

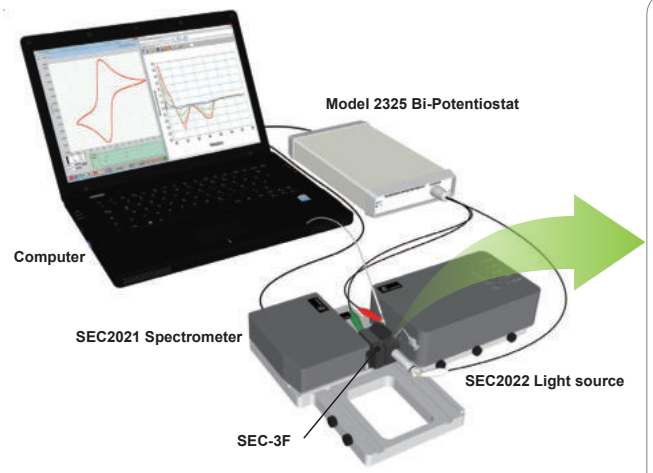
ALS support product manual
https://www.als-japan.com/support-product-manual.html
Manual download link

| Catalog No. | Description |
|---|---|
| 013684 | SEC-3F Spectroelectrochemical flow cell |

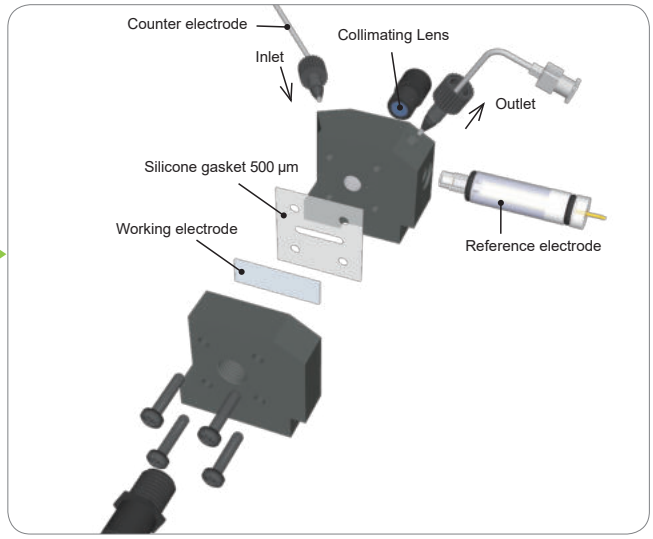
Using the spectroelectrochemical flow cell, it is possible to have different optical path length by changing the gasket. We offer, as an optional item, a silicon and Teflon gasket with 100, 250 and 500 µm of the thickness. Flow injection analysis or stopped flow analysis with thin layer cells which was impossible with SEC-C Thin Layer Quartz Glass Spectroelectrochemical cell kit became possible.

The SEC-3F can be connected to a variety of the optical fiber type spectrometer by setting the collimating lens. Depending on the research purpose you can select the working and reference electrodes. For working electrode, we offer: ITO and platinum, gold or carbon grid electrodes. For reference electrode: RE-3VT Reference electrode screw type (Ag/AgCl) and RE-7VT Non Aqueous reference electrode screw type (Ag/Ag$^+$).

### Configuration




### Structure diagram of Spectroelectrochemical flow cell




## Optional items

### 1) Gasket

| Catalog No. | Description | Thickness |
|---|---|---|
| 012661 | SEC-2F/3F S500 Silicone Gasket (4 pcs) | 500 µm |
| 012664 | SEC-2F/3F T500 Teflon Gasket (4 pcs) | 500 µm |
| 012665 | SEC-2F/3F T250 Teflon Gasket (4 pcs) | 250 µm |
| 012666 | SEC-2F/3F T100 Teflon Gasket (4 pcs) | 100 µm |

### 2) The full list of the working electrodes are shown in the next page.

### 3) Reference electrode

| Catalog No. | Description |
|---|---|
| 013488 | RE-3VT Reference electrode screw type (Ag/AgCl) |
| 013489 | RE-7VT Non Aqueous reference electrode screw type (Ag/Ag$^+$) |

### 4) Optical fiber

| | |
|---|---|
| 012667 | SEC-2F/3F 400um Optical Fiber SR (25 cm) |
| 012685 | SEC-2F/3F 400um Optical Fiber SR (2 m) |
| 013688 | UV/VIS Collimating Lens, 200-2000 nm |

## Comparison of the absorbance for different gasket thickness

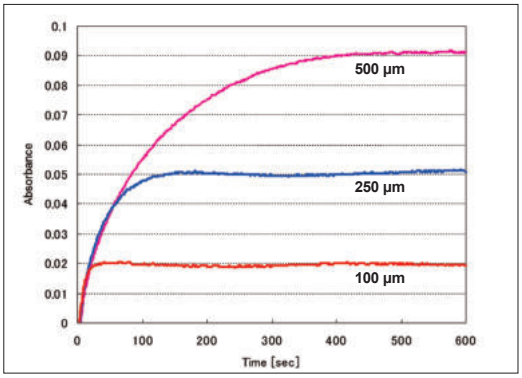



Fig.4-1. Changes of the equilibrium time in different gasket thickness.

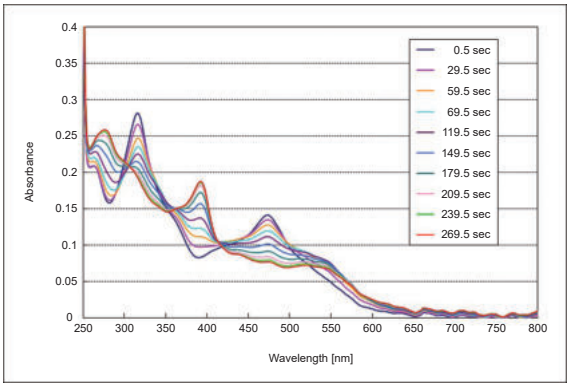


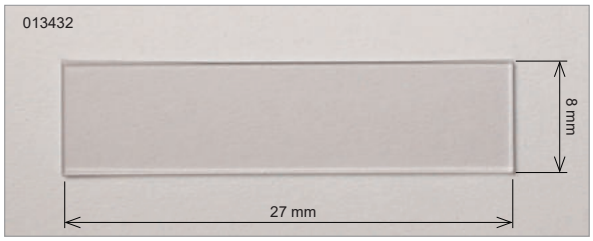

Fig.4-2. Electrolysis spectrum change of Vitamin $B_{12}$ derivative complex.

The absorbance, at 420 nm, during electrolysis of the potassium ferrocyanide, in function of time, was investigated using 100, 250 and 500 µm thickness gasket. For the measured sample, using the 100 µm gasket, in 40 seconds the equilibrium was shown (Fig.4-1). The 250 µm gasket was used for the monitoring of the electrolysis spectrum of the vitamin $B_{12}$ derivative complex (Fig.4-2).

# Spectroelectrochemical Electrodes

## ITO Optically transparent electrode

ITO (Indium Tin Oxide) electrode is generally used for spectroelectrochemical measurements. ITO electrode transmits the light of the visible range, but do not transmit the light of ultraviolet range. The thickness of the ITO membrane is 100 ± 10 nm, and the resistivity is 15 ± 1.5 Ω/sq*1.

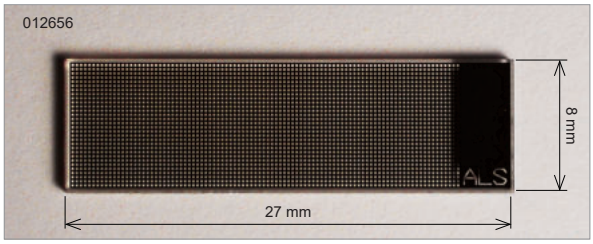



*1. The manufacturer guarantee value.
*2. Custom-made ITO electrode is also available.

| Catalog No. | Description |
|---|---|
| 013432 | ITO11 electrode 8 x 27 x 1.1 mm (10 pcs) |
| 013435 | ITO05 electrode 8 x 27 x 0.5 mm (10 pcs) |
| Others*2 | |
| 013433 | ITO11 electrode 10 x 10 x 1.1 mm (10 pcs) |
| 013434 | ITO11 electrode 10 x 20 x 1.1 mm (10 pcs) |
| 013436 | ITO05 electrode 10 x 10 x 0.5 mm (10 pcs) |
| 013437 | ITO05 electrode 10 x 20 x 0.5 mm (10 pcs) |

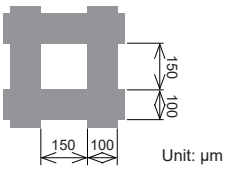
## Grid Electrode

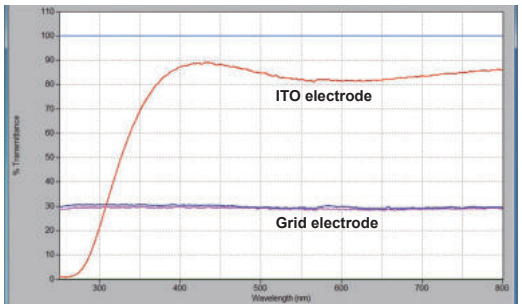
Grid electrode is produced by the deposition of the platinum, gold or carbon onto the quartz glass. The dimension of the glass is 8 x 27 mm, with a 1 mm of the thickness, and the grid line is 100 µm width with a distance of the 150 µm between lines.




| Catalog No. | Description |
|---|---|
| 012655 | SEC-2F/3F Pt grid electrode for flow cell |
| 012656 | SEC-2F/3F Au grid electrode for flow cell |
| 012657 | SEC-2F/3F Carbon grid electrode for flow cell |

### Schematic diagram of the grid




The light transmittance was compared with ITO electrode and Grid electrode (Au, Pt and Carbon) on a quartz glass as a reference. For ITO electrode the light cannot be transmitted easily in an ultraviolet range. The transmittance is about 10% at 280 nm of the wavelength. For wavelength above 400 nm the transmittance is above 80%. Compared with the quartz glass, the light transmission for grid electrode is about 30%, however it could be used in an ultraviolet range.

**Reference data:**
The light transmittance is 50 – 55% for SEC-C Platinum mesh electrode.

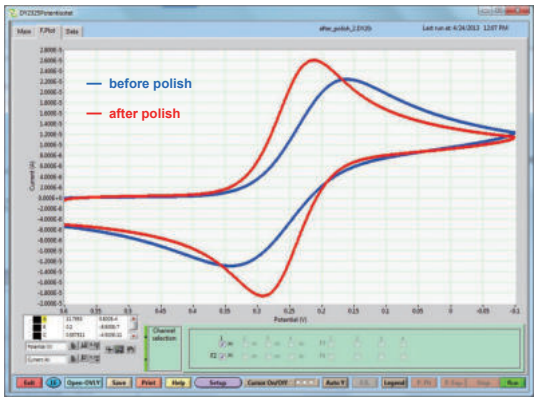
# 8 Others

## PK-3 Electrode Polishing kit

### Polishing refreshes working electrode response

The purpose of the polish is to remove redox reaction products accumulated on the working electrode surface. The polishing maintains a good condition of working electrode for CV/Flow cell.

With repeated electrochemical redox reaction experiments, the adhesion of the experimental products onto the electrode surface takes place and the electron transfer rate is attenuated gradually. If the electron transfer speed becomes slow, the difference between peak potentials for oxidation and reduction will broaden.



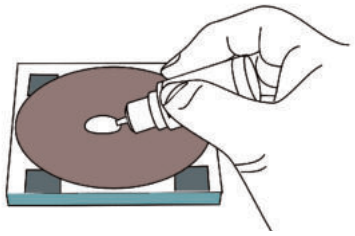

**Glassy Carbon electrode**

Upon refreshing the electrode surface by polishing, the electron transfer rate will increase again. Consequently, the peak potential difference becomes narrow and returns to an ideal CV.

### Instructions to polish the working electrode surface with PK-3

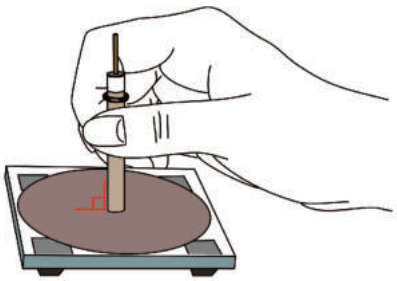
**STEP 1**

ALS PK-3 movie
https://www.als-japan.com/1634.html
Support Movie link



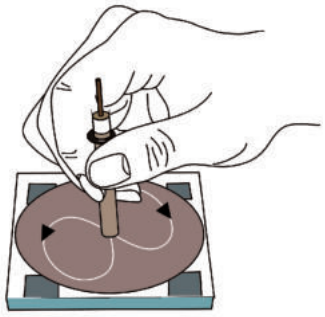
Prepare the glass plate, and put a few drops of polishing diamond on diamond polishing pad.

**STEP 2**



Hold the CV electrode at right angle to the pad.

**STEP 3**

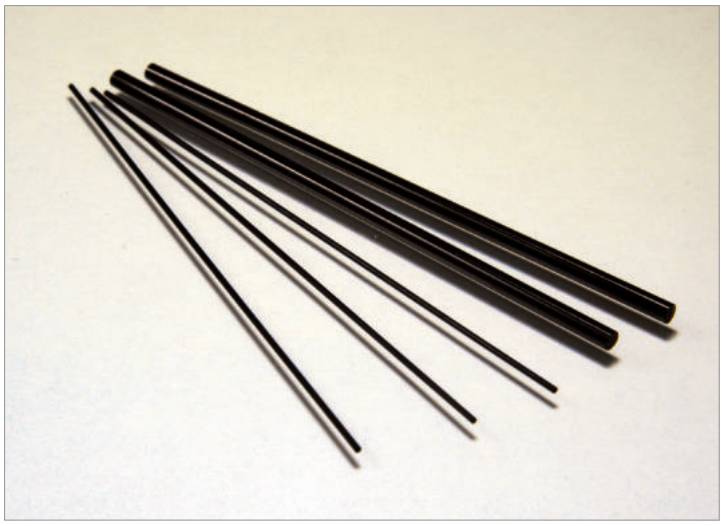


Polish in a circular motion, for 30 seconds to 2 minutes. Rinse the electrode surface with distilled water.

| Catalog No. | Description | | |
|---|---|---|---|
| 013223 | PK-3 Electrode Polishing kit | | |
| Contents | | Qty | Purpose |
| 012620 | 0.05 µm polishing alumina (20 mL) | 1 | For final polishing |
| 012621 | 1 µm polishing diamond (10 mL) | 1 | For intermediate polishing |
| (012600) | Alumina polishing pad | 10 | For final polishing |
| (012601) | Diamond polishing pad | 10 | For intermediate polishing |
| 013222 | Replacement glass plate for PK-3 | 1 | Glass plate to stick the polish pad |
| Optional items | | | Purpose |
| 013234 | 6 µm polishing diamond (10 mL) | | For rough polishing |
| 012600 | Alumina polishing pad (20 pcs) | | For final polishing |
| 012601 | Diamond polishing pad (20 pcs) | | For intermediate polishing |
| 012610 | Coarse polishing pad (20 pcs) | | For rough polishing |
| 012611 | Emery paper UF800* (20 pcs) | | For PG and PFCE electrode polishing |

* For polishing using the emery paper, use it only with distillated water. Polishing alumina and diamond cannot the used in Pyrolytic graphite electrode (PGE) and Plastic formed carbon electrode (PFCE).

# Glassy Carbon



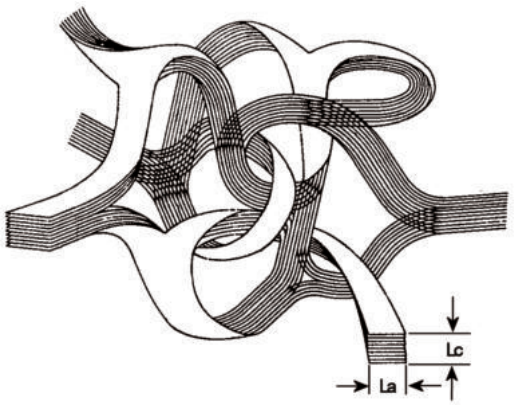
**Feature**

- *High-purity*
- *Excellent Stability as high as at 3,000 deg C in vacuum*
- *Well Inert against Chemical corrosion*
- *impermeability to gas and solution*
- *Sigificant hardness / strength*
- *Brings fine surface condition after polishing*
- *Favorable electric conducting property*
- *Low thermal expansion*
- *High resistance against inorganic and organic salts*
- *Good bio-compatibility*
- *Isotropic physical/chemical properties*

We are dealing with various kinds of Glassy Carbon products. Customer's special processing order such as pipe, pot shape etc. or custom sizing order is also available.

## Characteristics of Glassy carbon

Glassy Carbon has a quite unique structure. This material contains random combination of basal plane and edge plane. The figure, at the right, shows the model illustration introduced by G. M. Jenkins and K. Kawamura. It becomes an outstanding material, which can be used for the electrode in an analytical chemistry domain as electrochemical measurements, detection of high-speed liquid chromatography, biosensor and others.



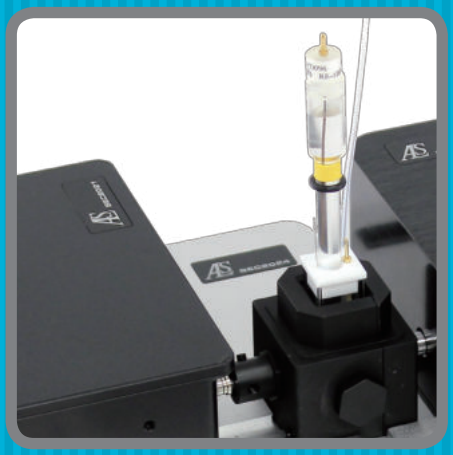

La: Intraplanar Microcrystaline Size, Lc: Interplanar Microcrystaline Size
G.M. Jenkins and K. Kawamura: Nature 231,175 (1971).

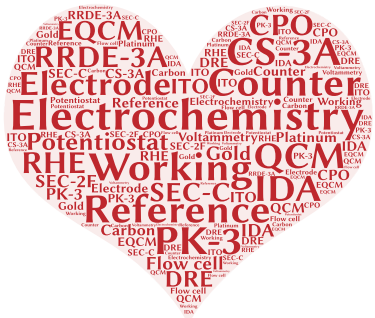
### Size range available for customized product

**Rod type:** diameter, from 1 to 10 mm; length until 800 mm
**Plate type:** within 300 x 300 mm; thickness of 0.3, 0.5, and 1 to 6 mm
**Film type:** within 100 x 100 mm; thickness of 60, 100 and 140 µm
Furthermore, drilling, cutting and mirror polishing are also possible.

| Catalog No. | Description | Size |
|---|---|---|
| | Rod type | |
| 010761 | R-1 Glassy carbon rod | dia 1 x 100 mm |
| 010762 | R-2 Glassy carbon rod | dia 2 x 100 mm |
| 010763 | R-3 Glassy carbon rod | dia 3 x 100 mm |
| | Plate type | |
| 012825 | P-1 Glassy carbon plate | 10 x 10 x 1 mm |
| 012086 | P-1 Glassy carbon plate | 25 x 25 x 1 mm |
| 012087 | P-2 Glassy carbon plate | 25 x 25 x 2 mm |
| 012088 | P-3 Glassy carbon plate | 25 x 25 x 3 mm |
| | Film type | |
| 012089 | F-100 Glassy carbon film | 25 x 25 x 0.1 mm |
| | Powder type (Spherical) | |
| 012090 | S-12 Glassy carbon powder | 0.4 - 12 µm, 10 g |
| 012091 | S-20 Glassy carbon powder | 10 - 20 µm, 10 g |

| Physical proberty | | |
|---|---|---|
| Shape | Other than Film | Film |
| Density | 1.42 g/cm$^3$ | 1.54 g/cm$^3$ |
| Ash content | < 100 ppm | |
| Upper Temparature Limit in vacuum | 3000 deg C | 1000 deg C |
| Porosity | 0 % | |
| Gas Transmission Rate | $10^{-9}$cm$^2$/s | $10^{-11}$cm$^2$/s |
| Hardness | 230 HV1 | 340 HV1 |
| Bending Strength | 260 N/mm$^2$ | 210 N/mm$^2$ |
| Compressive Strength | 480 N/mm$^2$ | 580 N/mm$^2$ |
| Young's Modulus | 35 kN/mm$^2$ | |
| Thermal Expansion Coefficient (20 - 200 deg C) | 2.6×$10^{-6}$ 1/K | 3.5×$10^{-6}$ 1/K |
| Heat Conducting (30 deg C) | 6.3 W/(m•K) | 4.3 W/(m•K) |
| Electrical resistivity | 45 µΩ•m | 50 µΩ•m |

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