

RRDE-3A Ver.3.0

Operation Manual



AS

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Chapter 1. Introduction

1-1 Introduction

RRDE-3A is a miniature rotator system for use in constant rotation and hydrodynamic techniques by rotating ring disk electrode in electrochemistry field. A short stainless-steel shaft and 12 mm diameter electrode provide a concentric circle electrode system that is capable of high accuracy.

RRDE-3A is electronically controlled by a proportional-integral closed loop circuit driven by a DC servomotor. The compact electrodes are easily and rapidly interchangeable. The unit also provides an adjustable valve system for inert gas purging inside the cell vial.

RRDE-3A can be operated as a stand-alone unit and directly controlled by Model 3325 or other instruments. During or between electrochemical analyses, a built-in gas control allows purging the sample.

Besides, easy to remove and replace the cell vial, easy for rinsing, cleaning, and replacing electrodes.

1-2 Features

1. Remote and manual controlled rotation
2. Quasi-oxygen free sample vial design (up to 200 mL)
3. Gas line connector is available
4. Remote and manual controlled purge lines
6. Teflon cap is adapted for BAS reference and counter electrodes
7. Cell lead connects directly to Model 3325 and CH Instruments, Inc. potentiostats
8. Open architecture for easy access to cell

1-3 Certification



The RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.3.0 complies with EMC Directive 2014/30/EU and Restriction of the use of certain hazardous substances (RoHS) 2011/65/EU. See "A-8 EC DECLARATION OF CONFORMITY" attached to the end of this operating manual.

1-4 Specifications

Size	190 (w) x 230 (d) x 400 (h) mm
Weight	3.5 kg
Rotational Range	100 to 8,000 rpm
Rotation stability	Error, < 1% at 100 to 1,000 rpm < 0.5% at > 1,001 rpm
Ring/Disk insulation resistance	> 10 M ohm
Electrode to lead pin contact resistance	5 ohms
Rotator Shaft	Stainless steel
Motor	12 V, ironless core, low inertial DC servo
Power	12 VDC
Operating Temperature	10 to 50 Celsius degrees
Relative humidity	≤ 80%
Inlet Gas Pressure	5 psi (34 KPa) maximum
Remote Control	Motor ON/OFF TTL or relay input to back panel connection. Purge TTL or relay input to back panel connection

1-5 Icons

	<p>Note: Important or complementary information.</p>
	<p>Tip: Useful hint and advice.</p>
	<p>Wait Time: Describes an operation or process which requires a waiting time.</p>
	<p>CAUTION: Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</p>
	<p>WARNING: Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Indicates hazardous information needed to prevent injury to a person or to prevent damage to equipment.</p>
	<p>CORROSIVE SUBSTANCES: Indicates hazardous situation that should remain careful while handling corrosive substances, if not avoided, can result in a serious injury or cause a tissue injury.</p>
	<p>ELECTROSTATIC SENSITIVE: Indicates that an electrical or electronic device or assembly is susceptible to damage for Electro-Static Discharge.</p>
	<p>CHEMICAL INCOMPATIBILITY: Indicates chemical incompatibility information needed to prevent damage to equipment.</p>
	<p>TEMPERATURE CONSTRAINT: Indicates when an operation or use of equipment is limited to a specified temperature range.</p>

1-6 Safety Labels

 <p>The image shows a rectangular warning label with a black border. At the top, it says 'WARNING' in a red box. Below that is a yellow triangular warning symbol with a black outline, containing a black silhouette of a hand being caught in a rotating gear. Underneath the symbol, the text reads: 'ENTANGLEMENT HAZARD', 'Entanglement of hand or clothes may result in severe injury.', 'Turn power off before removing the cover.', and '6R003-106' at the bottom.</p>	<p>ENTANGLEMENT HAZARD: This is a warning indication for entrapment into the motor shaft assembly rotating part. When opening the motor cover, turn the power supply of RRDE - 3A "OFF". For details, refer to "Chapter 6. Maintenance".</p>
 <p>The image shows a green terminal block with five terminals. To the left of the block is a yellow triangular warning symbol with a black exclamation mark. The background of the terminal block has some text, including 'D FOR D OR D' and 'D RGE'.</p>	<p>WARNING: This is a warning display about the remote-control terminal. For details, refer to "5-1 Remote Control".</p>
 <p>The image shows a circular silver terminal on a white surface. Above the terminal is a blue square icon with a white ground symbol (a circle with three horizontal lines of decreasing length). Below the terminal, the word 'GND' is printed in black.</p>	<p>FUNCTION EARTH: This is a functional ground terminal for keeping the ground potential between devices constant. Connect the ground wire if necessary.</p>

Chapter 2. General Information

2-1 User updates

In order to receive any updated information about product, and valuable information related to current and other BAS products, please register your e-mail address at our local distributors. We would like to know about your present status and interests regarding electrochemical analysis.

2-2 Technical changes

We reserve the right to make technical changes to improve the instrument without notice.

2-3 Damaged shipment

Breakage of any part of this instrument during shipping should be reported immediately to the freight handler and BAS Customer service.

It is necessary to keep the original packing box and contents for inspection by the freight forwarder. BAS will replace any new instrument damaged in shipping with an identical product as expediently as possible after the claim filing date. Claims not filed within 7 days after shipping may be invalid.

Do not return damaged goods to BAS directly. Please contact with your local distributor informing them of its damaged status.

They will contact with our service department.

2-4 Product warranty

BAS Inc. warrants equipment manufactured by the company are tested and inspected before shipping. In the unlikely event that a defect in the product is proved within the warranty period below, we will replace or repair it free of charge.

- Electronics parts of the RRDE-3A ...within 1 year after delivery
- Consumable parts of RRDE-3A ...within 90 days after delivery
(such as silver carbon brushes, contact probes, tubes, bearings, etc.)
- Consumables ... within 30 days after delivery
(such as electrochemical cells and working electrodes)

The service does not cover damage caused by disassembly of the instrument or, damage or corrosion caused by chemicals.

This product is intended for research applications using the rotating electrode method. Any other purpose use of the product is at the user's own risk. We do not accept any responsibility for any damage caused by not complying with the instructions of this manual.

2-5 Service information

BAS provides a skilled service staff to solve your equipment oriented problems. For further details, please contact us by e-mail (sales@als-japan.com).

Following discussion of your specific difficulties, an appropriate course of action will be described and the problem resolved accordingly.

Please contact with local distributor and describe to them the problem you are having in full detail.

They will obtain a RETURN MERCHANDISE AUTHORIZATION NUMBER (RMA#). The RMA# identifies you as the sender. All correspondence and shipments should be sent to BAS.

2-6 Others

In this manual, free material is used for some images. The copyrights on individual texts, photographs, trademarks, logo marks and other copyrighted materials belong to us, original authors, and other rights holders.

What is described in this manual does not guarantee and license of infringement of intellectual property rights such as patents and copyright and trademark rights of our company or a third party. We are not responsible for any problems related to the rights such as intellectual property rights of third parties by using the contents described.

Chapter 3. Installation

3-1 Shipment Inspection

After unpacking the instrument carefully, check the package contents and inspect for breakage. **Table 3-1** lists the parts of the **RRDE-3A**. This list is subject to change. Please refer to the packing slip with your instrument. Assembly of these various parts will be outlined in the following chapters.

Please keep the shipping box and packing material until you have fully tested the unit to be certain that no damage was incurred during shipping.

If a shortage exists, please contact with local distributor or BAS Customer Service and describe the shortage. A replacement part will be sent immediately subject to stock availability.

If you do not find out one of accessories, please contact with distributor or local dealer **within one month** from RRDE-3A arrival date. Otherwise, you won't get full support.

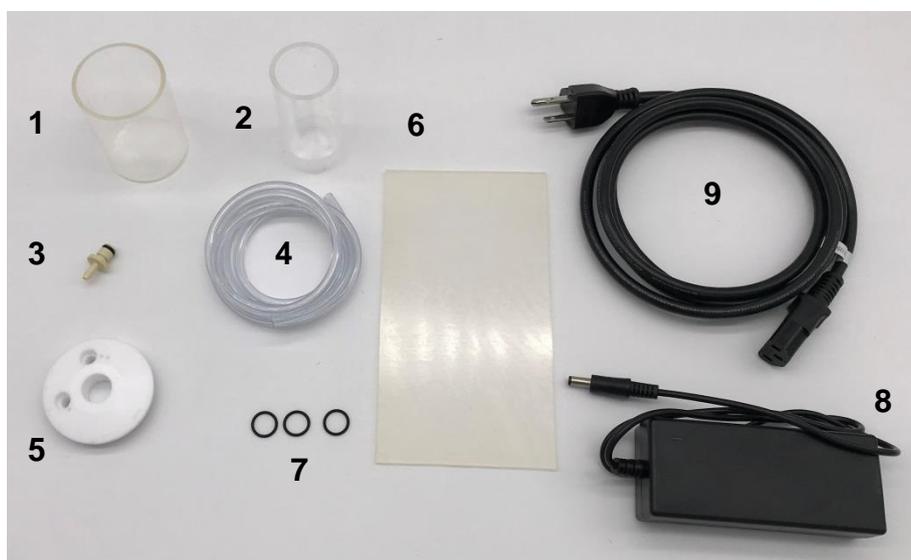


Fig. 3-1-1 RRDE-3A Accessories

Table 3-1

Cat. #		Description	Qty
013725		RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.3.0	1
RRDE-3A Accessory kit consists of			
1	(013580)	Sample vial for alkaline solution (100mL)	1
2	012064	Spin coating adapter	1
3	012065	Male connector for gas purge (PP)	1
4	013392	Tygon tubing, OD1/4 x ID1/8	1
5	013271	RRDE-3A Teflon cap V.2	1
6	012642	RRDE-3A Silicon sheet 100x180mm	1
7	012975	O-ring for RRDE-3A bearing assembly	3
8	013727	AC adapter	1
9		Power cable	1
		Quick manual	1

3-2 Options

Descriptions of working electrodes are available in Appendix "A-1 Working Electrodes".

You will find details on RRDE (Ring Disk Electrode), RDE (Disk Electrode) and DRE (Disk replaceable electrode).

3-3 Instrument setting

1. Provide a surge-free power source. Other laboratory equipment such as ovens, vortex mixers, centrifuges, and large motors may cause spikes in the power supply.
2. Make sure that all components of the system share the same ground circuit. It can be done by plugging all devices into the same multi-outlet power strip. Plugging devices into independent outlets can produce ground loops, which can produce baseline noise.
3. Select a room where temperature remains stable throughout the day. Avoid installing the **RRDE-3A** near windows air ducts, ovens, and refrigerators. A water-jacketed cell may be required for very precise work.
4. Place the **RRDE-3A** away from busy, congested areas. Remote, isolated areas are best for high-sensitivity work.

	<p>CAUTION: Avoid installing in places where there is radio interference.</p>
	<p>CAUTION: Avoid installing in dry place, place where carpet is drawn. Antistatic mat is effective, in order to prevent a spike noise caused by static electricity.</p>
	<p>WARNING: RRDE-3A is a non-explosion proof device. Be sure to use it in an area that is not explosion proof.</p>
	<p>WARNING: Place on a stable bench free of vibrations.</p>

	<p>Tip: When used in an environment with low humidity such as in a glove box, abrasion rate of the inner silver carbon brush rises. For the replacement procedure, Chapter 6. Maintenance, Section 6-6 Replacement of Silver carbon brushes.</p>
	<p>Tip: When highly sensitive measurement is required, please avoid using it in a place with many traffic and dense places.</p>
	<p>TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.</p>
	<p>CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.</p>

3-4 Power requirements

The RRDE-3A can be used with a 12 V DC power supply.

	<p>CAUTION: Please use surge free power supply. Spike noise may be generated in the power supply when there is equipment using large motors such as oven, vortex mixer, centrifuge etc. in the room.</p>
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3-5 Front panel components in RRDE-3A

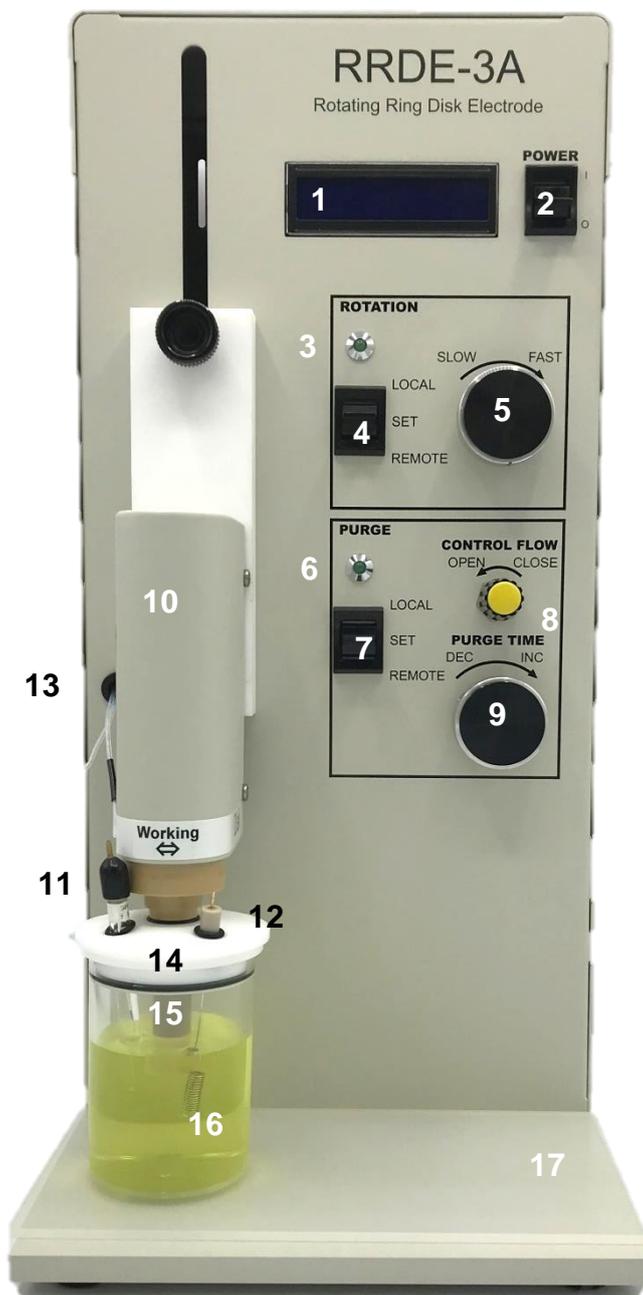


Fig. 3-5-1 Front panel of RRDE-3A

Table 3-5

No.	Description	No.	Description
1	Digital rpm and purge time display	10	Motor shaft assembly
2	Power On/Off Switch	11	Reference electrode
3	rpm LED: The LED is ON when rotation is turned ON; either remotely or manually	12	Counter electrode
4	Rotation control switch (SET, LOCAL, REMOTE*)	13	Teflon tube for gas purge
5	Rotation speed knob (X10) Setting range: 100 - 8,000 rpm	14	Teflon cap
6	Purge LED: The LED is ON when purge is turned ON, either remotely or manually	15	Working electrode
7	Gas purge switch (SET, LOCAL, REMOTE*)	16	Sample vial for alkaline solution
8	Gas purge flow control knob	17	Silicon sheet
9	Purge time knob Setting range: 0 - 9,999 sec		

*REMOTE: Enables the rotation speed control (IN) and gas purge control (PURGE) of the remote terminal on the back panel. For details, please refer to "5-1 Remote Control, 5-2 Gas Purge".

	WARNING: Place on a stable bench free of vibrations.
	TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.
	CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution. Also, follow the specified volume of the solution and immersion depth of the electrode.

3-6 Back Panel Controls and Connections

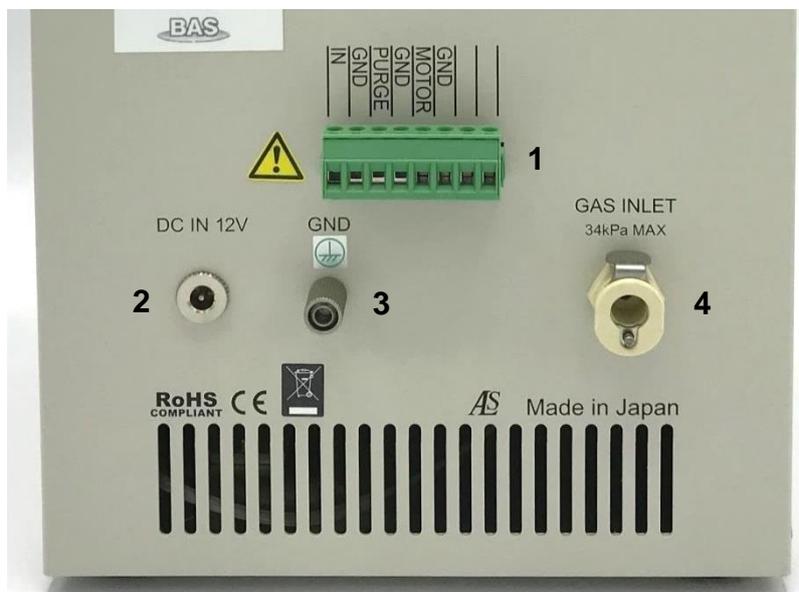


Fig. 3-6-1 Back Panel

Table 3-6-1 Description of each part of the back panel

No.	Function
1	Remote Terminal
2	Power plug
3	Ground terminal
4	Gas Inlet Connector for Cell Purging. Attached tubing providing connection to external gas source NOTE: 34 kPa (5 psi) maximum

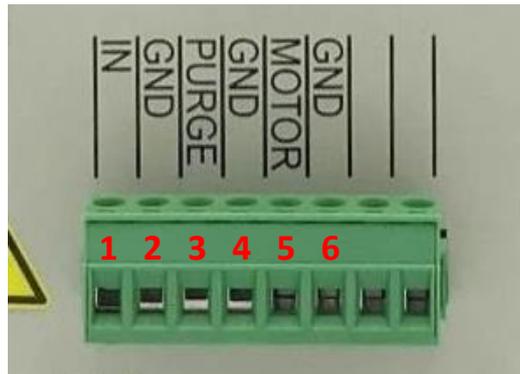


Fig. 3-6-2 Remote Terminal

Table 3-6-1 Description of each terminal on the remote terminal block

No.	Name	Function
1	IN	When the ROTATION switch on the front panel is set to REMOTE. Rotational speed control (controlled from 100 to 8,000 rpm with input voltage 100 to 8,000 mV (DC))*
2	GND	Analog ground, connected in conjunction with IN
3	PURGE	When the PURGE switch on the front panel is set to REMOTE Gas purge control (TTL, active low level)
4	GND	Ground, connected in conjunction with PURGE
5	MOTOR	When the ROTATION switch on the front panel is set to LOCAL Motor rotation ON/OFF control (TTL, active high level)**
6	GND	Ground, connected in conjunction with MOTOR
7		None
8		None

*For details, please refer to "3-8. Connection with potentiostat".

**If No.5 and No.6 are shorted during rotation, the motor will stop.

	<p>CAUTION: If you connect a TTL signal to IN, it will run out of control at about 5000 rpm, so be careful not to make a mistake in connection.</p>
--	--

3-7 Power Cord Connection

Put the power cord into the port located in the back-panel (**Fig. 3-7-1**). Then, power switch ON (position "I") or power switch OFF (position "O").

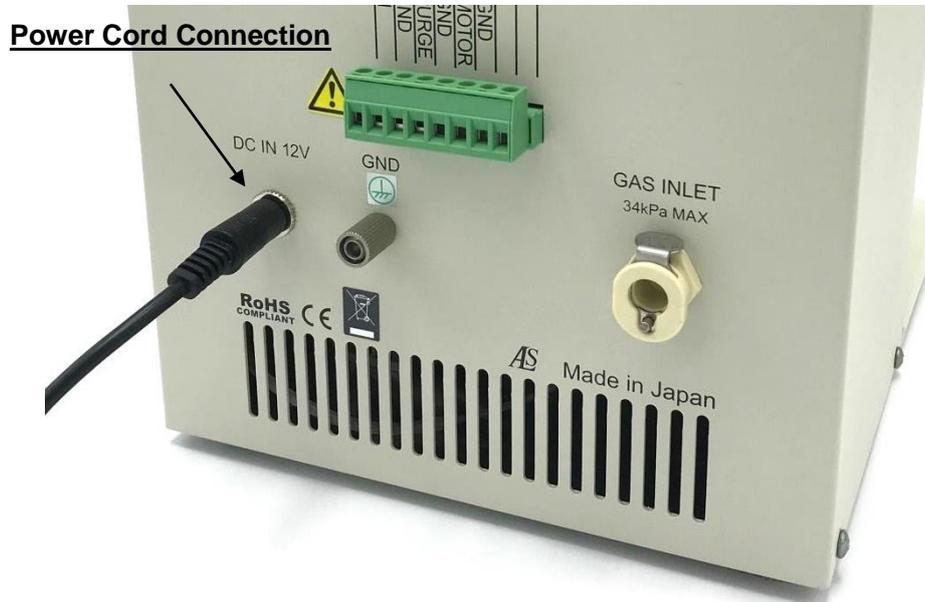


Fig. 3-7-1 Power Cord Connection

3-8 Making Connections

3-8-1 Model 3325

Here we are connecting Model 3325 Bi-Potentiostat. For detail about other potentiostat connections, see Appendix "A-7 Connecting other potentiostat".

Remote connection

Electrode rotation speed and **purge** can be remotely controlled from the potentiostat. By connecting a remote cable to RRDE-3A and setting the control switch to REMOTE, the potentiostat functions as a remote controller.

Cell Control terminal for Model 3325 is connected with the remote terminal of **RRDE-3A** via an optional remote cable (013818 CB-VS remote cable(15pin)) (**Fig. 3-8-1-1**).

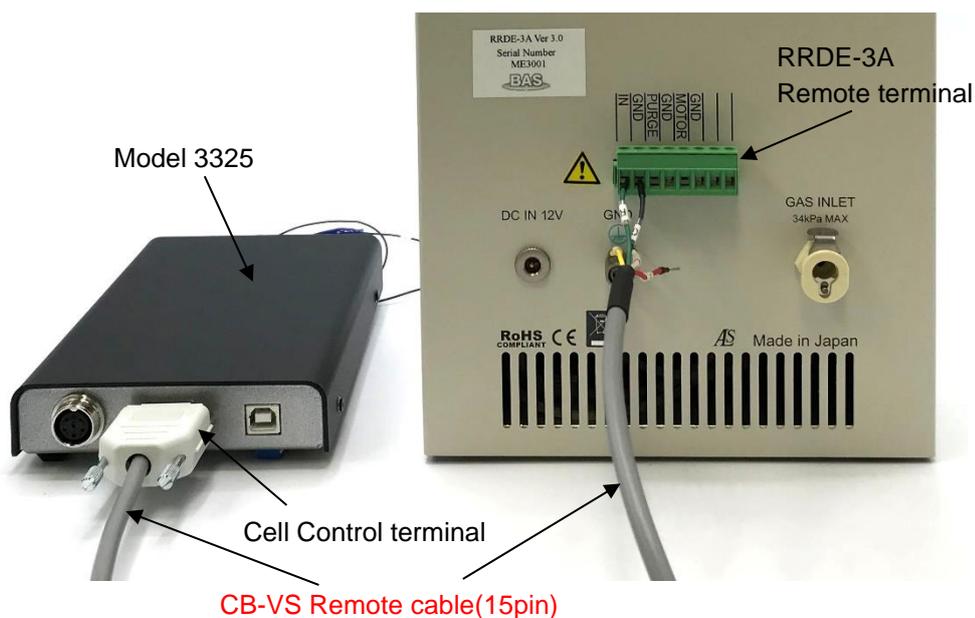


Fig. 3-8-1-1 Connection between RRDE-3A and Model 3325

Firmly insert the remote cable (013818) into the Cell Control terminal of Model 3325 and secure it with thumbscrews. Check the pin labels on the wire, For **Rotation speed control**, connect R (Pin#4, RDE), G (Pin#5, Ground) with the remote terminal IN, GND (next to IN) of RRDE-3A respectively (**Figure 3-8-1-2 left**).

If you also want to control the gas **purge**, connect P (Pin#13, Purge) to PURGE and connect GND (next to IN) and GND (next to the right of PURGE) with a jumper (**Figure 3-8-1-2 right**).

*Jumper needs to be prepared separately.

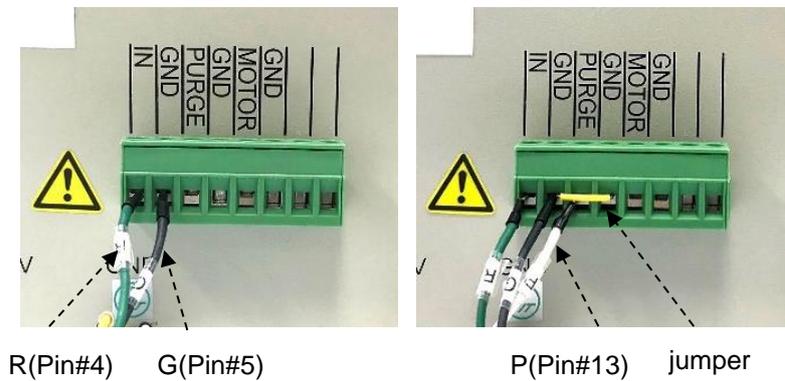


Fig. 3-8-1-2 Interface cable pinout.

Table 3-8-1 In case of coupling RRDE-3A with Model 3325 Bi-Potentiostat:

CB-VS Remote cable(15pin) (013818)			RRDE-3A Remote terminal
Label	Pin #	Function	
R	4	RDE	IN
G	5	Ground	GND (Right next to IN)
P	13	Purge	PURGE
G (jumper*)	5	Ground	GND (Right next to PURGE)

*Connect with Pin5 using jumper

Model 3325 Cell Control port outputs a voltage of 0 - 10 V corresponding to 0 - 10,000 rpm. The rotation speed of the RRDE-3A electrode can be controlled from 100 - 8,000 rpm with 100 - 8,000 mV (DC).

The purge and pinch valve in the **RRDE-3A** is controlled by TTL level active low.

Electrode cables should be attached to the appropriate connector according to device's specifications.

	<p>WARNING: When performing remote control, be sure to use a dedicated cable and take measures against high-frequency noise. When not using remote control function, please do not connect anything to the remote terminal.</p>
--	--

3-8-2 Cell Connections

The **reference electrode** and **counter electrode** lead wires extend from the potentiostats. The connectors are press-on type. Simply push the connector over the corresponding pin in the electrode to make the connection (**Fig. 3-8-2-1**). Alligator clips are color coded to the electrode it attaches.

The **ring electrode** and the **disk electrode** connector are located under the motor shaft assembly.

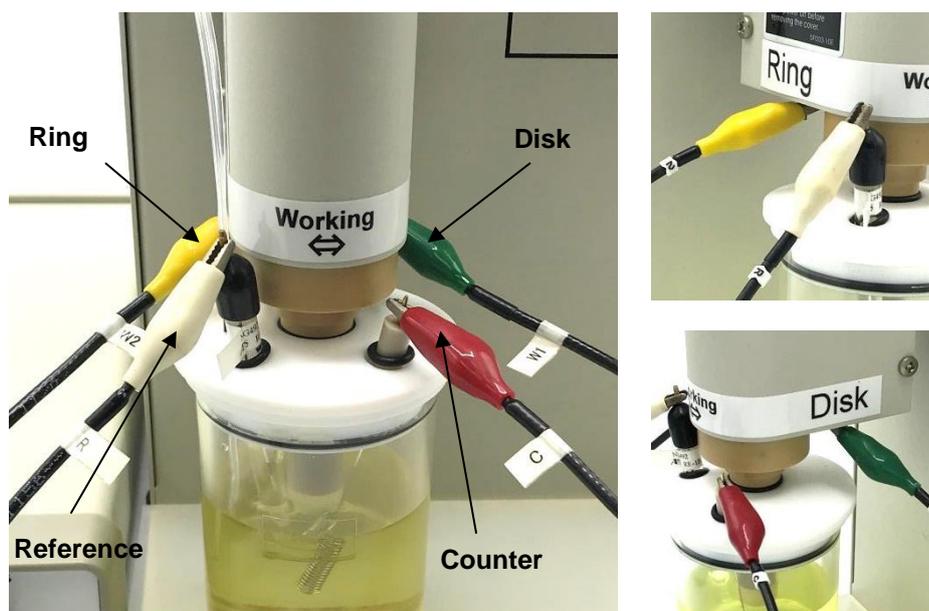


Fig. 3-8-2-1 Electrode lead connections

Table 3-8-2

Wire color	Electrode
Green	Disk
White	Reference
Red	Counter
Yellow	Ring

	<p>ROTATING SHAFT HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.</p>
	<p>CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.</p>
	<p>Tip: The working electrode surface should be polished adequately to obtain reproducibility in the measurement. For the polishing procedure, Appendix, A-6 PK-3 Electrode Polishing kit.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>
	<p>Note: The RRDE-3A motor unit height adjustment range has been limited, so that the shaft assembly side will not be immersed in the solvent unless the exclusive cell contains too much solvent.</p>

3-8-3 Gas Inlet Connection

The **RRDE-3A** includes 0.25" O.D. Tygon tubing and a gas line fitting. One end of the fitting is connected to the "GAS INLET" port on the rear panel of the **RRDE-3A**. To attach the line, simply push the connector (**Fig. 3-8-3-1**). The open end of the Tygon tube is connected to a regulated gas supply. The inlet gas pressure must not exceed 34 kPa (5 psi).

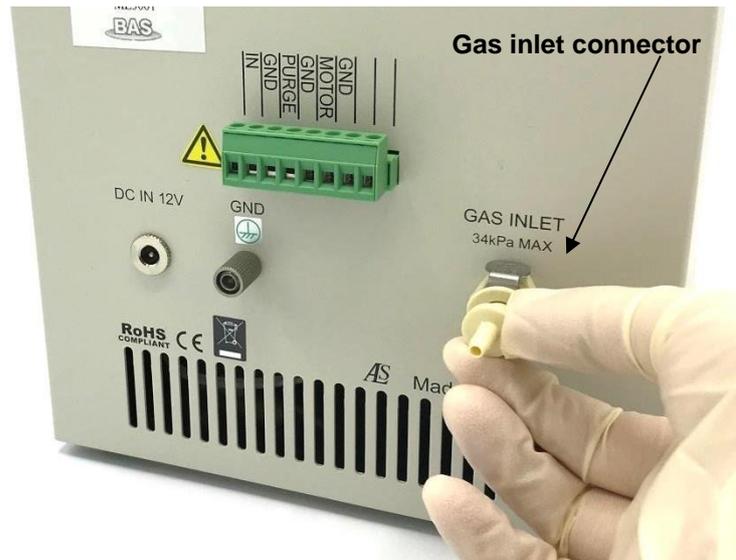


Fig. 3-8-3-1 Gas Line Connection to RRDE-3A

To remove the tube from **RRDE-3A**, squeeze the retaining ring tab against the connector and then pull the tube and connector away from **RRDE-3A**.



WARNING:

When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful to do not over pressure.

3-9 Placement

The RRDE-3A is designed for easy cell replacement and to accommodate regular cells. Follow these instructions for initial cell placement:



Fig. 3-9-1 Cell vial placed on the silicon plate.



Fig. 3-9-2 Teflon cap set on the cell vial



Fig. 3-9-3 Reference electrode, counter electrode and purge tubes are fixed at the Teflon cap.



Fig. 3-9-4 Six holes are located on the Teflon cap. These holes are for the reference, counter and working electrodes and purge tubes. Place the electrodes in the most convenient way. The last hole is for the gas outlet.

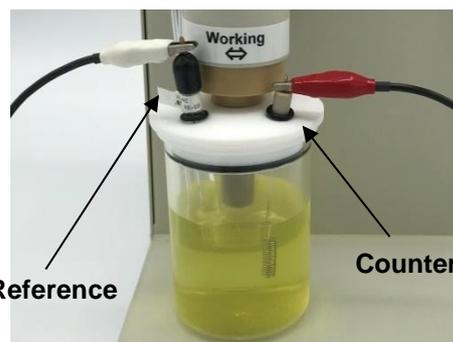


Fig. 3-9-5 Adjust the desired position of the reference and counter electrodes by moving O-ring.

	<p>WARNING: Place on a stable bench free of vibrations.</p>
	<p>WARNING: Be carefully setting the shaft assembly to the Teflon cap. Do not release the shaft assembly motor unit without tighten the screw in the motor side.</p>

	<p>WARNING: When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful to do not over pressure.</p>
	<p>WARNING: When performing gas purge, please do not seal the electrolytic cell completely. There is a possibility that the cell may burst due to an increase in internal pressure.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.</p>
	<p>CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.</p>
	<p>Tip: The working electrode surface should be polished adequately to obtain reproducibility in the measurement. For the polishing procedure, Appendix, A-6 PK-3 Electrode Polishing kit.</p>
	<p>Tip: When a dirty shaft assembly is used, the resistance value of the shaft assembly rise, and measurements were not successful.</p>
	<p>Tip: When used in an environment with low humidity such as in a glove box, abrasion rate of the inner silver carbon brush rises. For the replacement procedure, Chapter 6. Maintenance, Section 6-6 Replacement of Silver carbon brushes.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>
	<p>Note: The RRDE-3A motor unit height adjustment range has been limited, so that the shaft assembly side will not be immersed in the solvent unless the exclusive cell contains too much solvent.</p>

3-10 Purge Lines

The RRDE-3A has the ability to purge the sample solution with an inert gas. The purge removes oxygen by bubbling with an inert gas, typically nitrogen or argon through the solution.

The purge consists of two Teflon tubes (OD 1/16 inch) going into the cell through the Teflon cap (**Fig. 3-10-1**).

The tube with the black cover should be above the sample surface and the other one should be immersed into the sample solution.

An O-ring is installed to prevent the Teflon tubes from falling into the housing. You can adjust the tube length by moving the O-ring.

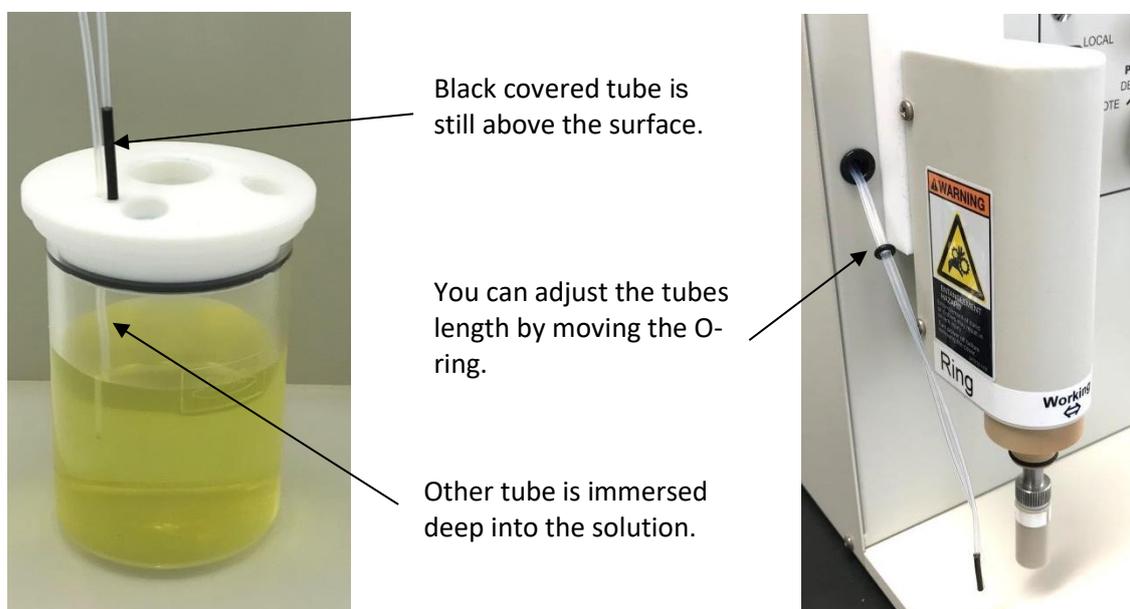


Fig. 3-10-1 Purge tubing setting.

	<p>WARNING: When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful not to over pressure.</p>
	<p>WARNING: When performing gas purge, please do not seal the electrolytic cell completely. There is a possibility that the cell may burst due to an increase in internal pressure.</p>

Chapter 4. Instrument Description

4-1 Display of LCD display

After power up, the LCD display will show the following information.

4-1-1 Initial display

When the power is turned on, the model's name and device version of the motor are displayed on the LCD display for 5 seconds. It will shift to a state that can be measured after this.



```
BAS Inc.  
RRDE-3A Ver3.00
```

Fig. 4-1-1-1 Initial display

If the rotation control switch and gas purge switch are not in the correct position (SET), an error will be displayed. Returning to SET will move to the setting screen after the initial display.



```
SW Position err!
```

Fig. 4-1-1-2 Switch position error display

4-1-2 Normal setting screen

When the rotary switch and gas purge switch are in the "SET" state, the set values of the rotation speed and purge time are displayed. By operating each encoder in this state, the set value can be changed. Each set value is saved even when the power of RRDE-3A is turned off.



```
Rotate 1000 rpm  
Purge 10 sec
```

Fig. 4-1-2-1 Setting display

It can be set in 10 rpm (sec) increments. The rotation speed can be switched to 1 rpm increments from the maintenance mode. For the procedure, refer to "6-2 Maintenance mode".

When the rotary switch is in the "LOCAL" or "REMOTE" state, the actual number of revolutions of the motor shaft assembly is displayed.



```
Rotate 1000 rpm  
Purge 10 sec
```

Fig. 4-1-2-2 Rotation operation display

When gas purge is started, the purge time countdown begins. When the purge time reaches 0 sec, the gas purging to the solution is stopped.

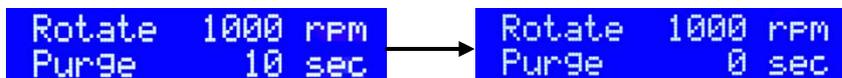


Fig. 4-1-2-3 Gas purge display

4-1-3 Error display

If a load is applied while the motor shaft assembly is rotating and the rotation speed becomes less than 10% of the set value for 3 seconds, the **RRDE-3A** automatically stops the rotation and an error is displayed on the LCD display. To cancel the error, turn the rotary switch back to "SET" once. This also applies to remote operation.



Fig. 4-1-3-1 Motor error display

※ If error display is not canceled even if returning the rotary switch to "SET", please contact sales@als-japan.com

4-1-4 Warning display

(1) 200H Shaft assembly cleaning warning

When the cumulative operating time of the motor exceeds 200 H, a warning message of cleaning the shaft assembly is displayed at the initial display. Refer to "6-6 Replacement of Silver carbon brushes" and clean the motor shaft assembly and the silver carbon brush. "Time" shows the cumulative time since last silver carbon brush cleaning or shaft assembly cleaning.



Fig. 4-1-4-1 "Cleanup shaft!" warning display

After clearing the warning display, the warning will be displayed again after 200 hours of use. When the motor shaft is rotating, the normal and warning indications are displayed alternately, and the rotating LED lamp blinks.

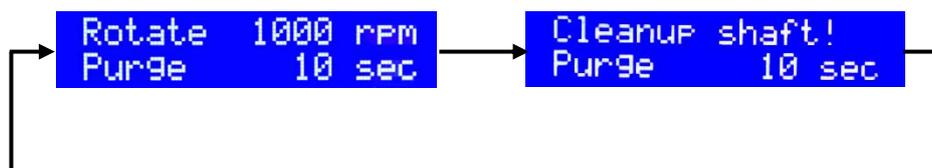


Fig. 4-1-4-2 When rotating, normal and warning display displayed alternately.

(2) 1000H Silver carbon brushes replace warning

When the cumulative operating time of the motor exceeds 1000 hours, a warning message of silver carbon brush exchange is displayed at initial display. Refer to "6-6 Replacement of Silver carbon brushes" and replace the silver carbon brush.

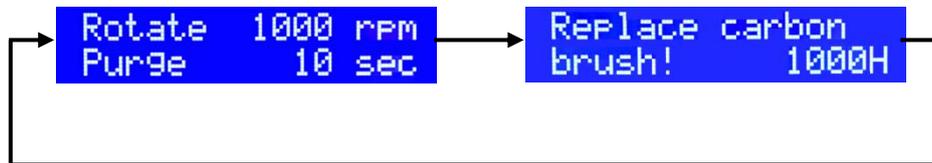


Fig. 4-1-4-3

(3) When both silver carbon brush cleaning warning and silver carbon brush change warning occur

The silver carbon brush exchange warning display has priority.

4-1-5 Clear warning display

After cleaning or replacing the brush, clear the warning display in maintenance mode. Please refer to "6-2 Maintenance mode".

※ When silver carbon brush replacement warning is canceled, silver carbon brush cleaning warning is canceled at the same time. Please also clean the shaft assembly as soon as you replace the silver carbon brush.



CAUTION:
Avoid strong impact to LCD display. The LCD may be damaged.

4-2 Release the working electrode from Motor shaft assembly

Power OFF **RRDE-3A** device. Then after removing all cables from electrode (reference, counter, ring and disk electrode), turn counterclockwise the motor shaft assembly.

While holding the shaft, tighten the working electrode onto the threaded part of the shaft. Tighten slowly and vertically, taking care not to tighten it diagonally. Tighten the electrode until it lightly touches the Teflon O-ring, so that the electrode and contact probe are in contact. Over tightening the electrodes may cause eccentricity or damage. Tightening the electrodes down to the O-ring, guarantees the conductivity between the shaft, contact probe and electrodes.

To remove the electrodes, reverse the procedure.

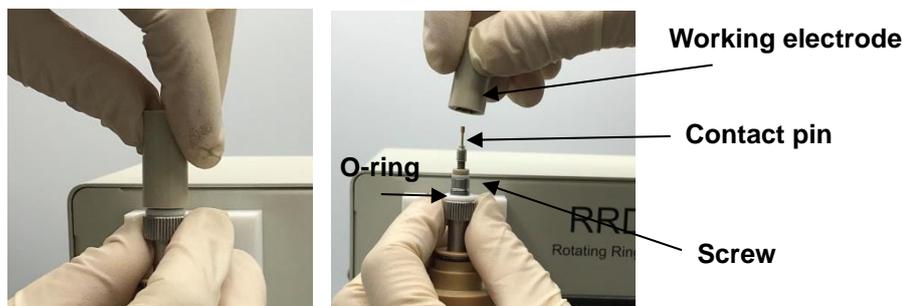


Fig. 4-2-1 Motor shaft assembly is turned counterclockwise slowly, and working electrode is unscrewed carefully.

	<p>CAUTION: Do not loosen the knob to move the motor/shaft assembly unit up and down without holding with hand.</p>
	<p>CAUTION: Do not fasten the working electrode too tightly for time of attachment and use by your hand not by tools for time of detachment.</p>
	<p>CAUTION: Do not set or remove the working electrode from the shaft assembly without tighten the knob in the motor side.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Turn off the power switch when the working electrode is setting to the shaft assembly or lowering the motor unit for setting into the cell.</p>

	<p>ROTATING SHAFT ASSEMBLY HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.</p>
	<p>Tip: The working electrode surface should be polished adequately to obtain reproducibility in the measurement. For the polishing procedure, Appendix, A-6 PK-3 Electrode Polishing kit.</p>
	<p>Tip: When a dirty shaft assembly is used, the resistance value of the shaft assembly rise, and measurements were not successful. For the maintenance procedure, Chapter 6. Maintenance, Section 6-7 Replacement of Shaft Assembly.</p>
	<p>Tip: When used in an environment with low humidity such as in a glove box, abrasion rate of the inner silver carbon brush rises. For the replacement procedure, Chapter 6. Maintenance, Section 6-6 Replacement of Silver carbon brushes.</p>
	<p>Note: For the design of the instrument, which the working electrode rotated in the tightening direction, the working electrode does not come off even if the electrode is attached somewhat loosely.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>
	<p>Note: The RRDE-3A motor unit height adjustment range has been limited, so that the shaft side will not be immersed in the solvent unless the exclusive cell contains too much solvent.</p>

Chapter 5. Operation

	<p>WARNING: Please use Protective eyeglasses to protect yourself from chemicals under experiment.</p> 
---	---

5-1 Remote Control

The remote connectors of the **RRDE-3A** allow controlling rotation and gas purge functions by an external unit. The **RRDE-3A** is specifically designed to be controlled by the appropriate commands from potentiostats as Model **3325** or **CHI Electrochemical Analyzer**.

When it is not in use, please make sure power is turned out.

The electrode rotation speed is set by an analog signal. The gas and pinch valve function are activated by turning a TTL signal to ON/OFF and operates on active low.

When the rotation control switch on the front panel is set to LOCAL, the motor rotation ON/OFF function (MOTOR) rotates the electrode at the rotation speed set by manual control, and rotates or stops depending on the ON/OFF of the TTL signal. Works with active high. The remote terminal MOTOR does not control the rotational speed, so there is usually no need to connect it for anything other than motor ON/OFF control, and currently for emergency stop.

	<p>WARNING: By design, the remote-control function is excluded from EU directive (EMC) compliance. When performing remote control, be sure to use a dedicated cable and take measures against high-frequency noise. When not using the remote-control function, please do not connect anything to the remote terminal.</p>
---	---

5-2 Gas Purge

The LED is ON when the purge function is ON, either manually or remotely.

When the purge switch is set to "LOCAL", the purge function operates. During operation, the purge LED is ON and purges inert gas through the Teflon tube into the solution. The purge flow rate knob allows you to control the purge speed.

When the set purge time finished, the purge LED turned OFF and the internal valve system switches. Purge in solution stops, and inert gas is supplied to the sample surface from a Teflon tube with a black cover. This prevents the outflow of inert gas from the solution and the flow of outside air into the electrolytic cell.

To control purge remotely, the remote cable should be connected to PURGE terminal on the back panel of the **RRDE-3A** and set the purge switch to REMOTE. Please refer to "3-8 Making Connections" for the connection procedure. Time of purging can be controlled manually or via "immediate purge/rotate" option under the control menu of the potentiostat operating software.

	<p>WARNING: When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful not to over pressure.</p>
	<p>WARNING: When performing gas purge, please do not seal the electrolytic cell completely. As the internal pressure increases, the cell may rupture.</p>
	<p>WARNING: When performing remote control, be sure to use an appropriate cable and take measures against high-frequency noise. When not using the remote-control function, please do not connect anything to the remote terminal.</p>

5-3 General Instructions

Turn off the power switch on the front panel and connect the AC adapter and power cable to the back panel. Be sure to connect to a grounded outlet.

Make sure that the working electrode is fixed to the shaft, and then turn on the power switch.

Set the rotation speed to 1000 rpm and start the rotation with the rotation control switch in LOCAL. Do not touch the shaft during rotation. Observe that the shaft and electrode are rotating perpendicular to each other during rotation.

Rotation is stopped by returning the rotation control switch to SET.

Before the actual measurement, the measuring solution should be purged using the gas purge control function. It is effective to purge for 15 minutes with an inert gas of 34 kPa or less.

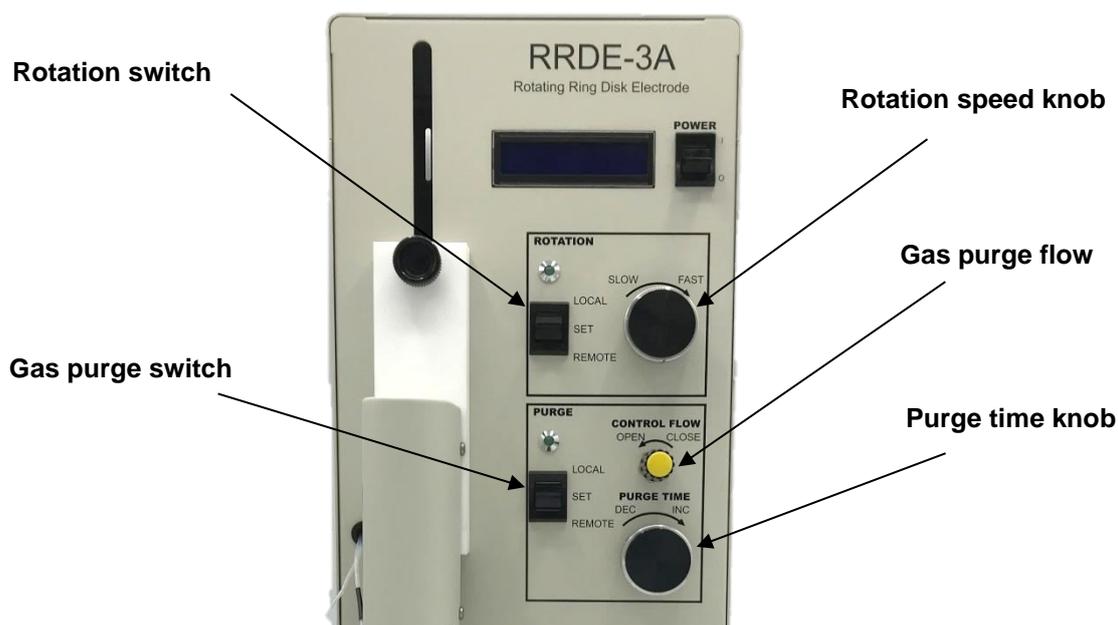


Fig. 5-3-1 Front control panel

	<p>WARNING: When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful not to over pressure.</p>
	<p>Note: The power cable is designed not to be charged immediately by cable connection alone. Also, double protection grounding is applied to where power supply voltage is applied.</p>
	<p>Note: If overload is applied to rotating shaft or working electrode, rotation stops automatically.</p>

5-4 Initial Instrument Operation

1. Push front panel power switch to OFF ("O").
2. Remove the electrode by unscrewing it.
3. Polish the electrode by following the instructions in the Polishing Kit. See Appendix **A-6 PK-3 Electrode Polishing kit**.
4. Replace the electrode. Note that a slight upward pressure may be applied to the electrode body to start the threads. When the electrode is replaced with another working electrode, the power switch should be "OFF".
5. Place a test solution in the cell vial. A common test solution is 2 mM potassium ferricyanide in 1 M KNO_3 .
6. Push front panel power switch to ON ("I").
7. Place the reference and counter electrodes inside two holes of the Teflon cap and attach the cell leads. Start purging the solution with inert gas as described previously.
8. Loosen the position setting knob to lower the motor shaft assembly and immerse the working electrode in the solution. While turning the rotary switch at "LOCAL" and rotating it at 1000 rpm or more, immerse it in the solution so that bubbles do not adhere to the electrode surface by centrifugal force.
9. Insert the purge tube into the electrolytic cell and purge the inert gas into the solution.
10. For manual control, set the rotary switch to "LOCAL" and for remote control to "REMOTE".
11. The equipment preparation is completed. Start measurement from the software screen. In the case of remote control, the working electrode rotates according to software setting items.
12. After the experimental run, the motor shaft assembly can be raised and electrodes can be rinsed or polished as needed. The system is then ready for the next experiment.

Notice

1. The range of rotation speed of RRDE-3A is from 100 to 8,000 rpm.
2. For the REMOTE speed control, please use a Model 3325 electrochemical analyzer.
3. Please use an inert gas and avoid the usage of flammable gas, like hydrogen gas. It could cause a risk of gas leakage.
4. During rotation sometimes the motor may be noisy due to the rotation speed, but there is no influence to the measurement.

	<p>CAUTION: When lifting or lowering the motor shaft assembly, do not loosen the position setting knob without holding the motor shaft assembly.</p>
	<p>CAUTION: Do not over tighten the screw when connecting the working electrode to the motor shaft assembly. Also, please do not use tools when detaching, please do by hand.</p>
	<p>CAUTION: Be sure to tighten the position setting knob of the motor shaft assembly when attaching/removing the working electrode of the motor shaft assembly.</p>
	<p>WARNING: When performing gas purge, use inert gas and avoid using flammable gas like hydrogen gas. Also, be careful not to over pressure.</p>
	<p>WARNING: RRDE-3A is a non-explosion-proof device. Be sure to use it in non-explosion-proof area.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Turn off the power switch when the working electrode is setting to the shaft assembly or lowering the motor unit for setting into the cell.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: Do not touch the rotating electrodes. It may cause injury or equipment damage.</p>
	<p>TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.</p>

	<p>CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.</p>
	<p>Tip: The working electrode surface should be polished adequately to obtain reproducibility in the measurement. For the polishing procedure, Appendix, A-6 PK-3 Electrode Polishing kit.</p>
	<p>Tip: Please perform electrochemical measurement after the rotation number (RPM) of LCD display becomes constant.</p>
	<p>Tip: By using at a rotation speed of 3,000 rpm or less, life of the motor and silver carbon brush will be prolonged.</p>
	<p>Tip: In the case of low-speed rotation, it may take several minutes for rotation to stabilize depending on room temperature. Warm up RRDE-3A before measurement.</p>
	<p>Note: When an overload is applied to the shaft or electrode the rotation stops automatically.</p>
	<p>Note: For the design of the instrument, which the working electrode rotated in the tightening direction, the working electrode does not come off even if the electrode is attached somewhat loosely.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>
	<p>Note: When performing measurement in the high-speed range, swirling occurs around the electrode axis, and oxygen in the air dissolves, which may be a source of noise.</p>
	<p>Note: There is a possibility that noise may be generated by the rotation speed of the motor, but it does not affect the measurement result.</p>
	<p>Note: The up-down movement of the RRDE-3A motor shaft assembly unit is limited. There is no worry that you will accidentally immerse into the solution, unless you put the too much solution in the electrolytic cell.</p>

5-5 Typical test parameters

Working Electrode:	RRDE (Platinum ring and platinum disk)
Reference Electrode:	Ag/AgCl
Counter Electrode:	Platinum wire
Test Solution:	2 mM Potassium ferricyanide/1 M KNO ₃
Initial E:	+600 mV
Final E:	-100 mV
Scan Rate (V):	0.01 V/S
Rotation Rate:	100 to 5,000 rpm
Sensitivity:	10 ⁻⁴ A/V

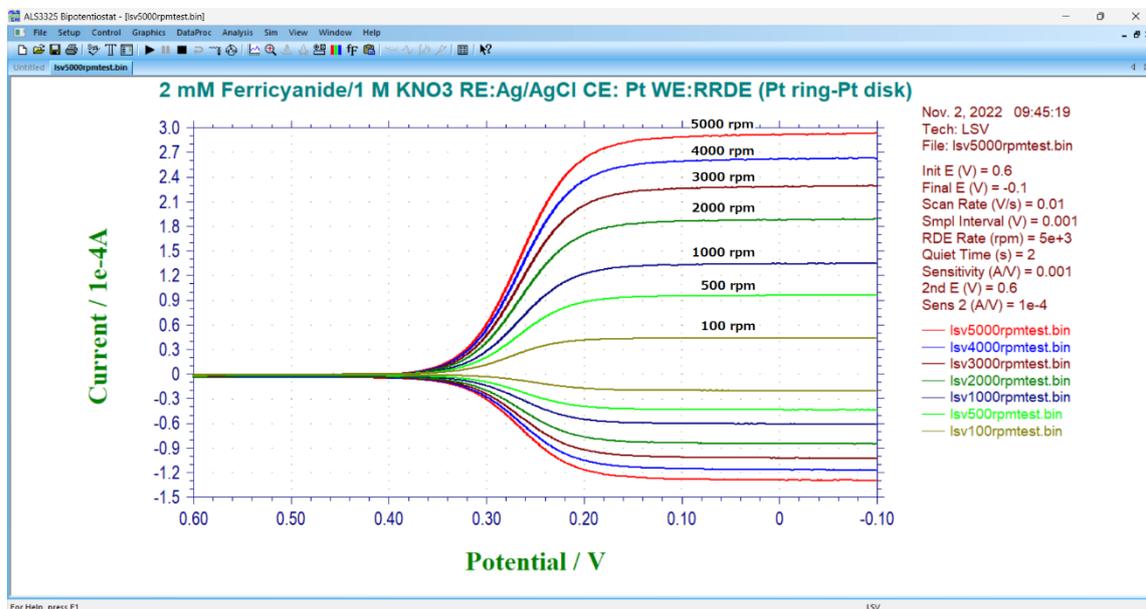


Fig. 5-5-1 Example of test results

5-6 Spin coating

In case of polymer is coated onto the electrode, please use the following way as reference. **RRDE-3A** motor shaft assembly is taken away from Teflon cap. Its motor housing is rotated at 180 degree (**Fig. 5-6-1**). Its contact pin is positioned at top, and RDE or RRDE electrode is assembled with motor shaft assembly unit. The acrylic cover is mounted at the top of motor housing. After power is ON, and rotation speed is fixed at proper speed, then a droplet of polymer is dropped on the electrode surface. You can get chemically modified electrode by spin coating. Its membrane thickness depends on rotation speed, sample viscosity, applied volume and working temperature.



Fig. 5-6-1 Fasten the knob of RRDE-3A, and Teflon plate moves up.



Fig. 5-6-2 Fixe the Teflon plate at the top position.



Fig. 5-6-3 Rotate at 180 degree the motor housing



Fig. 5-6-4 Now the contact pin is positioned at the top. Pin is sharp, handle with care. RDE or RRDE electrode is mounted here.



Fig. 5-6-5 Acrylic spin coating cover, to be mounted on the top of the motor housing.



Fig. 5-6-6 It's ready for spin coating experiment. A sample you want to coat is dropped on RDE or RRDE. The motor is rotated for a few minutes, then the chemically modified electrode with a constant membrane thickness is available.

	CAUTION: Do not loosen the knob to move the motor/shaft assembly unit up and down without holding with hand.
	CAUTION: Do not fasten the working electrode too tightly for time of attachment and use by your hand not by tools for time of detachment.
	CAUTION: Do not set or remove the working electrode from the shaft assembly without tighten the knob in the motor side.
	ROTATING SHAFT ASSEMBLY HAZARD: Turn off the power switch when the working electrode is setting.
	ROTATING SHAFT ASSEMBLY HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.
	ROTATING SHAFT HAZARD: Do not touch the rotating electrodes. It may cause injury or equipment damage.
	CORROSIVE SUBSTANCES: The spin coating adapter, which prevents the solution scattering, must be used for the spin coating of the working electrode.
	TEMPERATURE CONSTRAINT: The RRDE-3A can be used only in the temperature range between 10 to 50 degrees centigrade.
	CHEMICAL INCOMPATIBILITY: WARNING Do not recommend to use the working electrode in a strong acid and basic solution, and after measurement must be removed from the solution and stored in dry. Also, follow the specified volume of the solution and immersion depth of the electrode.
	Tip: The working electrode surface should be polished adequately to obtain reproducibility in the measurement. For the polishing procedure, Appendix, A-6 PK-3 Electrode Polishing kit.
	Note: When an overload is applied to the shaft assembly or electrode the rotation stops automatically.
	Note: For the design of the instrument, which the working electrode rotated in the tightening direction, the working electrode does not come off even if the electrode is attached somewhat loosely.
	Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.

Chapter 6. Maintenance

6-1 General Maintenance

Proper maintenance of the **RRDE-3A** will maintain the performance of the equipment for a long period of time.

Consider the following precautions to prolong the life of your equipment. When turn on the power, do not touch the **RRDE-3A** shaft assembly.

1. Follow customary, good laboratory practices.
2. Clean all spills, especially salt solutions, on or near the cabinet immediately.
3. Avoid placing the unit in a corrosive atmosphere.
4. Avoid dropping, shaking, or other forms of mechanical abuse to prevent loosening of components or subassemblies.
5. Clean gas lines (rinse and wipe dry) after use.
6. Do not bend the auxiliary electrode when removing or placing the cell vial. Repeated bending will cause break of the wire.

6-2 Maintenance mode

6-2-1 How to activate maintenance mode

After turning on the power, while the model name is shown on the LCD display, operate the rotation control switch as follows.

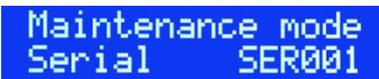
SET→LOCAL→SET→LOCAL→SET→REMOTE→SET



```
BAS Inc.
RRDE-3A Ver3.00
```

Fig. 6-2-1-1 Initial display

After the operation, the maintenance mode is activated. The maintenance mode is displayed and the serial number of the device is shown.



```
Maintenance mode
Serial SER001
```

Fig. 6-2-1-2 Maintenance mode

When you finish the maintenance mode, turn off the power and then turn on again.

6-2-2 Maintenance mode menu

The switch the menu can be by turning the rotation speed setting knob.

The maintenance mode menu is as follows.

1. Change the rotation speed setting



```
1:RPM step set
```

Fig. 6-2-2-1 1:Rpm step set

2. Total rotation time & next warning time display



```
2:Total 9H
Remain 190H
```

Fig. 6-2-2-2 2:Total time

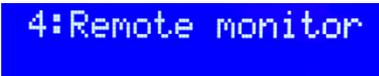
3. Clear warning display



```
3:Warning clear
Non warning
```

Fig. 6-2-2-3 3:Warning clear

4. Remote voltage confirmation display



4:Remote monitor

Fig. 6-2-2-4 4:Remote monitor

6-2-3 Change of rotation speed setting unit

It is possible to change the setting unit of the rotation speed.

Set the menu to [1. Rpm step set] and set the rotation control switch to LOCAL to shift to the mode.



1:RPM step set

Fig. 6-2-3-1 1:Rpm step set

The rotation speed knob switches the setting unit between [1 rpm] and [10 rpm].



Fig. 6-2-3-2 Step 1rpm, Step 10rpm

If you return the rotation control switch to SET while adjusting to the unit you want to set, [Set OK] will be displayed with the buzzer and the settings will be saved.



1:RPM step set
Set OK

Fig. 6-2-3-3 Set OK

6-2-4 Total rotation time & next warning time display

The total rotation time is shown at the top and the time remain until the next warning (brush cleaning or replacement) at the bottom.



2:Total 9H
Remain 190H

Fig. 6-2-4-1 2:Total rotation time and remain time for next warning

6-2-5 Clear warning display

Set the menu to [3:Warning clear], set the rotation control switch to LOCAL, and shift to the mode.



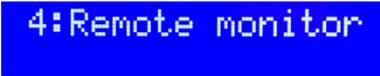
```
3:Warning clear
Non warning
```

Fig. 6-2-5-1 3:Warning clear

Use the rotation speed setting knob to switch between Yes / No. If you return the rotation control switch to SET with Yes displayed, the brush cleaning and brush replacement warning display will be cleared.

6-2-6 Remote voltage confirmation display

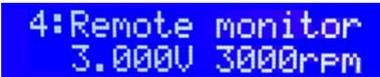
Set the menu to [4:Remote monitor] and set the rotation control switch to LOCAL to shift to the mode.



```
4:Remote monitor
```

Fig. 6-2-6-1 4:Remote monitor

By connecting the remote terminal on the back panel of the RRDE-3A to the potentiostat, the actual voltage input from the potentiostat can be checked.



```
4:Remote monitor
3.000V 3000rpm
```

Fig. 6-2-6-2 Remote monitor

For the connection method, refer to "3-8 Making Connections".

6-3 Re-polishing Electrodes

1. Carefully remove the electrode as outlined above.
2. Polish the electrode according to instructions using **PK-3 Polishing Kit**. See Appendix A-6 PK-3 Electrode Polishing kit.

The objective of polishing the electrode is to remove the products of the redox reaction or physical adsorption which accumulate during some experiments.

The rate of electrode coating (and corresponding decrease in responsiveness) will depend upon the following factors:

- Chemical species of analyte molecule
- Concentration of the analyte molecule
- Composition of stationary phase
- Applied potential
- Frequency of use

Electrodes used in electrochemistry may need repolishing after each experiment, depending on the application. Rotating ring disk electrode and hydrodynamic modulation applications have the advantage of a moving solution which helps to remove redox products and often deals with lower concentrations of analyte than are typically seen with voltammetry methods and often deals with lower concentrations of analyte than those in voltammetry methods with non-stirred solutions. The need for polishing varies greatly with the application.

Polishing is justified when a gradual decrease in electrode response is observed.

Electrodes can also accumulate contaminants by adsorption from the environment. The environment such as cigarette smoke, aerosols, and other airborne materials can be adsorbed quite easily.

The polishing process should remove a negligible amount of electrochemically active materials. To refresh the electrode, three different abrasive polish systems are used, progressing from coarse particle sizes to very fine polishing powders.

Most electrode surfaces need only a single polishing step to physically remove the contaminants. Besides, rare metal (gold, silver, and platinum) electrodes need to polish with either an alumina or a diamond. To determine whether the desired results are obtained, it is best to start with the diamond polishing. Then, chemically modified (gold/mercury amalgam) and glassy carbon electrodes tend

to require a two to three step series of abrasives in order to restore the original responsibility.

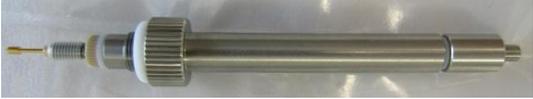
All polishing steps require extensive rinsing of the electrode before moving onto the next stage.

Without thorough rinsing, minute particulates from the previous polishing step will hinder the progression towards a finely polished surface. A major concern to polishing is that you do not corrode the softer electrode material below the level of the supporting plastic or glass. This can be avoided by always polishing the electrode on a very flat surface. Always follow the general precautions listed below when handling your working electrode:

6-4 Spare parts for RRDE-3A

Some spare parts are available for your daily maintenance of RRDE-3A.

Table 6-4

Parts No.	Spare Parts	photos
013229	Silver carbon brush for RRDE-3A (See also "6-6 Replacement of Silver carbon brushes".)	 Fig. 6-4-1
013643	RRDE-3A Shaft assembly Ver.2 (See also "6-7 Replacement of Shaft Assembly".)	 Fig. 6-4-2
013342	RRDE-3A Shaft contact probe repair kit (See also "6-8 Replacement of Shaft Contact Probe".)	 Fig. 6-4-3
013607	RRDE-3A High corrosion resistant bearing assembly (See also "6-9 Replacement of Bearing Assembly".)	 Fig. 6-4-4
013645	O-ring for RRDE-3A Shaft (white), 3 pcs (See also "6-5 O-ring replacement".)	 Fig. 6-4-5
012975	O-ring for RRDE-3A Bearing assembly (3 pcs) (See also "6-5 O-ring replacement".)	 Fig. 6-4-6
012641	O-ring for RRDE-3A Bearing assembly (10 pcs)	
013646	RRDE-3A Maintenance tool kit	 Fig. 6-4-7

6-5 O-ring replacement

Two kinds of O-ring are used at rotator shaft assembly (**Fig. 6-5-1**):

- One for **RRDE-3A bearing assembly (A)** is used to improve airtightness between Teflon cap and shaft assembly, so oxygen penetration from atmosphere is prevented.
- Other one for **RRDE-3A shaft assembly (B)** is used to protect from corrosion of electrical contact for RRDE electrode.

If **RRDE-3A** is used frequently, these O-rings should be replaced when some deformation or damage is found, and trouble with corrosion would be prevented.

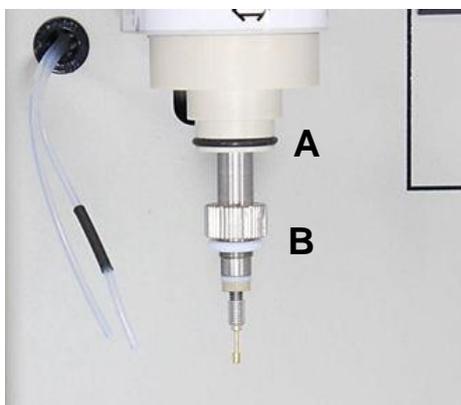


Fig. 6-5-1 O-ring

	<p>CAUTION: Do not loosen the knob to move the motor/shaft assembly unit up and down without holding with hand.</p>
	<p>ROTATING SHAFT HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>

6-6 Replacement of Silver carbon brushes

The electrical resistance between **silver carbon brushes** and the **shaft assembly** will increase over time. If you get noisy signal or that the current value is smaller than usual, please exchange the **silver carbon brushes** for new ones.



Fig. 6-6-1 Unscrew four metal screws, which are used for fastening the white motor assembly cover of RRDE-3A, with a screwdriver (#1 or #2).



Fig. 6-6-2 Remove the motor assembly cover.



Fig. 6-6-3 Unscrew two tiny screws connecting between the brush base and the bad **silver-carbon brush** unit with a screwdriver (#0).

Never lose tiny screws after the removal and keep them for the attachment of a new silver carbon brush.

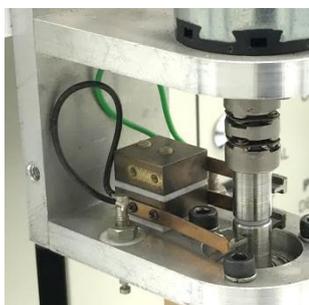


Fig. 6-6-4 Remove the old **silver carbon brush** unit and put the new one on the brush base.



Fig. 6-6-5 Fix the new **silver carbon brush** unit with tiny screws.



Fig. 6-6-6 Put the motor assembly cover and fix it.



If **shaft assembly** becomes dirty due to dust of **silver carbon brush**, please clean it by sing cotton swab.

When the motor shaft is rotating, do not stop it with your fingers. You may get injured. For safety, the internal poly switch operates and the rotation operation stops. By turning the power on again, it will return to the operable state again.

Fig. 6-6-7 Please rotate the rotator by 8000 rpm for 10 minutes for making the low resistance between silver carbon brushes and shaft assembly and for turning down the noisy sound during rotation.



The RRDE-3A should be used between 100 to 8,000 rpm. It is recommended to use the RRDE-3A at rotation speed below 3,000 rpm as much as possible due to unintended turbulence at high rotation speed.

The **silver carbon brush** is a disposable item; therefore, it is not covered for one year of the warranty. If its S/N ratio becomes worse, please replace with new one.

Fig. 6-6-8 Silver carbon brush for RRDE-3A

	<p>CAUTION: Do not release the silver carbon brush when loosen the screws.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: While replacing the shaft assembly, turn off the power supply and unplug the power cable. Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>Wait Time: When replaced to a new silver carbon brush, it is recommended to make running for several hours in operation, to avoid that the conduction get worse and affects the measurement.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>

6-7 Replacement of Shaft Assembly

If you find some problem on your **shaft assembly** such as **distortion**, badly dirty surface, or **corrosion**, you should exchange it for a new one.



Fig. 6-7-1 Unscrew four metal screws, which are used for fastening the white motor assembly cover of RRDE-3A, with a screwdriver (#1 or #2).



Fig. 6-7-2 Remove tiny screws connecting the four silver carbon brush with a screwdriver (#0).
Be careful not to lose tiny screws.



Fig. 6-7-3 Loosen two screws on the lower side of the coupling unit with hexagon wrench (0.89 mm = 0.035 inch), while holding the shaft assembly with another hand.
Please be careful not to loosen the upper screw by mistake as this will cause the coupling to move out of position.

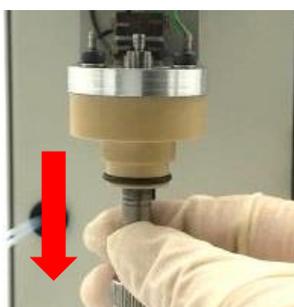


Fig. 6-7-4 Pull the **shaft assembly** gently.
If the shaft assembly is significantly damaged and hard to pull out, please remove it with the bearing assembly.



Fig. 6-7-5 Stick the new shaft assembly into the hole of the bearing assembly. Screw two set screws on the lower side of the flexible coupling unit with hexagon wrench (0.89mm = 0.035inch).



Fig. 6-7-6 Fix the four silver carbon brushes with tiny screws.

NOTE: Please be careful not to loosen the upper shaft fixing screws of the coupling unit, as shown in Figures 6-7-3 and 6-7-7, as this may cause the position of coupling unit to shift.

The gap between the coupling unit and the motor aluminum frame is 1 mm. If it is out of position, it needs to be adjusted. Please refer to "7-2 Reported problems. If the coupling unit is out of position" for adjustment procedure.

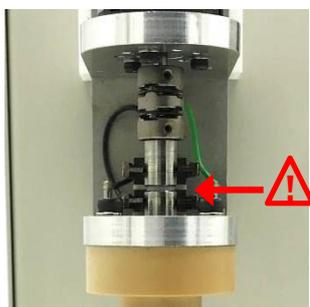


Fig. 6-7-7 Make sure the silver carbon brush is in the upper and lower positions of the Teflon separator.



Fig. 6-7-8 Enclose the **shaft assembly** with white motor assembly cover and then, fix it by four metal screws, with a screwdriver (#1 or #2).

	<p>CAUTION: Do not release the silver carbon brush when loosen the screws.</p>
	<p>CAUTION: Turn off the RRDE-3A power switch and unplug the power cable.</p>
	<p>ROTATING SHAFT ASSEMBLY HAZARD: While replacing the shaft assembly, turn off the power supply and unplug the power cable. Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>

6-8 Replacement of Shaft Contact Probe

There RRDE-3A **shaft contact probe** has a **contact probe** on the top and the tip of the **contact probe** sometimes gets rusty. If you can see some **corrosion** (Fig. 6-8-1, left) or **distortion** of the **contact probe**, you should change it.

The corrosion of the **contact probe** tip could cause problems for your experiments.

Please also see the information on the dimensions of the **contact probe** (Fig. 6-8-2)



Fig. 6-8-1 Corroded **contact probe** on the left

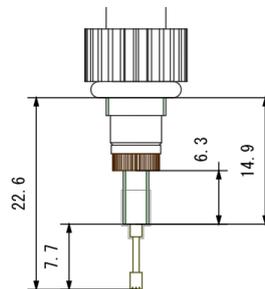


Fig. 6-8-2

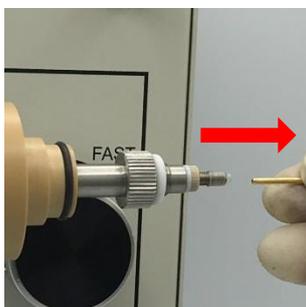


Fig. 6-8-3 Remove the old RRDE-3A shaft assembly **contact probe** by pulling it.



Fig. 6-8-4 Stick the new **contact probe** into the hole of the **shaft assembly**.

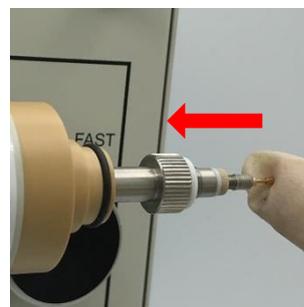


Fig. 6-8-5 Press the **contact probe** carefully.

If the heat shrink tubing is broken, you will not be able to attach a new contact probe. You need to replace the defective heat shrink tubing with a new one as follows:



CAUTION:
Turn off the RRDE-3A power switch and unplug the power cable.

If the **heat shrink tubing** is damaged during replacement or the probe cannot be held, please follow the steps below to replace the **heat shrink tubing**.



Fig. 6-8-6 After taking out the **contact probe** cut the **heat shrink tubing** with a knife.



Fig. 6-8-7 Remove the **heat shrink tubing** like peeling.



Fig. 6-8-8 Put a new **heat shrink tubing** on the tip of the **shaft assembly**.



Fig. 6-8-9 Heat shrink tubing to wrap the shaft with heat gun or a dryer (by 150 degrees Celsius).

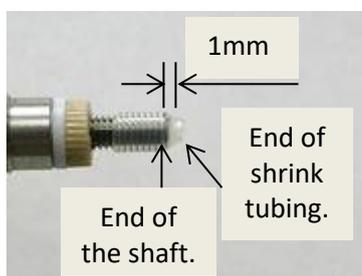


Fig. 6-8-10 Cut the **heat shrink tubing** with some knife at **1mm** far from the tip of the **shaft assembly**.



Fig. 6-8-11 Attach the **contact probe** again.



CAUTION:
Turn off the RRDE-3A power switch and unplug the power cable.

6-9 Replacement of Bearing Assembly

If you feel that the rotator does not work smoothly, it may be caused by the **rusty bearing assembly**. (See also "6-7 Replacement of Shaft Assembly")



Fig. 6-9-1 Unscrew four metal screws, which are used for fastening the white motor assembly cover of **RRDE-3A**, with a screwdriver (#1 or #2).



Fig. 6-9-2 Remove tiny screws connecting the four silver carbon brush with a screwdriver (#0). **Be careful not to lose tiny screws.**



Fig. 6-9-3 Loosen two screws on the lower side of the coupling unit with hexagon wrench (0.89 mm = 0.035 inch), while holding the shaft assembly with another hand. Pull out the shaft assembly gently. **If the shaft assembly is significantly damaged and hard to pull out, please remove it with the bearing assembly.**

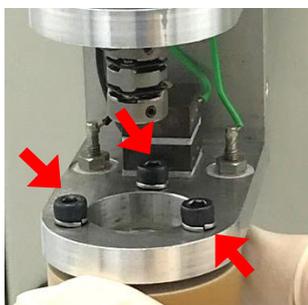


Fig. 6-9-4 Remove the **bearing assembly** by loosening three set screws connecting between the **aluminum frame** and the **bearing assembly** with hexagon wrench (2.5 mm).



Fig. 6-9-5 Rotate the motor housing at 180 degree and wipe the bottom of the **aluminum frame** with some swab or paper.

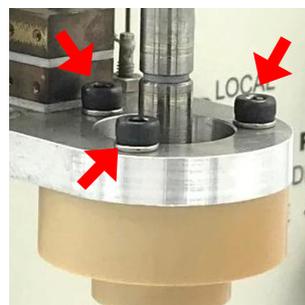


Fig. 6-9-6 Rotate the housing back to initial position and attach the new **bearing assembly** with hexagon wrench carefully. **Don't overtighten the screws of the bearing assembly as the screw threads are somewhat weak.**



Fig. 6-9-7 Stick the new shaft assembly into the hole of the bearing assembly. Screw two set screws on the lower side of the flexible coupling unit with hexagon wrench (0.89mm = 0.035inch).



Fig. 6-9-8 Fix the four silver carbon brush unit with tiny screws.



Fig. 6-9-9 Enclose the **shaft assembly** with white motor assembly cover and then, fix it by four metal screws, with a screwdriver (#1 or #2).

NOTE: Please be careful not to loosen the upper shaft fixing screws of the coupling unit, as shown in Figures 6-9-3 and 6-9-7, as this may cause the position of coupling unit to shift.

The gap between the coupling unit and the motor aluminum frame is 1 mm. If it is out of position, it needs to be adjusted. Please refer to "7-2 Reported problems. If the coupling unit is out of position" for adjustment procedure.

	<p>ROTATING SHAFT HAZARD: Do not rotate the shaft assembly with its axis offset, broken or damaged.</p>
	<p>CAUTION: Turn off the RRDE-3A power switch and unplug the power cable.</p>
	<p>Note: When the non-perpendicular axis, broken or damaged shaft assembly is rotated, it could be dropped out from the motor. Do the inspection and maintenance periodically.</p>

Chapter 7. Trouble shooting

7-1 General

Trouble	No	Cause	Solution	Note
a. Noisy Signal	a-1	Bad ground connection	Connect the RRDE-3A and the potentiostat to the same earth ground.	
	a-2	2 The volume of solution is too much or too few.	When you use "Sample vial (100 ml, Cat. #012632)", 65 ml \pm 5 ml is suggested to use for the measurement to avoid noise.	For minimizing the noise caused by turbulence, The electrode tip should be placed in around 5 mm depth into the solution.
	a-3	Electrode is attached to the shaft assembly in askew direction.	Remove the electrode from the shaft assembly, and connect it to the shaft assembly again.	
	a-4	Air bubble adsorbs on the electrode surface	Take out the electrode from the solution, rotate the electrode over 1000 rpm, and then dip the rotating electrode into the solution to eliminate air bubble with whirling flow.	Air bubble on electrode surface occurs easily after the gas purge. Air bubble is occurred during the electrochemical measurement sometimes.
	a-5	Air bubble on the reference electrode tip	Flip the reference electrode and move off the air bubble.	The alteration of the liquid temperature may cause the generation of air bubble.
	a-6	Dirty or uneven electrode surface	Polish the electrode. If some catalyst is loaded on the disk electrode, please reload the catalyst so that the catalyst layer is thin and flat.	
	a-7	Poor reference electrode.	Exchange the reference electrode for a new one.	
	a-8	After long time use, the contact resistance between silver carbon brush and shaft assembly has changed.	Remove the silver carbon brushes from the shaft assembly and clean the carbon powder on the shaft assembly. Place Emery paper UF800, on the surface of the dirty shaft assembly. Then, start rotation for a few seconds at 100rpm. In the case that silver carbon brushes are consumed greatly by friction after long time use, please replace them.	The silver carbon brushes damaged may possibly occurred by the big shock during the transportation. [Accessories] 012611 Emery paper UF800 (20 pcs) 013229 Silver carbon brush for RRDE-3A

	a-9	Silver carbon brush shave powder is collected on the bearing assembly part.	Open the motor cover and remove the shave powder with such as a cotton swab etc.	The carbon powder stored on the bearing assembly may possibly cause the ring current noise in most cases. Please see "7-2 Q4 - The ring current is showing more noise than normal".
	a-10	The big vibration of the shaft assembly contact probe tip after long time use.	Distorted contact probe on the shaft assembly often causes the vibration. Please replace the shaft contact probe. If the shaft contact probe is straight, please adjust and fix the screw of shaft assembly to motor. If it does not help, please replace the shaft assembly.	[Accessories] 013342 RRDE-3A Shaft contact probe repair kit 013643 RRDE-3A Shaft assembly Ver.2
b. Lower current than usual.	b-1	Different concentration of redox agents	Prepare the test solution again.	
	b-2	High resistance between silver carbon brushes and shaft.	Remove the silver carbon brushes, and attach it again or exchange the silver carbon brush for the new one. Place Emery paper UF800, on the surface of the dirty shaft assembly and rotate for a few seconds at 100 rpm.	[Accessories] 013229 Silver carbon brush for RRDE-3A 012611 Emery paper UF800 (20pcs)
	b-3	High resistance contact probe on the shaft assembly and disk electrode.	Replace the contact probe or exchange the shaft assembly for a new one.	[Accessories] 013342 RRDE-3A Shaft contact probe repair kit
	b-4	Deterioration of the electrode catalysis.	Polish the electrode surface or the replacement of the electrode.	
c. Overflow current	c-1	The reference electrode isn't immersed in the solution.	Dip the tip into the electrolyte. If the volume of the solution is not enough, please increase it until the electrode tip is soaked.	The recommended solution volume is 65 ml \pm 5 ml.
	c-2	Unsuitable sensitivity setting for potentiostat, or potentiostat is in bad condition.	Fix the potentiostat or update the application software of the potentiostat. Adjust the sensitivity setting.	

	c-3	Over-potential of the potentiostat compliance voltage due to unexpected high resistance between rotating electrode and counter electrode.	Measure the resistance with a multimeter from tip of shaft assembly through disk pin, or from shaft assembly near the electrode stopper through ring pin. When the resistance is more than 1000 ohms, inspect the cause of the high resistance and fix it. Replace the rotating electrode. Confirm whether your electrolyte, counter electrode etc. have low resistance. If there is something with high resistance, fix or replace it.	
d. No Current flow.	d-1	The rotating electrode or counter electrode isn't immersed in the solution.	Dip the tip into the electrolyte. If the volume of the solution is not enough, please increase it until the electrode tip is soaked.	The recommended solution volume is 65 ml \pm 5 ml.
	d-2	Disconnection of electrodes with electrode leads of potentiostat.	Connect the electrode leads to electrodes firmly.	
	d-3	Disconnection Between contact probe and disk electrode.	Replace the contact probe or exchange the shaft assembly for a new one.	[Accessories] 013342 RRDE-3A Shaft contact probe repair kit
	d-4	Weak electrode catalysis.	Polish the electrode surface or replace it. If some catalyst is loaded on the disk electrode, please check the catalyst activity at first, then active catalyst should reload on the electrode surface.	
e. No ring current (Disk current is available).	e-1	Loosen screw of rotating electrode	Unscrew the rotating electrode, and screw it to the end again.	
	e-2	Broken rotating electrode	Replace the rotating ring-disk electrode.	

7-2 Reported problems

Q1 - When I start the rotation after setting a rotation speed, the shaft assembly does not rotate and there is no movement (or it move a small bit before stopping).

A1- Please perform the three check inspections below:

1. Inspection of the shaft assembly

Unplug the power cable and switch off the RRDE-3A system.

Remove the motor assembly cover, and check the **shaft assembly**.

The best way to check the **shaft assembly** is to remove it.

First, follow the 3 steps bellow, and if you cannot remove the **shaft assembly**, you can follow the 4th step (See also "6-7 Replacement of Shaft Assembly" and "6-9 Replacement of Bearing Assembly").



Fig. 7-2-1

Step 1

Unscrew four metal screws, which are used for fastening the white motor assembly cover of RRDE-3A, with a screwdriver (#1 or #2).



Fig. 7-2-2

Step 2

Remove tiny screws connecting the four silver carbon brush with a screwdriver (#0).

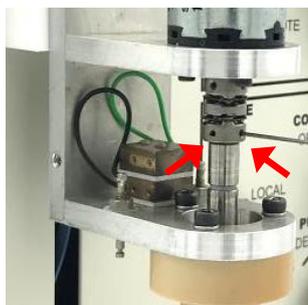


Fig. 7-2-3

Step 3

Hold the shaft assembly underpart with one hand and loosen the screw pair on underside of coupling unit with hexagon wrench (0.89 mm) with the other hand. Pull out the shaft assembly gently.

NOTE: If the shaft assembly is significantly damaged and hard to pull out, please follow Step 4 below to remove it with the bearing assembly.

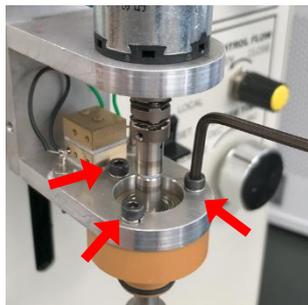


Fig. 7-2-4

Step 4

Remove the three hexagon screws for fixing the **bearing assembly** using the hexagon wrench (2.5 mm)

If you can see damage on the **shaft assembly**, you need to change it.

If you had to remove the **bearing assembly** to remove the **shaft assembly**, then you need to change the **shaft assembly** and the **bearing assembly** both.

2. Inspection of the coupling unit

If the coupling unit is out of position, follow the steps below to move the coupling unit.

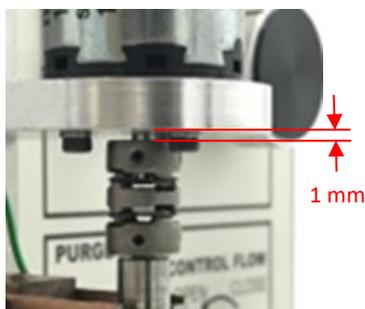


Fig. 7-2-5

Step 5

The coupling unit is fixed to the motor.

The distance between the coupling unit and the motor frame should be 1 mm (see Fig.7-2-5).



Fig. 7-2-6

If the coupling unit gets stuck in the motor frame and is out of place as shown in Figure 7-2-6, remove the motor and then move the coupling unit.



Fig. 7-2-7

Step 6

After removing shaft assembly (and bearing assembly) as described above, rotate the motor housing at 180 degree and remove the motor unit by unscrewing the 3 screws with an Allen wrench 1.5 mm.

Hold the motor unit in your hand to prevent it falling due to its own weight.

Do not unplug the motor unit, it is not necessary.



Fig. 7-2-8

Step 7

Now you have released the motor unit, you have access to the coupling unit screws. Remove the coupling unit from the motor unit by loosen the 2 screws (motor side) of the coupling unit with a hexagon wrench.

Place the motor unit back with the 3 screws and continue the inspection.

3. Inspection of the RRDE-3A system

Once removed the **shaft assembly** and **bearing assembly** (the 4th step above), check the motor.

Set the rotation to 1,000 rpm, and turn the rotation switch to "LOCAL", and check if the rotation can display 1,000 rpm.

If any problem occurs, contact us at: sales@als-japan.com

**CAUTION:**

Turn off the RRDE-3A power switch and unplug the power cable.

Q2 - The purge button does not work. It is always purging the solution when the purge button is on SET or REMOTE position.

- A2-** Check the purging tubing inside the device, maybe they have been dislocated from the valve system. That can be occurred if the purging tubing were pulled out to far from the device.
Remove the right-side panel in order to access inside the device.

<p>Also, from other side</p> <p>Fig. 7-2-9</p>	<p>Remove the back panel by removing the screws, with a screwdriver, at the four places shown in Fig. 7-2-9, in a total of eight screws, including four from opposite side.</p> <p>※ Ground wire is attached to the back panel, please be careful to do not damage or cut it.</p>	<p>Fig. 7-2-10</p>
<p>Fig. 7-2-11</p>	<p>Check the purging tubing, they should be inserted into the valve system as Fig. 7-2-11. If tubing is not inserted into the valve system, just insert them gently.</p>	<p>Fig. 7-2-12</p>
<p>Black covered tube</p> <p>Other tube</p> <p>Fig. 7-2-13</p>	<p>Insert the black covered tube into the pinch nearest the valve system and the other tube into the more distant pinch from the valve system.</p>	

	<p>CAUTION: Turn off the RRDE-3A power switch and unplug the power cable.</p>
	<p>ELECTROSTATIC SENSITIVE: Perform the maintenance service using the ground strap.</p>

Q3 - The acquired data are not good

A3- Please repeat the following experiment with exactly same steps:

Step1: Polish the electrode with the PK-3 0.05 μm alumina polishing kit as described in Appendix **A-6 PK-3 Electrode Polishing kit**.

Step2: Use a **fresh** potassium ferricyanide sample solution

1M KNO_3

2mM $\text{K}_3\text{Fe}(\text{CN})_6$

If the solution is not fresh, Potassium ferricyanide may be turned into Potassium ferrocyanide ($\text{K}_4\text{Fe}(\text{CN})_6$)

Step3: Proceed the experiment with a **1000 rpm**.

Reference Electrode: Ag/AgCl

Counter Electrode: Platinum wire

Initial E: +600 mV

Final E: -100 mV

Scan Rate: 0.01 V/S

Sample interval: 0.001 V

Sensitivity: 10^{-4} (A/V)

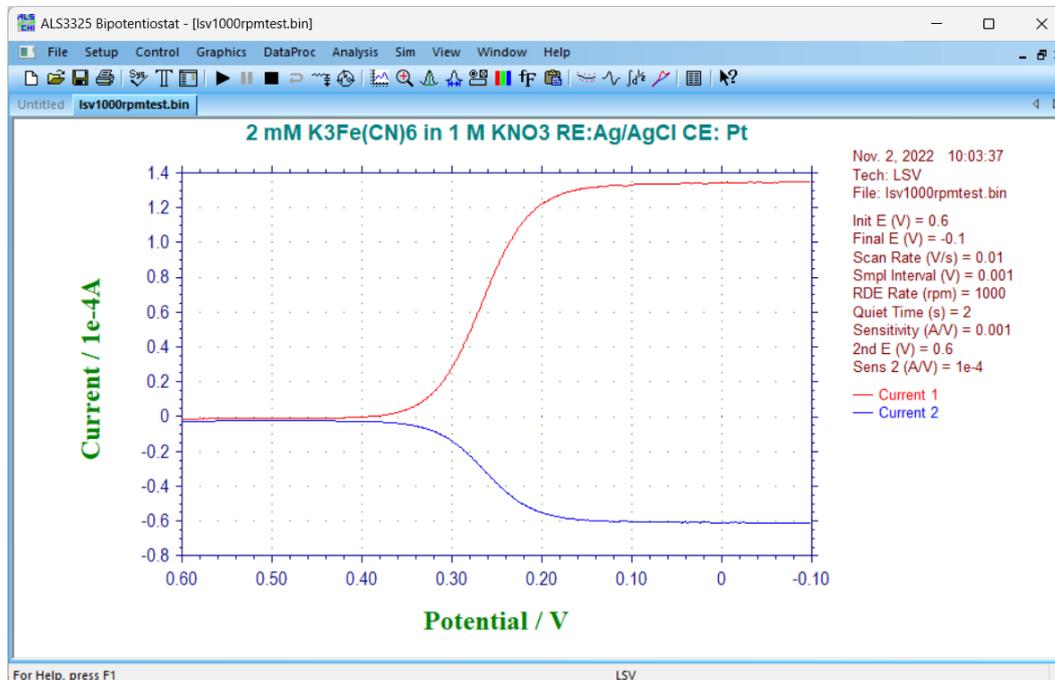


Fig. 7-2-14

If you don't get this kind of curves, contact our service: sales@als-japan.com.

Q4 - The ring current is showing more noise than normal

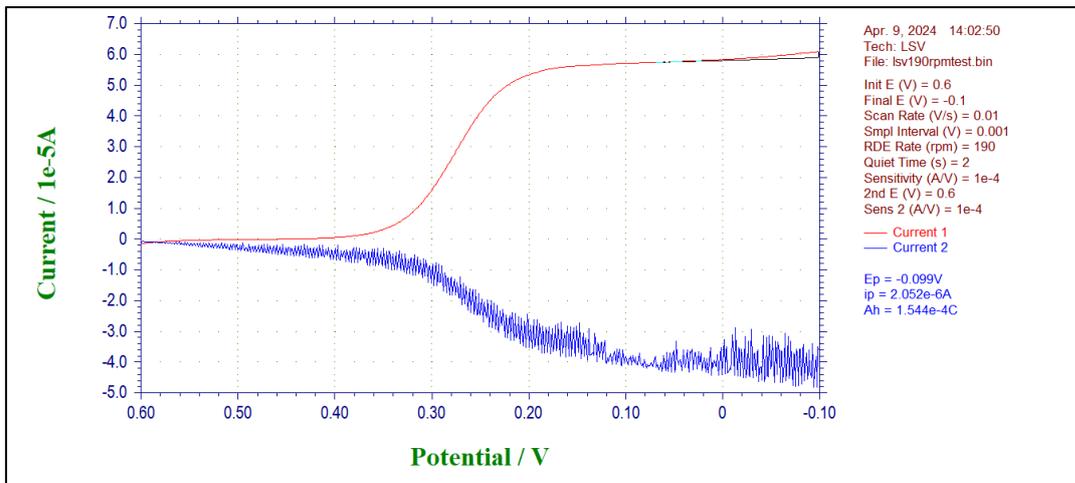


Fig. 7-2-15 Example of noise in ring current

- A4-** Even if the usage time is short and the LCD display does not indicate the need for maintenance or replacement of the silver-carbon brush or shaft, the silver-carbon brush, shaft, and bearings may become dirty depending on the usage environment. Please clean them regularly according to the procedure below.



Fig. 7-2-16.

Step 1

Unscrew four metal screws fastening the motor assembly cover with a screwdriver (#1 or #2) and remove the cover.



Fig. 7-2-17.

Step 2

Remove the shave powder that have accumulated on the bearing by blowing them away with a commercially available air duster, etc. If the shave powder stuck to the frame or other parts and are difficult to blow off with the air duster, wipe them off with a Kimwipe or cotton swab.



Fig. 7-2-18.

Step 3

To remove dirt from the shaft assembly where the silver carbon brush makes contact, wipe it with a clean Kimwipe or cotton swab while rotating at 100 rpm.

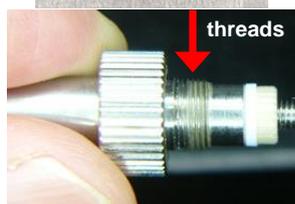


Fig. 7-2-19.

Step 4

If the noise in the data does not improve, remove the shaft assembly and use Kimwipe to remove dirt from the part that comes into contact with the bearing assembly (upper image in Fig. 7-2-19).

Remove dirt from the threads of shaft assembly that connects ring electrode (lower image in Fig. 7-2-19) with a Kimwipe or cotton swab.

For instructions on how to remove the shaft assembly, see "6-7 Replacement of Shaft Assembly".



Fig. 7-2-20.

Step 5

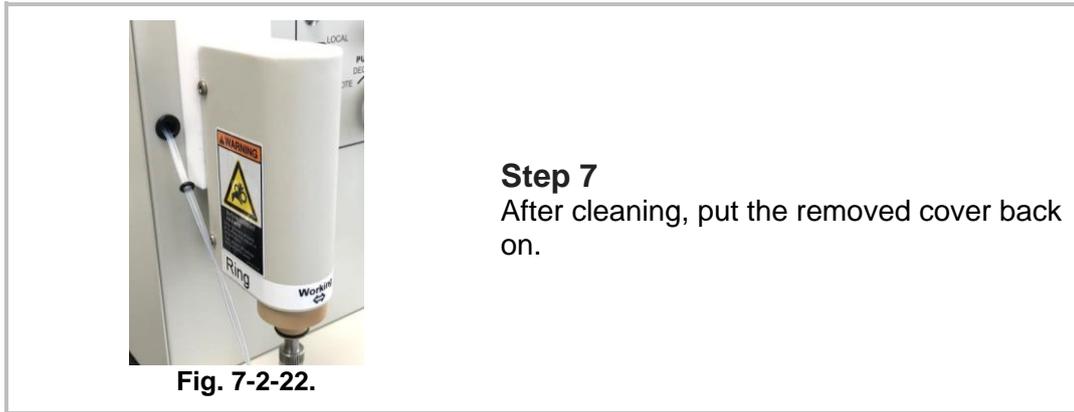
Remove powder adhering to the inside of the bearing assembly by blowing it away with an air duster etc.



Fig. 7-2-21.

Step 6

Attach the shaft assembly and silver carbon brush. Before measuring, run in the machine for 10 minutes at 8000 rpm. Blow off any powder that may have accumulated on the bearing assembly with an air duster.



Check the operation after cleaning using a potassium ferricyanide aqueous solution, etc. By comparing the measurement data before and after cleaning, you can see that the noise has been improved (Fig. 7-2-23).

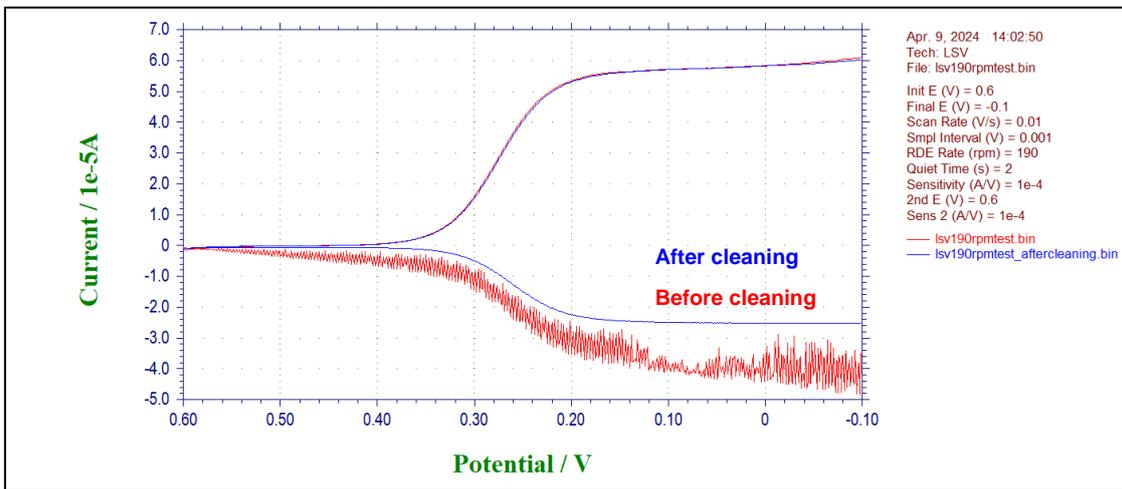


Fig.7-2-23 Comparison of ring current noise before and after cleaning

	<p>CAUTION: Please wear a mask or protective goggles to prevent shavings from getting into your eyes or mouth.</p>
	<p>ELECTROSTATIC SENSITIVE: When performing maintenance, wear an anti-static wrist strap.</p>

Appendix

A-1 Working Electrodes

A-1-1 RRDE/RDE

Products listed in below are working electrodes for rotating ring disk electrode system, **RRDE-3A**.

Organic solvent-resistant resin, PEEK, is used as an insulator, and is able to be polished with **PK-3 Electrode polishing kit**.



Fig. A-1-1

The diameters of regular rotating electrodes (Glassy carbon, platinum, and gold) are decided. Diameter of Disk electrode of RDE is 3 mm. Diameter of Disk electrode of RRDE is 4 mm. The inner and outer diameter of Ring electrode of RRDE is 5 mm and 7 mm. Electrodes of other materials and sizes will be made on a custom request.

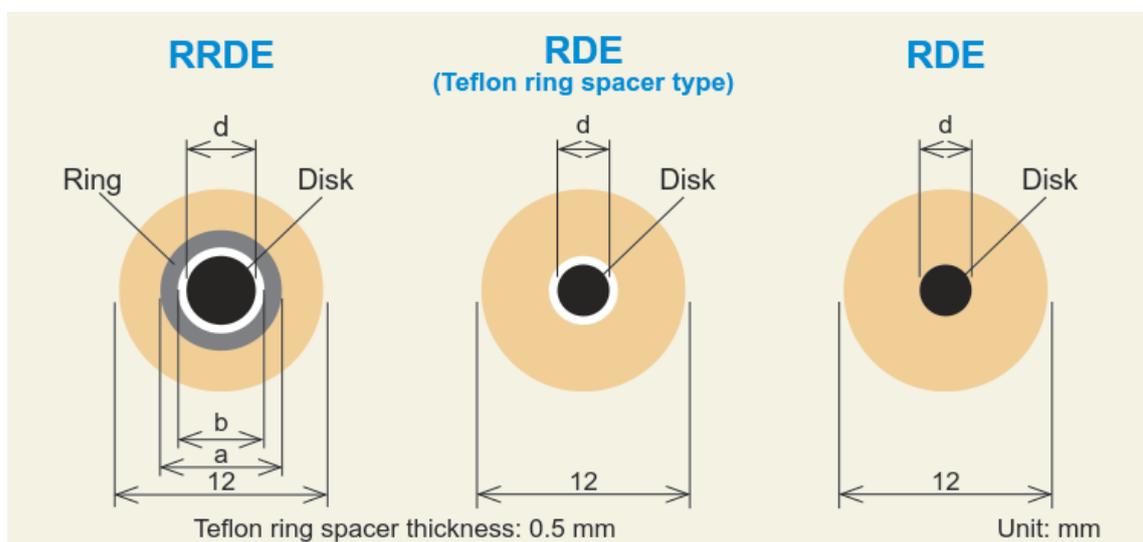


Fig. A-1-2

For more information on our products, please visit the following URL.

<https://www.als-japan.com/1570.html>

A-1-2 DRE – Disk Replaceable Electrode

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

Full detailed manual:

http://usr.bas.jp/dl_sub/?id=518c47a52982c

Features:

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.



Fig. A-1-2-1

For more information on our products, please visit the following URL.

<https://www.als-japan.com/1571.html>

A-2 Reference Electrodes

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



Fig. A-2-1

For more information on our products, please visit the following URL.

<https://www.als-japan.com/1341.html>

A-3 Non-Aqueous reference electrode: RE-7N

This electrode is silver-silver ion reference electrode for non-aqueous solution.

The non-aqueous solvent-based reference electrode is an assembly type. By preparing an internal solution that matches the measurement system, it can be used for various experiments.



Fig. A-3-1

For more information on our products, please visit the following URL.

<https://www.als-japan.com/1389.html#defaultTab14>

A-4 RHEK – Reversible Hydrogen Electrode Kit

Reversible Hydrogen Electrode (RHE) is a reversible electrode which the hydrogen gas is generating by electrolysis of strong acid and trapping, while it is used. It makes unnecessary the complicated and dangerous set-up of the hydrogen cylinder and avoids the large volume of hydrogen gas exhaustion, even though it has a good potential stability.

The RHE has a large application field, it can be used in a strong acid solution ($< \text{pH} 2$), such as 0.5 mol/L sulfuric acid, also in a neutral solution, when it is applied with a double junction chamber.

Full detailed manual:

http://usr.bas.jp/dl_sub/?id=529d7ecacf927

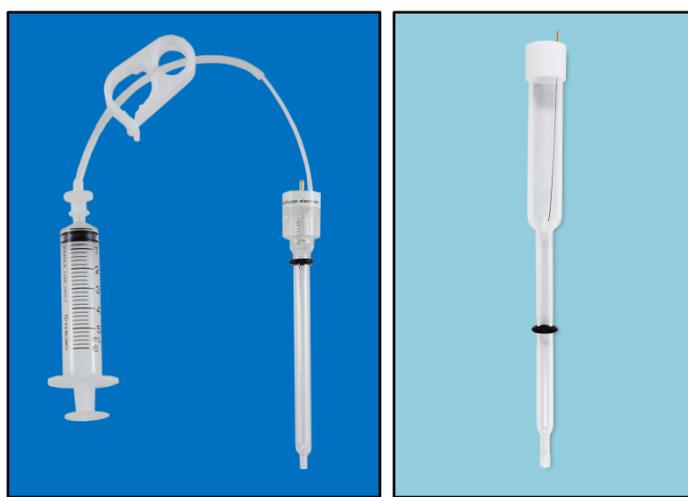


Fig. A-4-1 For application in an acid solution (left), and RHE with a double junction chamber, for application in a neutral solution (right).

Reversible hydrogen electrode kit

The RHEK Reversible hydrogen electrode kit can be used without Double junction chamber when the strong acid (<math>pH < 2</math>, such as 0.5 mol/L sulfuric acid) is used as an electrolyte solution.

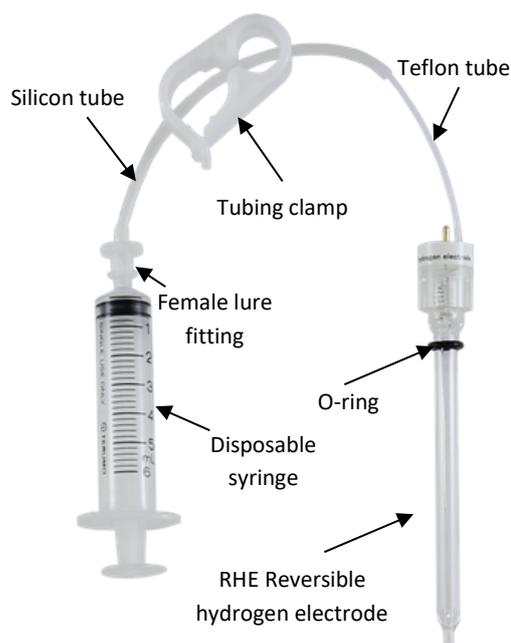


Fig. A-4-2

For more information on our products, please visit the following URL.

<https://www.als-japan.com/RHE.html#defaultTab13>

Double junction chamber kit

The Double junction chamber kit is used when the electrolyte solution is a weak acid, neutral solution, solution containing scum etc.

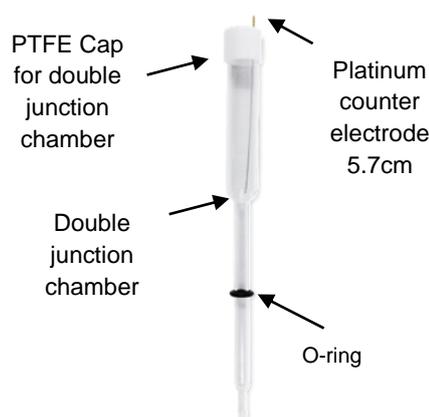


Fig. A-4-3

For more information on our products, please visit the following URL.

<https://www.als-japan.com/RHE.html#defaultTab14>

A-5 Counter electrodes

Please select suitable counter electrodes according to your application. A counter electrode with a large surface area is recommended, as the rotating electrode method involves a relatively large current flow.

Custom made counter electrode is also available. Please do not hesitate to contact us.

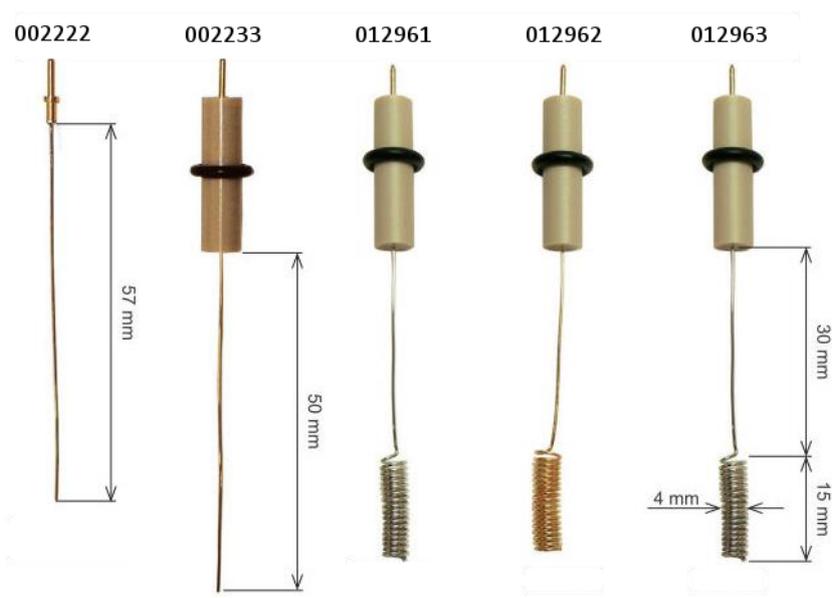


Fig. A-5-1

For more information on our products, please visit the following URL.
<https://www.als-japan.com/1340.html>

A-6 PK-3 Electrode Polishing kit

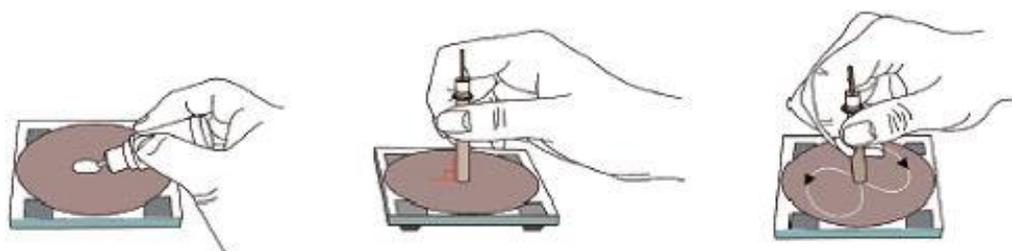
PK-3 is a polishing kit to refresh the working electrode surface for CV/Flow cell. Contents of PK-3 can be provided separately. In that case, each polishing pad (012600 Alumina polishing pad/012601 Diamond polishing pad) includes 20 pieces of them in per sales unit.

For more information on our products, please visit the following URL.

<https://www.als-japan.com/1405.html>

How to use:

Fig. A-6-1



1. Prepare the glass plate, put drops of polishing diamond on diamond polishing pad.
2. Hold the CV electrode at right angle to the pad, polish in a circular motion.
3. Replace by an alumina polishing pad, put drops of polishing alumina and polish to be mirror surface. Rinse the electrode surface with distilled water, dry in air before use.

Attention: Polishing with PK-3 is the most appropriate way to clean up electrode surface. Please consult us when other methods are applied.

A-7 Connecting other potentiostat

The RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.3.0 can be connected and remote controlled with other potentiostat like CH Instruments, Inc. potentiostat, Gamry Instruments, Inc. potentiostat.

Here we will introduce some quickly reference for connection of RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.3.0.

The followed information was supplied by the manufacturer, and for any additional or updated information, please contact directly the respective manufacturer.

A-7-1 CHInstrument

Remote connection

The RRDE-3A **rotation speed** and **purge** can be controlled by **CHI** Electrochemical Analyzer.

- Rotation speed control:
Link the CHI and RRDE-3A devices with a banana jack to wire cable (**Fig. A-7-1-1, A-7-1-2**).

Cat. No.	Description
008133	CB-BS BAS Accessory cable

ALS/CHI	RRDE-3A
RDE	IN
GND	GND (next to IN)



Fig. A-7-1-1 Rotation remote cable

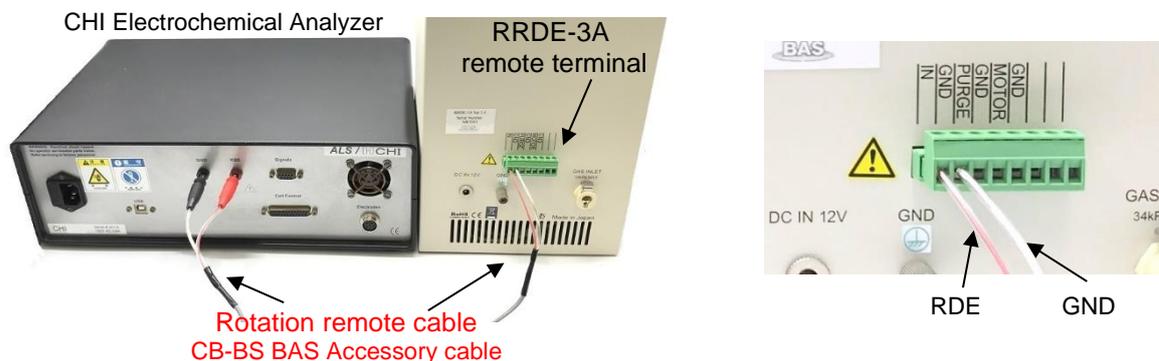


Fig. A-7-1-2 Rotation remote cable connection between CHI and RRDE-3A

- Purge control:
Link the CHI and RRDE-3A devices with an optional cable (Fig. A-7-1-3, A-7-1-4).

Cat. No.	Description
013847	CB-ES Remote cable(25pin)

CHI		RRDE-3A
Cell Control	P(Pin#21)	Purge
	G(Pin#7)	GND (next to Purge)



Fig. A-7-1-3 CB-ES Remote cable(25pin)

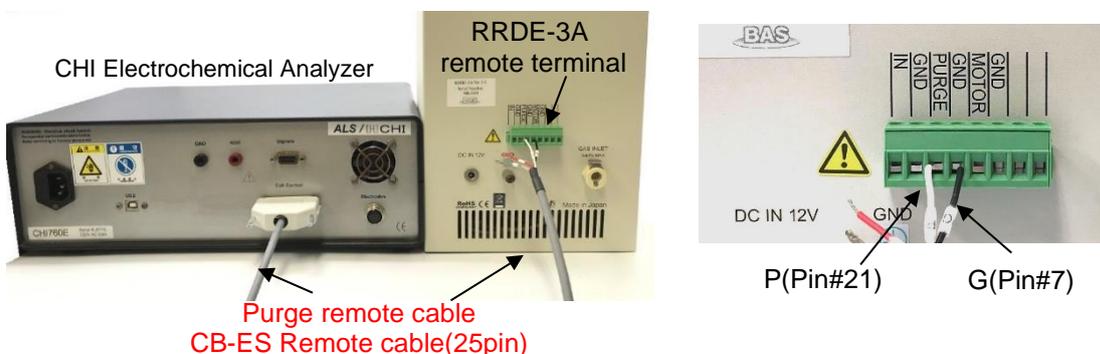


Fig. A-7-1-4 Purge remote cable connection between CHI and RRDE-3A

Cell Connections

Connect lead wires of CHI Electrochemical Analyzer to the **reference, counter, ring, and disk electrodes**, respectively. The **ring electrode** and the **disk electrode** connectors are located under the motor shaft assembly (**Fig. A-7-1-5**).

Alligator clips are color coded depending on the electrode they are attached to.

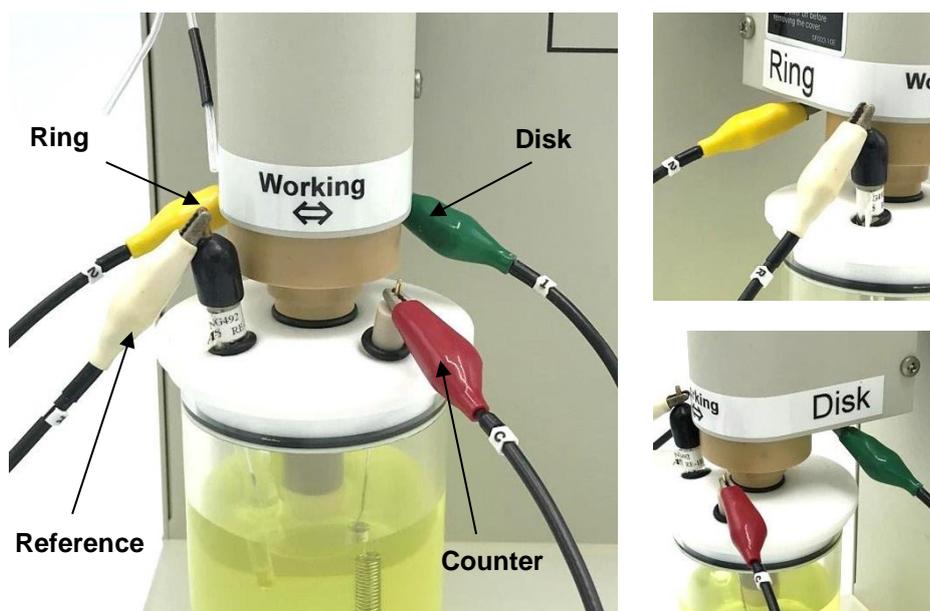


Fig. A-7-1-5 Electrode lead connections

Wire color	Electrode
Green	Disk
White	Reference
Red	Counter
Yellow	Ring
Black	Not used

A-7-2 Gamry Interface 1010™

Gamry potentiostats can be used in BiPotentiostat configuration for the purpose of rotating Ring-Disk electrode experiments. Special cables and scripts are required to synchronize the data acquisition of the potentiostats. In this configuration one potentiostat is the "**Master**" and the other is the "**Serf**". The **Master** will connect to the **Disk** electrode and the **Serf** will connect to the **Ring** electrode.

Editing scripts

For RRDE-3A, 1 V corresponds to 1,000 rpm, but the Interface 1010™ is set up with the ratio 0.5 V for 1,000 rpm. Therefore, we have to edit the Interface 1010™ scripts from Gamry Framework software.

To do that, follow this procedure:

1. Open the file "classElectrode.exp".

Location:

Win 7/Win 8.1/Win 10/Win 11:

C:\ProgramData\GamryInstruments\Framework\Scripts

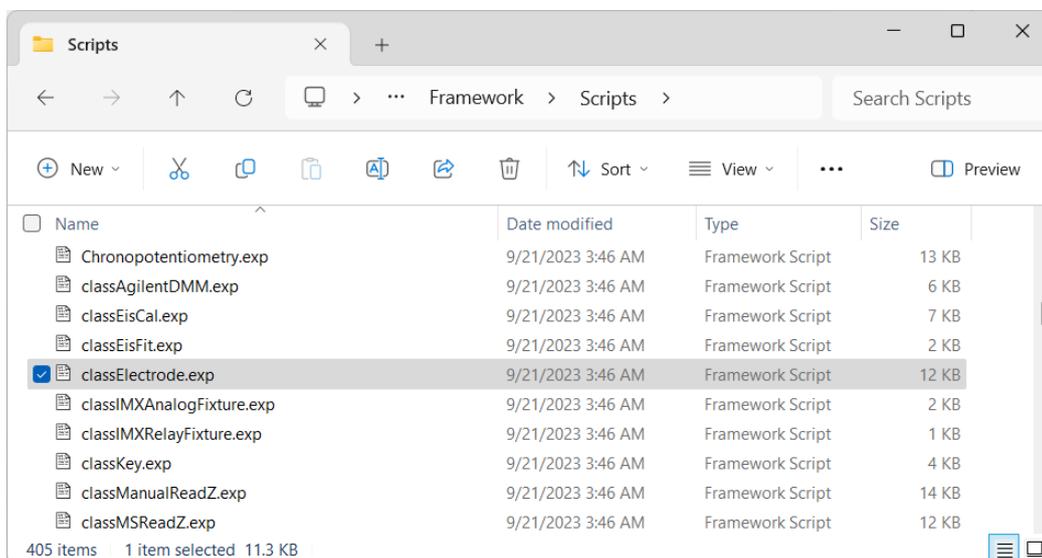


Fig. A-7-2-1 Scripts folder

2. Rewrite the script as below

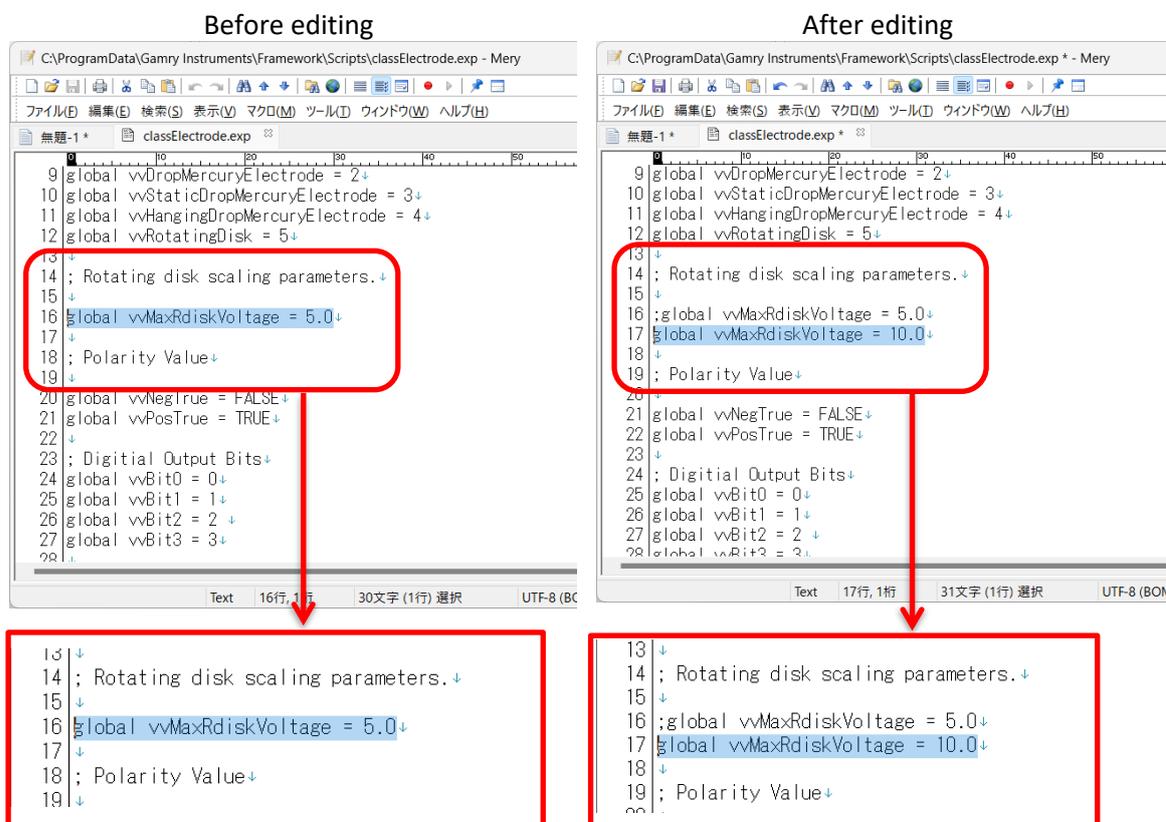


Fig. A-7-2-2 Editing scripts

Place a semicolon ";" at the beginning of the line:
global vvMaxRdiskVoltage= 5.0.

And add this line:
global vvMaxRdiskVoltage= 10.0

Connecting the Potentiostats

In order to synchronize the data acquisition of the Disk and Ring electrodes, an interconnection between the two potentiostats is required. Gamry Interface BiPotentiostat Synchronization Cable can be used to connect Master Interface 1010™ and Serf Interface 1010™. The Master end of the cable has the identification by a large **M** on the DIN connector.

For RRDE-3A remote control, connect a remote cable to the User I/O port on Master Interface



Gamry Interface BiPotentiostat Synchronization Cable

Fig. A-7-2-3 Connection of BiPotentiostat Synchronization Cable

Remote connection

The current version of **Gamry Interface 1010™** series can remotely control the RRDE-3A rotation. Just link the I/O port **pin 1** to the **IN** of the RRDE-3A remote terminal port and the I/O port **pin 2** to the **GND** of the RRDE-3A remote terminal port.

* For RRDE-3A remote connection, you can use a Gamry Multipurpose User I/O Cable.

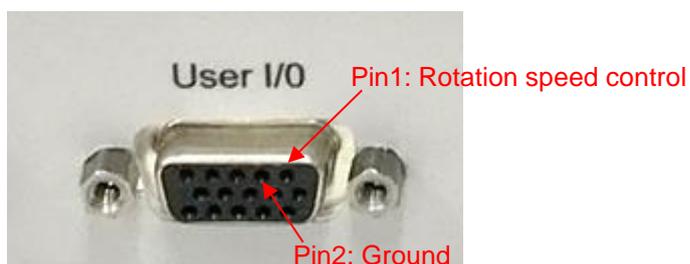


Fig. A-7-2-4 Connection of Remote-control cables for RRDE-3A

Cell Connections

Two standard Gamry Cell Cables are be used to connect to the Cell to the Gamry Potentiostats. There are many wires! Be certain that unwanted interconnections are not made accidentally!

The single **Reference** Electrode should be connected to **BOTH** of the **White**, Reference Electrode pin jack sockets. The single **Counter** Electrode should be connected to **BOTH** of the **Red**, Counter Electrode banana plugs. Banana-to-Alligator or Pin Jack-to-Alligator adapters may be useful here.

The **Blue (Working Sense)** and **Green (Working)** leads of the **Master** potentiostat should be connected to the **disk** electrode of the RRDE-3A.

The **Blue (Working Sense)** and **Green (Working)** leads of the **Serf** potentiostat should be connected to the **ring** electrode of the RRDE-3A.

The "Counter Sense" (Orange) leads of both Gamry Potentiostats should be left disconnected. They are not used.

The Ground wire ("Floating" ground) or the Ground "jack" of the Disk Potentiostat may be connected together to provide better noise rejection. The Ground wire and Grounding jack of the Ring Potentiostat must both remain unconnected to any other ground or cell lead.

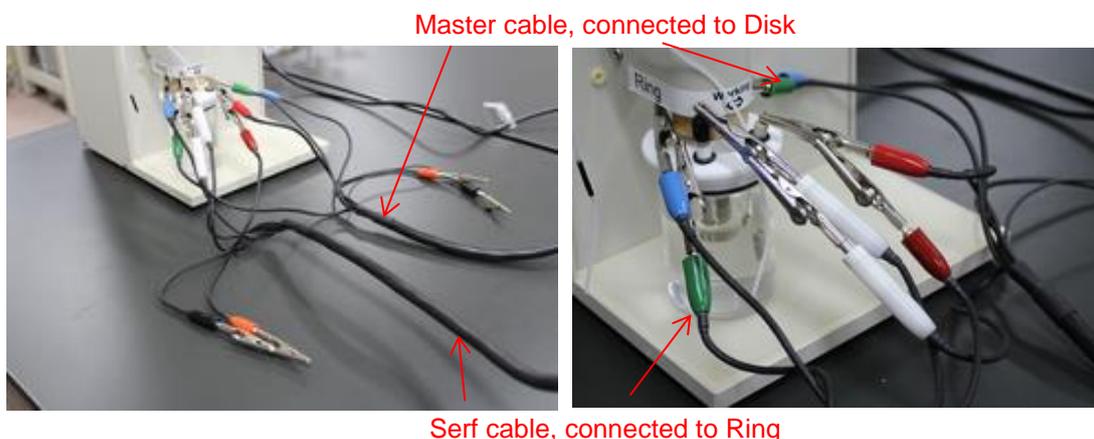


Fig. A-7-2-5 Cell connections

A-8 EC DECLARATION OF CONFORMITY

EC DECLARATION OF CONFORMITY

Manufacturer's name: BAS Inc.
 Manufacturer's address: 1-28-12, Mukojima, Sumida-ku, Tokyo, 131-0033, Japan
 E-mail: sales@als-japan.com

Declare that the DoC is issued under our sole responsibility and belongs to the following product;

Product Code: 013725
 Product Name: RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.3.0
 Serial Number: M1716

The object of the declaration described above is in conformity with the relevant union harmonization legislation;

1. COMMISSION DELEGATED DIRECTIVE (EU) 2015/863 of 31 March 2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council as regards the list of restricted substances
2. DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
3. DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

The following harmonised standards and technical specifications have been applied:

IEC EN 63000: 2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
 EN 61326-1: 2013 Electrical equipment for measurement, control and laboratory use
 – EMC requirements – Part 1: General requirements

Tokyo, Japan

Place

Mar 2, 2021

Date of issues

Masao Asano

name



signature