PT5E-0642

RIKEN KEIKI

Photoemission Yield Spectroscopy in Air (PYSA)

AC-2S Series

AC-2S
AC-2S Pro *α*
AC-2S Pro *β*

Operating Manual

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Contents

1. Product Overview 6
1-1 Introduction 6
1-2 Intended use and product features 7
1-2-1 Intended use 7
1-2-2 Product features 7
1-3 DANGER, WARNING, and NOTE 8
1-4 Notes on using the software 9
1-4-1 Software license terms 9
1-4-2 Precautions 9
2. Important Safety Information 10
2-1 Warning labels 10
2-2 Warning information 11
2-3 Precautions 13
2-4 Method of confirmation for CE marking type 14
3. Product Configuration 15
3-1 Main unit and accessories 15
3-1-1 Components 15
3-1-2 Accessories 15
3-1-3 Optional accessories 16
3-2 Part names and functions 17
3-2-1 AC-2S LC (light source unit) 17
3-2-2 AC-2S DC (measuring unit) 19
3-3 Block diagram 21
4. Installing the Main Unit 23
4-1 Installation precautions 23
4-2 Cable connection 24
4-3 Pipe installation 26
5. Operating the Main Unit 27
5-1 Turning on the power 27
5-2 Heated sample stage temperature adjustment 29
5-2-1 Setting up the temperature controller 29
5-2-2 Increasing the heated sample stage temperature 32
5-2-3 Replacing samples on the heated sample stage 33
6. Measurement 35
6-1 Measurement precautions 35
6-2 Launching the AC-2S measurement application 36
6-6-2 Launching the AC-2S measurement application 36
6-2-2 AC-2S measurement application main window component names and functions 37
6-2-3 Files created by the AC-2S measurement application 38
6-3 Main unit preparation 39
6-3-1 Dry compressed air supply and unit connection 39
6-3-2 Initializing the UV intensity controller and setting the detector voltage 42
6-4 Work function measurement 45
6-4-1 Selecting the work function 45
6-4-2 Setting the measurement data file save destination folder 45
6-4-3 Setting work function measurement conditions 46
6-4-4 Setting the Incident UV Spectrum 49
6-4-5 Mounting samples 51
6-4-6 Starting single-point measurement 53
6-4-7 Starting multi-point measurement 58
6-5 Calibration curve measurement 62

6-5-1 Selecting calibration curve measurement ... 62
6-5-2 Setting the count rate data file save destination folder ... 62
6-5-3 Setting calibration curve measurement conditions ... 63
6-5-4 Mounting samples ... 65
6-5-5 Starting calibration curve measurement ... 66
6-6 Creating and editing calibration curve files ... 67
6-6-1 Creating calibration curve files ... 67
6-6-2 Editing calibration curve files ... 69
6-6-3 Calibrating calibration curve files ... 71
6-7 Film thickness measurement ... 74
6-7-1 Selecting film thickness measurement ... 74
6-7-2 Setting the film thickness data file save destination folder ... 74
6-7-3 Calling up calibration curve files ... 76
6-7-4 Setting film thickness measurement conditions ... 76
6-7-5 Mounting samples ... 78
6-7-6 Starting film thickness measurement ... 79
6-8 UV intensity controller and detector maintenance ... 80
6-8-1 Initializing the UV intensity controller ... 80
6-8-2 Resetting the anode voltage ... 80
6-8-3 Readjusting the dead time ... 81
6-9 Quitting measurement ... 83
7. Analysis ... 85
7-1 Launching the AC-2S analysis application ... 85
7-1-1 Launching the AC-2S analysis application ... 85
7-1-2 AC-2S analysis application main window component names and functions ... 86
7-1-3 Files handled by the AC-2S analysis application ... 87
7-2 Opening measurement results files ... 88
7-2-1 Plotting measurement results on a graph ... 88
7-2-2 Plotting multiple measurement results on a single graph ... 92
7-3 Analyzing measurement results ... 93
7-3-1 Changing the Incident UV Spectrum ... 93
7-3-2 Calculating the mean of measurement results ... 94
7-3-3 Calculating the photoemission threshold ... 95
7-3-4 Estimating density of states ... 96
7-3-5 Saving analysis results ... 97
7-4 Customizing the graph display ... 98
7-4-1 Changing the X- and Y-axis maximum and minimum values ... 98
7-4-2 Changing grid lines ... 99
7-4-3 Changing line graph dots ... 100
7-4-4 Changing the ground level and regression line graph display ... 101
7-4-5 Renaming samples ... 102
7-5 File management ... 103
7-5-1 Data Manager component names and functions ... 103
7-5-2 Viewing data ... 104
7-5-3 Searching for files ... 105
7-5-4 Renaming files ... 108
7-5-5 Deleting files ... 108
7-6 Outputting measurement results ... 109
7-6-1 Outputting data and measurement conditions ... 109
7-6-2 Outputting graphs ... 110
7-6-3 Bulk outputting data, measurement conditions, and graphs ... 110
7-7 Graph right-click operation list ... 111
8. Data conversion ... 113
8-1 Overview of the AC-2S data conversion application ... 113

8-2 Basic file conversion operations 113
8-2-1 Launching the AC-2S data conversion application 113
8-2-2 AC-2S data conversion application window component names and functions 114
8-2-3 Files supported by the AC-2S data conversion application 114
8-3 Converting to AC-2S format (AC-5 measurement data files) 115
8-4 Converting to AC-2S format (AC-2/AC-3 measurement data files) 117
8-5 Quitting the AC-2S conversion application 119
9. Ending Main Unit Operation 120
9-1 Turning off the power 120
10. Maintenance 122
10-1 Daily inspection 122
10-1-1 Display lamp inspection 122
10-1-2 Sample chamber interior inspection 123
10-2 Consumable part replacement intervals 124
10-2-1 Detector (LE-6118) 124
10-2-2 Optical fiber 126
10-2-3 Deuterium (D_2) lamp 127
10-2-4 Activated carbon filter 127
11. Storage, Relocation, and Disposal 128
11-1 Procedures for storage or when not used for extended periods 128
11-2 Procedures for relocation or reuse 128
11-3 Product disposal 128
12. Troubleshooting 129
12-1 Fault diagnosis 129
12-2 Corrective action 129
13. Product Specifications 131
13-1 Product specifications 131
13-2 Display/control unit specifications 132
13-3 Software (measurement/analysis) function specifications 132
13-4 Software (data conversion) function specifications 133
14. Appendix 134
14-1 Detection principle 134
14-1-1 Photoelectron detection principle 134
14-1-2 Photoelectric work function measurement 135
14-2 Terminology 137

1

Product Overview

1-1 Introduction

Thank you for purchasing this AC-2S Series Photoemission Yield Spectroscopy in Air(“the product” hereinafter).
This operating manual describes product operating procedures and specifications. The manual provides essential information for the correct use of the product.
Make sure you have read and fully understood the contents of this manual before using the product.
Keep this operating manual on hand to allow ready reference during use.
The contents of this manual are subject to change without notice to allow product improvements.

Riken Keiki accepts no liability for accidents or damage resulting from use of the product, whether within or outside the warranty period.
Review the warranty policy indicated on the warranty.

Before using the product, confirm that this operating manual covers the model you purchased.

<Models covered by this operating manual>

- AC-2S
- AC-2S Pro α
- AC-2S Pro β

<This operating manual>

Where descriptions differ for different product models, this operating manual uses the following icons to indicate each model:

AC-2S	**AC-2S**
AC-2S Pro α	**Pro α**
AC-2S Pro β	**Pro β**

Operating procedures and specifications for which no icons appear apply to all models.

1-2 Intended use and product features

This product can detect and count a small number of photoelectrons by exposing samples to low-intensity ultraviolet radiation. The AC-2S measurement application and AC-2S analysis application provided with the product can also be used to measure the work function and ionization potential of materials such as metals, semiconductors, and organic materials.
Use the device correctly after confirming you understand the product's features and characteristics.

1-2-1 Intended use

- Work function measurement for metal materials
- Ionization potential measurement for semiconductors and organic materials
- Density of states measurement
- Thickness measurement of coatings formed on sample surfaces (down to thicknesses on the order of tens of nm) (AC-2S Pro α and AC-2S Pro β)
- Measurements of sample maintained at high temperatures (from room temperature up to 100 °C) (AC-2S Pro α and AC-2S Pro β)

1-2-2 Product features

- Allows measurements in air of the work function of materials such as metals, with no need for vacuum conditions.
- Allows easy sample insertion and removal for rapid measurement of many samples.
- Allows measurement of powder samples requiring high UV intensity and materials requiring low-energy measurement (down to 2.0 eV). (AC-2S Pro α)
- Capable of microscopic area measurement (0.4 mm × 0.4 mm square or less) to measure semiconductors and other small samples (AC-2S Pro β)
- Includes a heated sample stage for measurement at user-specified temperatures up to 100 °C. This makes it possible to evaluate characteristics of new materials with temperature-dependent characteristics at their actual operating temperatures. (AC-2S Pro α and AC-2S Pro β)
- The analysis application can be used to estimate photoemission threshold values and density of states from measurement results.

Function	AC-2S	AC-2S Pro α	AC-2S Pro β
Work function measurement	○	○	○
Ionization potential measurement	○	○	○
Density of states measurement	○	○	○
Film thickness measurement	—	○	○
High-temperature measurement	—	○	○
Laser-driven light source (LDLS)	—	○	○
Micro area measurement	—	—	○
Low-energy measurement	—	○	—
Multi-point measurement	○	○	○
Repeated measurement	○	○	○
Consumable part replacement notification	○	○	○

1-3 DANGER, WARNING, and NOTE

This operating manual applies the following categories to indicate potential damage/hazards if the user disregards the information provided and handles the product incorrectly:

 **DANGER**	This indicates situations in which improper handling may result in fatal or serious injury or significant property damage.
 **WARNING**	This indicates situations in which improper handling may result in serious injury or significant property damage.
 **CAUTION**	This indicates situations in which improper handling may result in minor injury or minor property damage.

Additionally, usage recommendations are indicated as follows:

NOTE	This indicates items that will be helpful to know when using the product.

1-4 Notes on using the software

Be sure to read the following ‘Software license terms’ and ‘Precautions’ before using the software (AC-2S measurement application and AC-2S analysis application). Carefully read the contents of this manual to ensure proper use of the software.

1-4-1 Software license terms

Permission to use this software is granted only on the condition that the user consents to the following terms and provisions. Use of this software constitutes the user’s consent to the following terms and provisions:

1. License terms
   Riken Keiki Co., Ltd. grants the user the nonexclusive rights to use this software in accordance with the following license terms.
2. Scope of license
   Except where permitted by these license terms, the user may not use, copy, modify, adapt, process, or otherwise alter this software in part or its entirety, and may not loan or transfer it to third parties.
3. Copyright
   The copyright of this software and manuals belongs to Riken Keiki, and no rights are transferred to the user other than the usage rights for this software granted by these license terms.
4. Agreement period
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5. Warranty
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6. Disclaimer
   Riken Keiki accepts no liability whatsoever for loss of profits, damages arising from special circumstances (including damages that is or could be predicted by Riken Keiki), or direct or indirect damages due to claims against the user by third parties resulting from use of this software.
7. Termination of the agreement
   User violations of any of these license terms will result in immediate termination of the agreement. The user must immediately destroy the software and any copies thereof after such violation.
8. Miscellaneous
   Comply with all Japanese export control regulations when taking this software outside Japan. Regardless of the country in which the software is actually used, this agreement is governed by the laws of Japan.

1-4-2 Precautions

The descriptions in this manual assume the following:

- The AC-2S main unit and control PC have been correctly installed and set up.
- The AC-2S measurement application and AC-2S analysis application have been correctly installed.
- The user is familiar with the Windows operating system.
- The user is familiar with the meanings of the terms work function, ionization potential, and density of states, and their relationship to photoemission.

2

Important Safety Information

2-1 Warning labels

The following warning labels are affixed to the product to prevent accidents.
These warning labels must be strictly observed in conjunction with the warnings and precautions in this manual when carrying out installation, operation, and maintenance work.

Warning label	Warning	Warning details
	CAUTION: ELECTRIC SHOCK	Indicates the presence of a dangerous voltage. The label is affixed on or inside the device.
	CAUTION: HOT	Indicates that surfaces may be dangerously hot. The label is affixed on or inside the device.
	CAUTION: UV RADIATION	Indicates a risk of damage to eye and skin if direct exposure occurs. The label is affixed on or inside the device.
	General warning	Indicates that improper handling may result in serious injury or property damage. The label is affixed on or inside the device.

2-2 Warning information

WARNING

Opening and closing the cover while the power is turned on

- Do not open the cover on the main unit while the power is turned on. Doing so may result in electric shock from high-voltage components inside the main unit.
- Ultraviolet radiation is emitted from the UV lamp while it is turned on. Never look into the UV lamp with the naked eye. Doing so may cause eye pain or vision impairment.
- Do not point the UV light directly at your skin. Doing so may cause skin irritation.
- Never touch the UV lamp while it is turned on or immediately after turning it off, as it will be hot. Doing so may result in burn injuries.

Overheating, smoke, abnormal sound, or abnormal odors

- Stop using the product immediately if any irregularities occur. If overheating, smoke, abnormal sound, or abnormal odors arise, turn off the power and unplug the power cable from the mains socket. Continuing to use the product may result in electric shock or fire.

Impact due to dropping

- Do not subject the product to impact, such as by dropping it or hitting it. The product contains precision-construction components, including the optical system and automatic stage. Subjecting the product to impact may prevent correct operation or correct measurement.

Operating ambient temperature and humidity

- Do not use or store the product in hot, humid, or dusty locations. Doing so may result in malfunctioning, electric shock, or fire. Use the product within the specified operating temperature and humidity range (15 - 35 °C, up to 60 %RH).
- Condensation may form on the outside or interior of the product when it is moved to a location with a large temperature difference, such as when moving from a cold location to a hot location. Use under these conditions may result in product failure. If the product is moved, allow it to stand for several hours in the location in which it is to be used to enable it to adjust to the surrounding temperature before use.

Power supply information

- Do not use the product with a power supply voltage other than that specified. Using with a power supply voltage other than that specified may damage the product. It may also cause electric shock or fire.
- Connect the grounding terminal. For safety, plug the power supply cable into a grounded (three-pin) socket. Failure to ground the ground terminal may result in electric shock.
- Do not place objects on top of the power supply cable, or pull, squeeze, bend, or process the cable. Doing so may damage the power supply cable and cause electric shock or fire.
- When plugging in and unplugging the power supply cable, always hold the plug itself. Pulling on the cable may pull out some of the wires and result in fire.
- Check to ensure that dust is not allowed to build up on the power supply plug and that it is fully inserted into the socket.
- Do not use with sockets with faulty connections. Doing so may result in fire.
- Do not plug the power supply cable into the socket with wet hands. Doing so may cause electric shock.
- Do not connect multiple plugs into the same mains socket. Doing so may result in fire, cause a power overload, trip the circuit breaker, or affect other devices. Doing so will also increase the likelihood of noise in the power supply, leading to malfunctions.

Foreign object ingress

- Insert only measurement samples into the sample inlet. Keep metal or combustible foreign matter from entering the product via the vents. Continuing to use the product with foreign matter inside may result in malfunctions. It may also cause electric shock or fire.

Installation

- Do not place containers of water such as vases and plant pots, or small metallic objects such as pins and clips on top of the product.
  Using the product with such items fallen inside may result in damage. It may also cause electric shock or fire.
- Install the product on a stable surface of sufficient load-bearing capacity.
- This product incorporates an interlock function. The stage cannot be operated while the sample inlet is open.
- If it is used with methods other than we have specified, the protective functions provided by this unit may be deteriorated.

Movement and transportation

- Move or transport the product with care. The product is heavy. Be careful to avoid dropping the product and injuring workers when moving or transporting the product. Assign at least two persons to carry the product. Support the product from below.

Maintenance

- Do not use worn or degraded parts. Inspect the piping system periodically. Replace parts as and when necessary. Continuing to use worn or degraded parts may lead to accidents such as pipe damage or ruptures. Continuing to use lamps significantly beyond their service life may resulted in explosion.
- The product must be maintained by an engineering supervisor. Product maintenance involving opening maintenance doors and removing covers must be performed by engineering supervisors trained by Riken Keiki or engineering supervisors who have passed the appropriate written exam.

Sample mounting

- To open the sample inlet, press gently with your finger on the part marked “PUSH”.
  Any of the following actions may damage the sample inlet:
  - Pressing on the sample inlet anywhere other than the part marked “PUSH”
  - Pressing on the sample inlet with the palm of your hand
  - Subjecting the sample inlet to a load of 400 N or more (The sample inlet can be opened and closed with a force of 5 - 6 N.)
  - Forcing open the sample inlet when it does not open
- Be sure to adjust the height of the sample when mounting a sample. If a sample is mounted without adjusting the height, contact between the sample and internal parts during measurement may result in damage to the product.
- Push the height gauge to pull it out from the side of the sample stage.
  Any of the following actions may damage the height gauge:
  - Subjecting the height gauge to a force of 20 N or more from above, below, or diagonally
  - Pulling out the height gauge by the tip (pin)
- Allow the heated sample stage to cool before replacing samples. (AC-2S Pro α and AC-2S Pro β)
  Replacing samples while the sample stage is hot may result in burn injuries.

Fuse

- Use a fuse of the specified rating (2.5 A, 250 V, time-lag type) to prevent fire hazards.
  Turn off the power switch and unplug from the mains socket before replacing the fuse. Safeguard the fuse holder from short circuits.

2-3 Precautions

CAUTION

Installation environment

- Use the product indoors in laboratories or similar settings under conditions of stable temperature and humidity.
  Do not install the product in the following locations. Doing otherwise may result in malfunctions or accidents.
  - Outdoors or in locations where the product may be exposed to splashing water
  - Dusty or humid locations
  - Locations subject to vibration
  - Locations subject to rapid temperature or humidity fluctuations
  - Locations subject to direct sunlight or drafts from air-conditioning equipment
  - Locations where the air contains chemicals such as solvent, acid, or alkaline vapor or gas
  - Locations subject to noise from equipment such as large-capacity transformers, motors, and power supplies or noise sources such as high-voltage generators

Contact with metal edges

- Avoid contact with metal edges. Take great care when touching the edges of metal panels, etc., e.g., when moving the product.

Using walkie-talkies

- Do not use walkie-talkies near the product. Radio waves emitted from walkie-talkies or similar devices used near the product or cables may affect measurements. Use walkie-talkies or similar devices only in locations where they will not affect product functions.

Turning on the power

- Wait at least five minutes after turning off the power before turning the power back on. The product may not function correctly if the power is turned on before waiting five minutes.
- Turn on the power to the main unit as instructed by the AC-2S measurement application. When operation is complete, close the AC-2S measurement application before turning off the power to the main unit.

Use in unstable locations

- Do not install the product on a slope or in locations subject to vibration. Doing so may affect measurements.

Precautions when using dry compressed air

- Use dry compressed air free of substances such as solvents, acids, gases, and oil. The presence of the following substances in the air supply may result in deterioration or damage to the product:

Type	The dry compressed air must be entirely free of the following substances:
Solvents	Acetone, benzene, phenol, toluene, trichloroethylene, xylene, cresol, thinner, aniline, chloroform, alcohol, dioxane, tetrahydrofuran, dichloromethane, cyclohexanone, tetrachloromethane, etc.
Acids	Sulfuric acid, nitric acid, hydrochloric acid, acetic acid, lactic acid, chromic acid, etc.
Gases	Chlorine, sulfurous acid gas, hydrogen sulfide, bromine, semiconductor production gases, etc.
Oil	Phosphate-based hydraulic fluid, fuel oil, water-soluble cutting fluid (alkaline), kerosene, etc.

- Do not use air at pressures above the specified pressure.
- Use only the compressor recommended by Riken Keiki.
- The compressor should be installed in the same conditions as the product.
- The ingress of water or other liquids via the dry compressed air pipes will damage the product.
- The ingress of gases other than air (e.g., nitrogen, oxygen, and inert gases) via the dry compressed air pipes may damage the product.
- Use Teflon tubes of the specified diameter for dry compressed air piping.
- Use tubes provide by Riken Keiki.

Product disassembly and modification

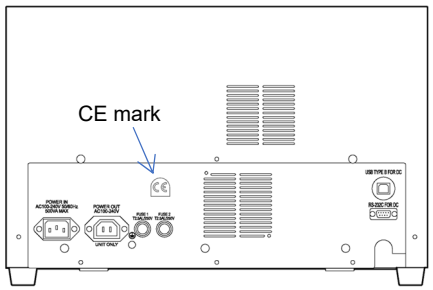
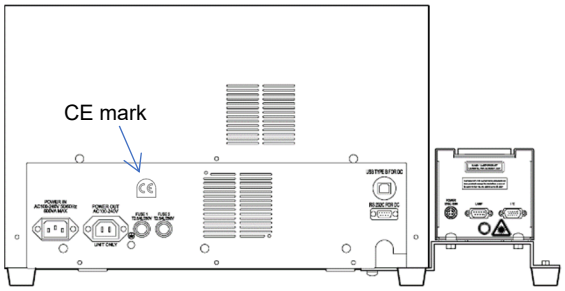
- Do not disassemble or modify the product. Product performance cannot be guaranteed if the product is disassembled or modified. Read this operating manual carefully to ensure correct use of the product.

Accessory samples

- Store the accessory samples (Au plates) in the dedicated holder and cover.

2-4 Method of confirmation for CE marking type

The CE marking is labeled on the detector in case of comply with CE mark. Please confirm the instrument specification before using. Please refer Declaration of Conformity that is at the end of this manual if you have CE marking type.

<table>
<tr><td colspan="3">CE mark label</td></tr>
<tr><td></td><td>AC-2S</td><td>AC-2S Proα/AC-2S Proβ</td></tr>
<tr><td>LC (light source unit)</td><td> 
</td><td> 
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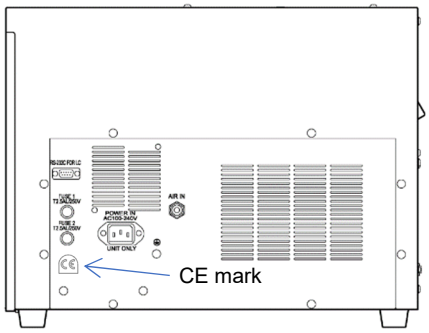
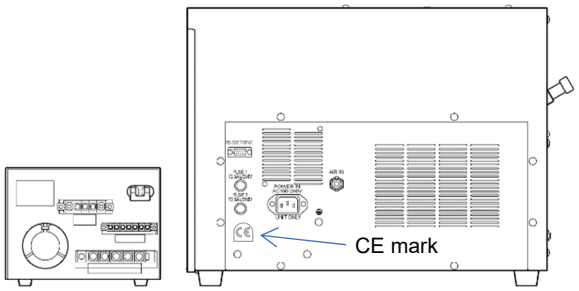
<tr><td>DC (measuring unit)</td><td> 
</td><td> 
</td></tr>
</table>

3

Product Configuration

3-1 Main unit and accessories

Check the main unit and accessories.
If any accessories are missing, contact our sales department.

3-1-1 Components

Item name	Model	Quantity	Remarks
AC-2S measuring unit	AC-2S DC	1	
AC-2S light source unit	AC-2S LC	1	

3-1-2 Accessories

Item name	Quantity	Remarks
Display	1	
Control PC	1	OS: Windows
Power supply cable (for LC)	1	
Power supply cable (LC-DC)	1	
USB interface cable (PC-LC)	1	
RS-232C interface cable (LC- DC)	1	
Detector	1	
Optical fiber	1	
Accessory sample set	1	The accessory sample contains an Au plate, holder, and cover.
Tweezers	1	
Measurement/analysis/data conversion software (CD- ROM)	1	
Operating manual	1	
Warranty	1	

CAUTION

- For safety, plug the power supply cable into a grounded (three-pin) socket. Failure to ground the ground terminal may result in electric shock.

3-1-3 Optional accessories

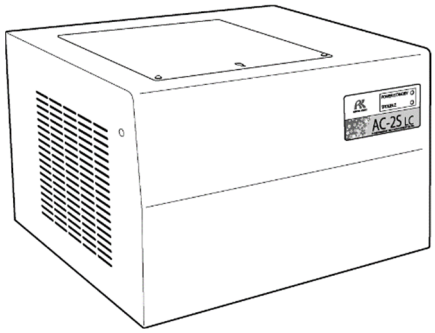
Item name	Remarks
Adaptor plug	Plug converting from 3-pin to 2-pin + ground wire. ・Required quantity of AC-2S : 1 ・Required quantity of AC-2S Proα/AC-2S Proβ: 3
Tray for powder samples (1.0 mm deep)	One set containing 20 pieces
Tray for powder samples (0.5 mm deep)	One set containing 20 pieces
Compressor*1 (with dry air generator)	Riken Keiki recommended compressor
Optical fiber protective acrylic cover	
Dry air union adapter	Adapter for converting ⌀6 mm pipes to ⌀1/4 inch pipes. (1/4 inch = 6.35 mm)
Different-diameter union joint (for dry air)	
Detector (for replacement)	
Optical fiber (for AC-2S/Pro α)	
Optical fiber (for Pro β)	
Ozone filter	

*1 Use only the compressor available as an optional accessory to supply dry compressed air. Use the following Teflon tubes for piping:
- Outer diameter 6 mm, inner diameter 4 mm
- Withstand pressure 0.3 MPa or greater

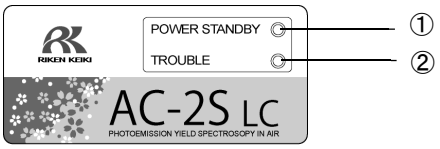
3-2 Part names and functions

3-2-1 AC-2S LC (light source unit)

AC-2S LC main unit

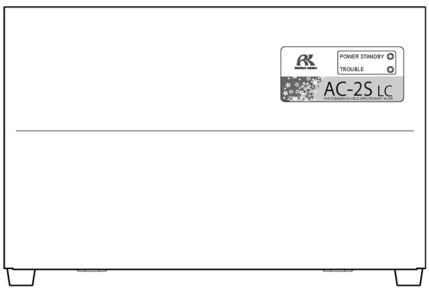


LED display unit

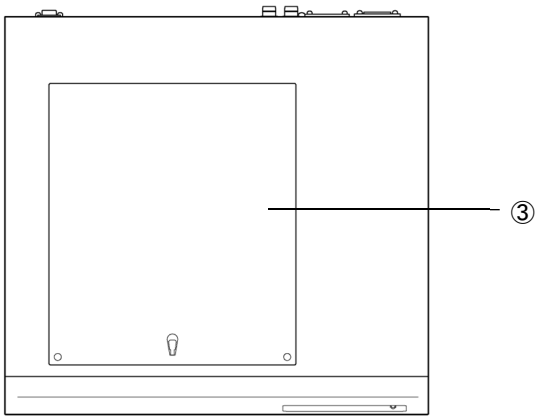


<AC-2S>

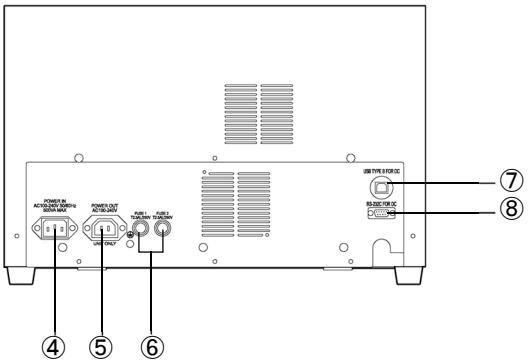
Front view



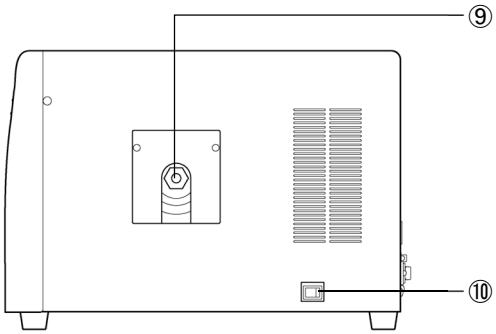
Top view



Rear view

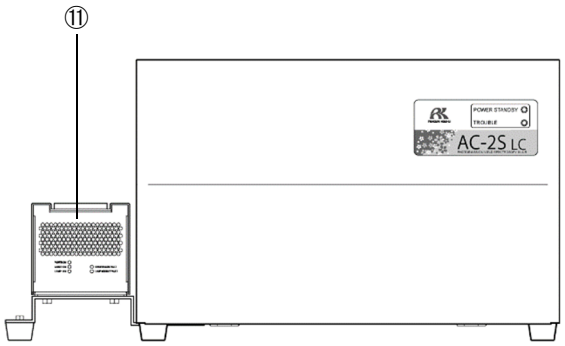


Right side

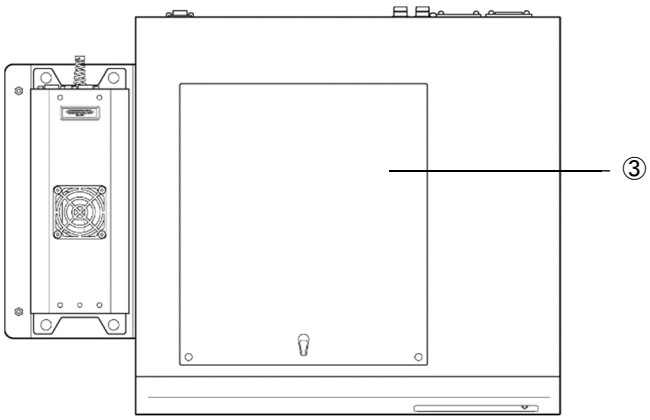


<AC-2S Pro α/AC-2S Pro β>

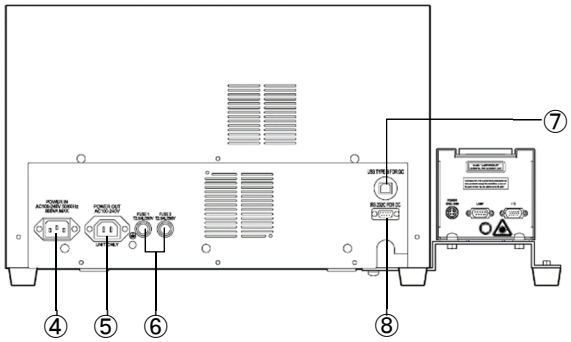
Front view



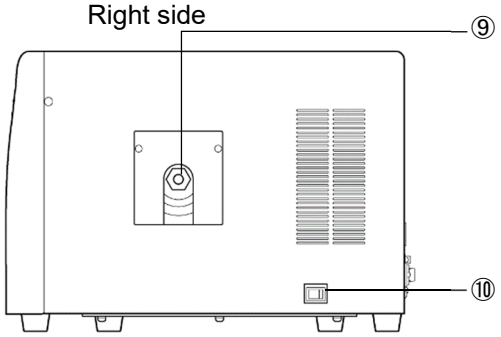
Top view



Rear view



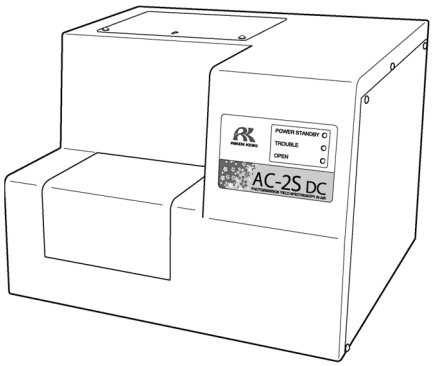
Right side



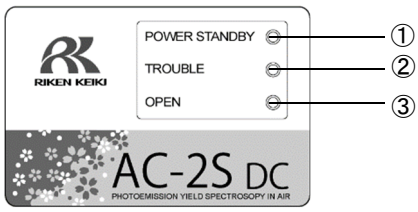
No.	Name	Function
①	POWER/STANDBY LED	This is the power supply LED. Lights up (green) when measurement is in progress. Blinks (green) when at standby (warming up).
②	TROUBLE LED	This is the fault LED. This lights up (red) in the event of a product abnormality. The LED blinks (red) when operation is being checked and immediately after turning on the power.
③	Lamp replacement and inspection panel	Panel used to replace the UV lamp This panel is also for used for inspections.
④	AC power supply input	Connector for connecting to the AC power supply
⑤	AC power supply output (for DC unit)	Power supply connector for connecting the AC-2S DC unit
⑥	Fuse	Littelfuse fuse (T2.5 AL/250 V)
⑦	USB connector (for PC)	USB connector for connecting to a PC
⑧	RS-232C connector (for DC unit)	RS-232C connector for connecting to the AC-2S DC unit
⑨	Optical fiber connector	Connector for connecting an optical fiber
⑩	Power switch	Switch for turning on and off the power to the AC-2S LC and AC-2S DC units
⑪	Plasma light source (LDLS)	Laser-driven light source (LDLS)

3-2-2 AC-2S DC (measuring unit)

AC-2S DC main unit

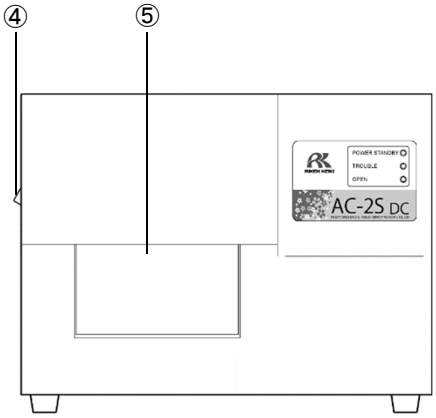


LED display unit

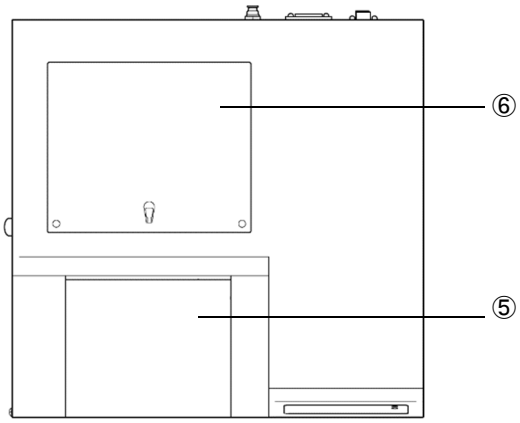


<AC-2S>

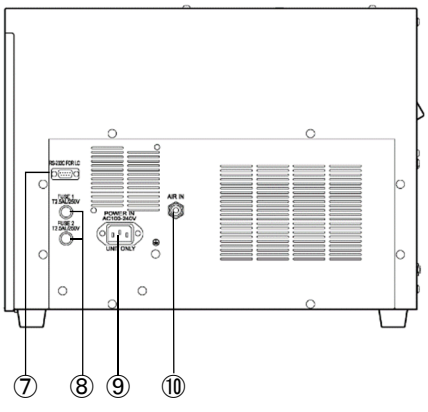
Front view



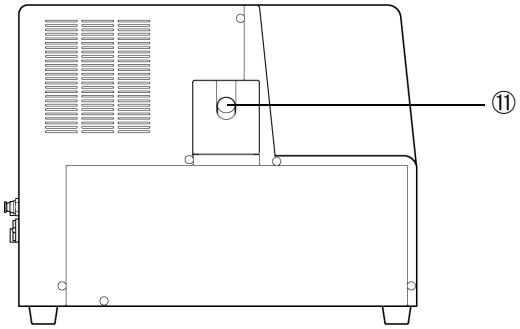
Top view



Rear view

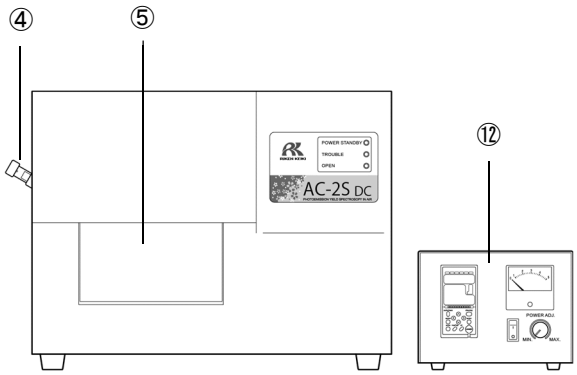


Left side

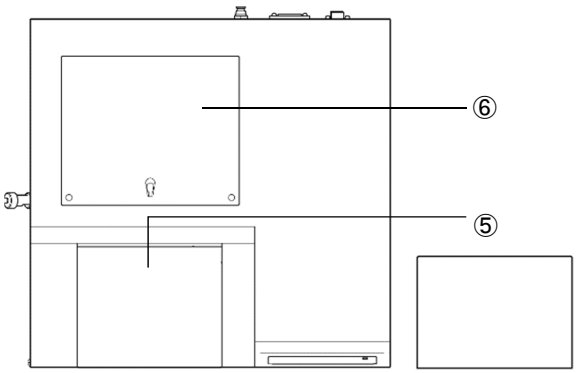


<AC-2S Pro α/AC-2S Pro β>

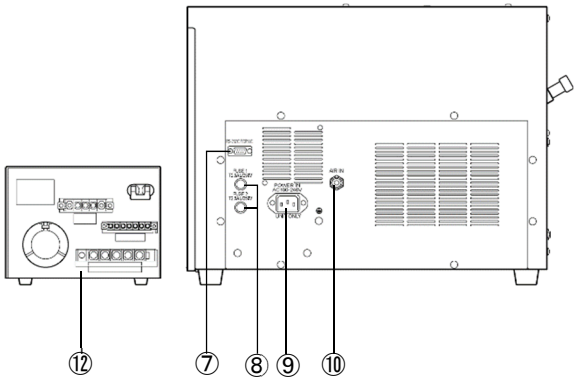
Front view



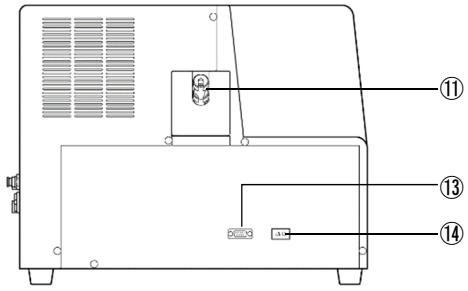
Top view



Rear view



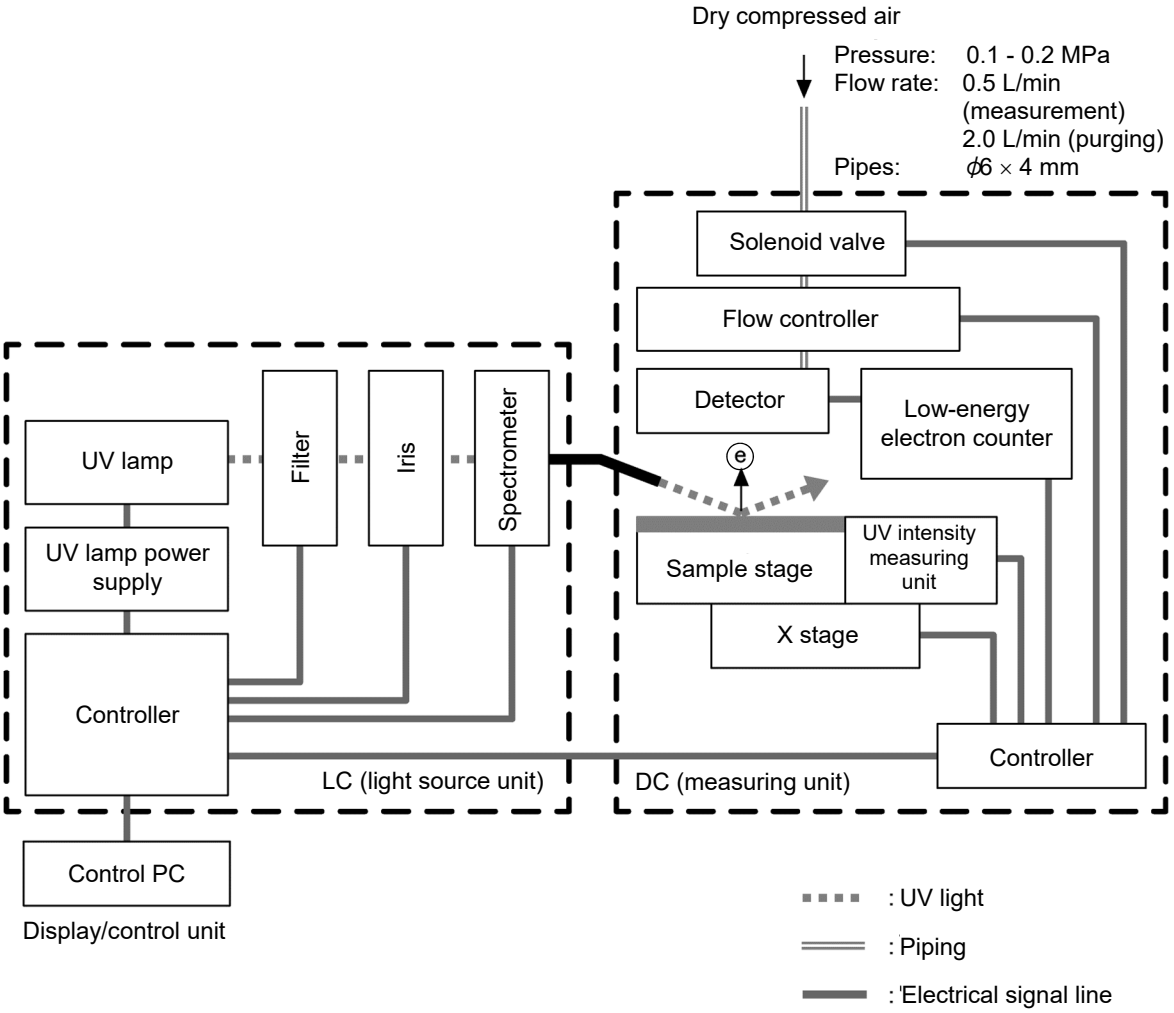
Left side



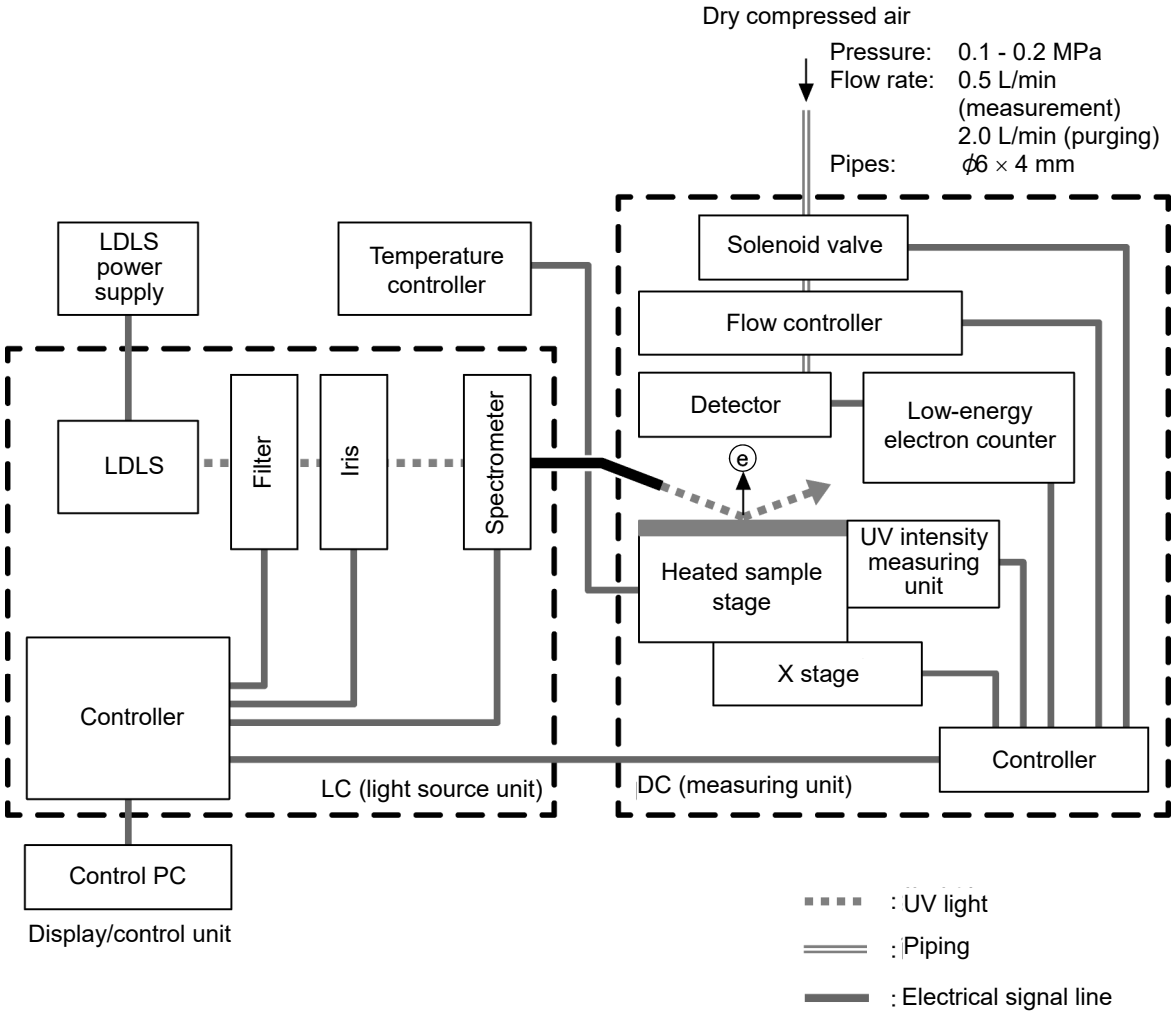
No.	Name	Function
①	POWER/STANDBY LED	This is the power supply LED. Lights up (green) when measurement is in progress. Blinks (green) when at standby (warming up).
②	TROUBLE LED	This is the fault LED. This lights up (red) in the event of a product abnormality. The LED blinks (red) when operation is being checked and immediately after turning on the power.
③	OPEN lamp	Sample inlet open/close indicator LED. Lights up (orange) when the sample inlet is open.
④	Optical fiber holder	Secures the optical fiber. (The configuration differs for the AC-2S Pro β.)
⑤	Sample inlet	Inlet for measuring samples
⑥	Detector inspection panel	Panel for inspecting and replacing the detector
⑦	RS-232C connector (for LC)	RS-232C connector for connecting to the AC-2S LC unit.
⑧	Fuse	Littelfuse fuse (T2.5 AL/250 V)
⑨	AC power supply input (for LC unit)	Power supply connector for connecting to the AC-2S LC unit
⑩	Dry air inlet	Inlet connector for the dry compressed air used during measurement
⑪	Optical fiber connector	Connector for connecting an optical fiber
⑫	Temperature controller	Device for regulating the temperature of the heated sample stage
⑬	Temperature controller heater cable connector	Connector for connecting the temperature controller heater cable
⑭	Temperature controller thermocouple cable connector	Connector for connecting the temperature controller thermocouple cable

3-3 Block diagram

<AC-2S>



<AC-2S Pro α/AC-2S Pro β>



4

Installing the Main Unit

4-1 Installation precautions

WARNING

- Assign at least two persons to carry the product. Support the product from below.
- Install the product on a surface of sufficient load-bearing capacity.

CAUTION

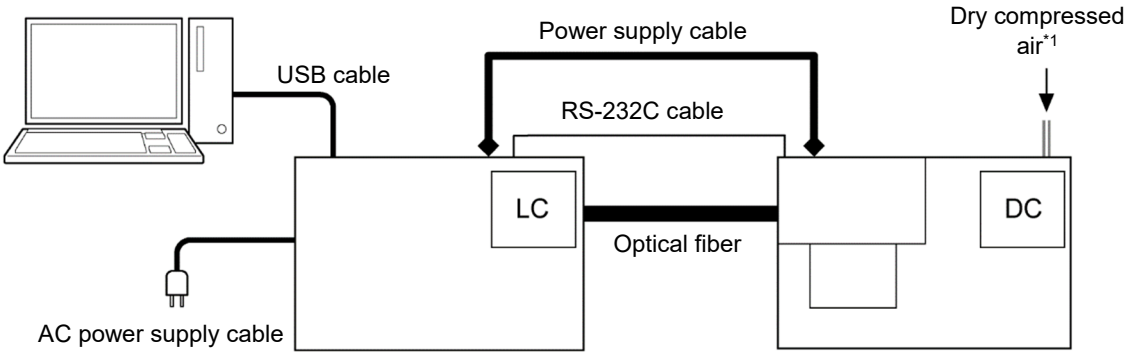
- Use the product indoors in laboratories or similar settings under conditions of stable temperature and humidity.
  Do not install the product in the following locations. Doing otherwise may result in malfunctions or accidents.
  - Outdoors or in locations where the product may be exposed to splashing water
  - Dusty or humid locations
  - Locations subject to vibration
  - Locations subject to rapid temperature or humidity fluctuations
  - Locations subject to direct sunlight or drafts from air-conditioning equipment
  - Locations where the air contains chemicals such as solvent, acid, or alkaline vapor or gas
- Install the product on a stable and level location. Be careful to avoid dropping or striking the product. The product contains precision electronic components. Subjecting the product to impact may affect measurements.
- Avoid installing in locations subject to noise from equipment such as large-capacity transformers, motors, and power supplies or noise sources such as high-voltage generators. The product may be affected by electromagnetic noise, etc.
- Maintain a distance of at least 1 m from the product when using devices like walkie-talkies and cellphones.
  Failure to do so may result in malfunctions due to radio interference.
- When installing, leave at least 15 cm (at least 20 cm for the AC-2S Pro β) all around the product.
- Leave at least 15 cm (at least 20 cm for the AC-2S Pro β) at the rear to allow the power plug to be unplugged immediately if a problem occurs.

4-2 Cable connection

Connect the product light source unit to the measuring unit. Connect the control PC.

<AC-2S>

Connect the AC-2S LC to the AC-2S DC and the PC for control with a cable, and also connect the AC-2S DC to the temperature controller.

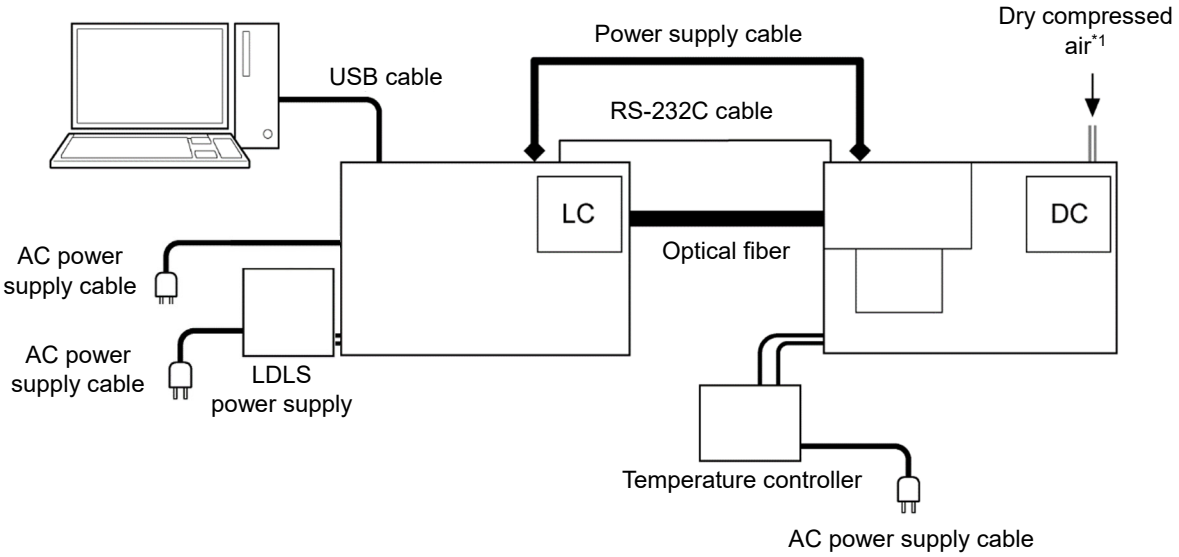


1 Connect the provided power supply cable (LC-DC) between the AC-2S LC and AC-2S DC units.
2 Connect the provided RS-232C interface cable (LC-DC) between the AC-2S LC and AC-2S DC units.
3 Connect the provided USB interface cable (PC-LC) between the AC-2S LC and control PC.
4 Connect the provided power supply cable (LC) to the AC-2S LC unit.

*1 Pressure: 0.1 - 0.2 MPa; flow rate: 0.5 L/min (measurement), 2.0 L/min (purging); pipes: $\phi 6 \times 4$ mm

<AC-2S Pro α/AC-2S Pro β>

Connect the cables between the AC-2S LC and AC-2S units, and to the LDLS power supply, temperature controller, and control PC.
Connect as shown in the following diagram.



1 Connect the provided power supply cable (LC-DC) between the AC-2S LC and AC-2S DC units.
2 Connect the provided RS-232C interface cable (LC-DC) between the AC-2S LC and AC-2S DC units.
3 Connect the provided USB interface cable (PC-LC) between the AC-2S LC and control PC.
4 Connect the provided power supply cable (LC) to the AC-2S LC unit.
5 Connect the temperature controller heater cable to the temperature controller heater cable connector on the left side of the AC-2S DC unit.
6 Connect the temperature controller thermocouple cable to the temperature controller thermocouple cable connector on the left side of the AC-2S DC unit.

*1 Pressure: 0.1 - 0.2 MPa; flow rate: 0.5 L/min (measurement), 2.0 L/min (purging); pipes: $\phi 6 \times 4$ mm

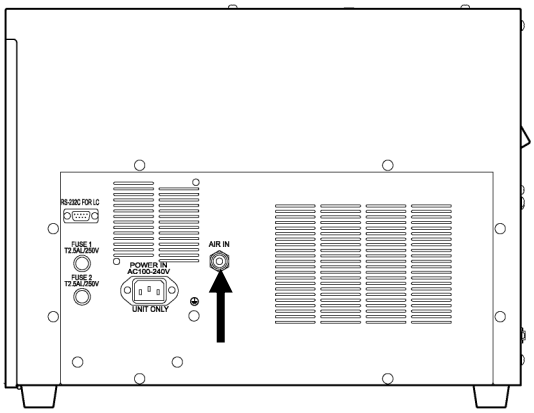
4-3 Pipe installation

Connect the tube supplying dry compressed air to the dry air inlet at the rear of the AC-2S DC unit.

NOTE

- Use the following Teflon tubes for piping:
  Outer diameter: 6 mm; inner diameter 4 mm; withstand pressure: 0.3 MPa or greater
- Check to confirm that the piping tubes have been cut perpendicularly and that the cut faces are circular. Also check to confirm that the outer surface is not damaged.

1 Insert the tube securely into the dry air inlet at the rear of the AC-2S DC unit.
Pull the tube to confirm that it does not come loose.



2 Connect the other end of the tube to the dry compressed air supply.
Adjust the pressure of the dry compressed air*1 supply to 0.1 - 0.2 MPa.

*1 Use only the compressor available as an optional accessory to supply the dry compressed air.

5

Operating the Main Unit

5-1 Turning on the power

WARNING

- To prevent electric shock, be sure to plug the power supply cable into a grounded (three-pin) socket.
- Failure to ground the ground terminal may result in electric shock.

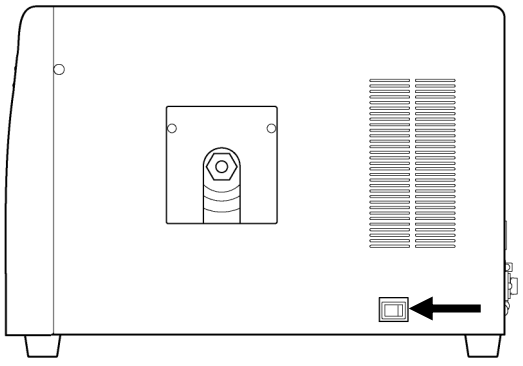
NOTE

- Plug the AC-2S LC power supply cable and control PC power supply cable into grounded sockets.
- Check to confirm that the power supply voltage at the socket matches the power supply voltage indicated on the product.
- If the mains socket has a switch, turn this switch on.

<AC-2S>

1 **Turn on the power to the control PC.**
Check to confirm that Windows has started up correctly.

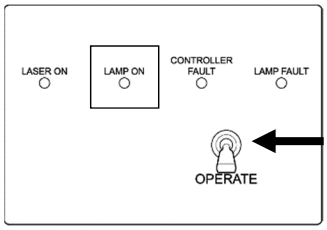
2 **Turn on the power switch on the right side of the AC-2S LC unit.**



<AC-2S Pro α/AC-2S Pro β>

1 Turn on the plasma light source (LDLS).

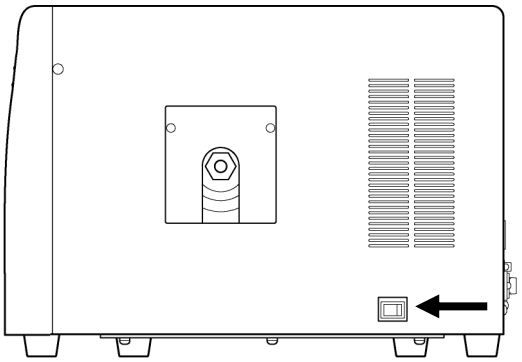
Insert the power cable of the plasma light source unit into the power outlet. After confirming that the unit's fan is running, raise the OPERATE switch in the controller section. Check to confirm that the LAMP ON LED lights up (green).



2 Turn on the power to the control PC.

Check to confirm that Windows has started up correctly.

3 Turn on the power switch on the right side of the AC-2S LC unit.



5-2 Heated sample stage temperature adjustment Pro α Pro β

For high-temperature measurements, set the measurement temperature using the temperature controller, then adjust the sample stage temperature.

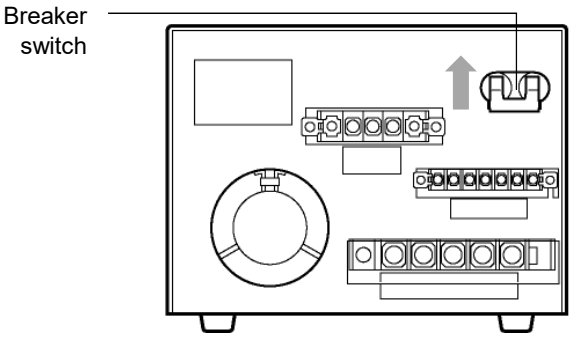
WARNING

- Check to confirm that the sample stage has cooled sufficiently before mounting or replacing samples. Replacing the samples while the sample stage is still hot may result in burn injuries.

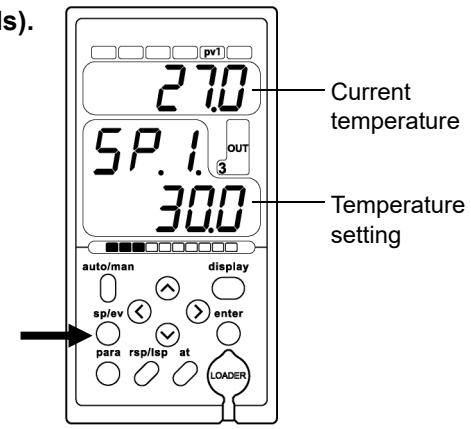
5-2-1 Setting up the temperature controller

Before turning on the temperature controller heater, set the initial temperature to the current temperature (room temperature).
Here, the current temperature is set to 27 °C.

1 Turn on the breaker switch at the rear of the temperature controller.

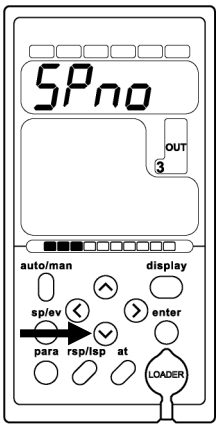


2 Hold down the sp/ev button (for about two seconds).

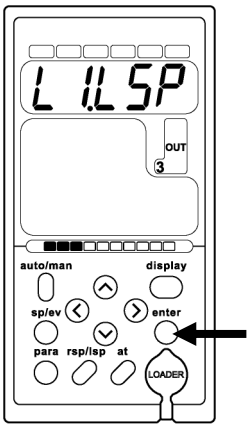


The top row of the display changes to [SPno], and blinks.

3 Hold down the V button until the top row of the display changes to [LI.LSP].

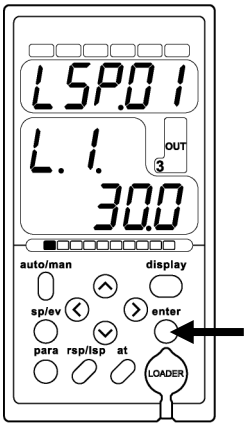


4 Press the enter button after the top row of the display changes to [LI.LSP].



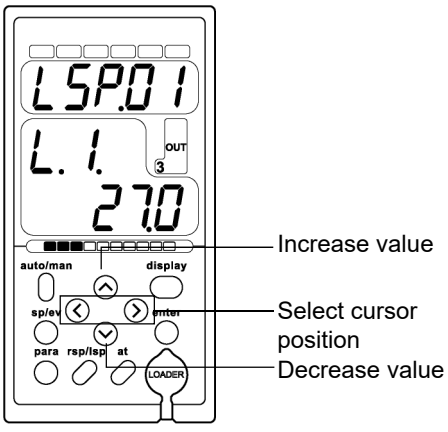
The top row of the display changes to [LSP.01].

5 Press the enter button when the second row of the display reads [L.1.].

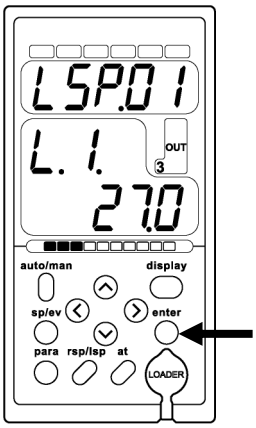


6 Use the ∧, ∨, <, and > buttons to set the required temperature.

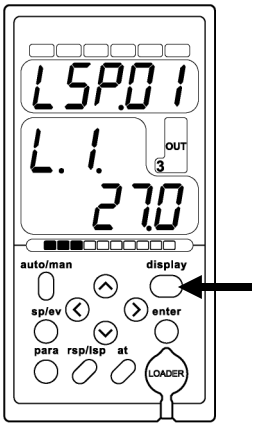
Use the < and > buttons to select the cursor position.
Use the ∧ and ∨ buttons to increment or decrement the value.



7 Press the enter button to enter the temperature.

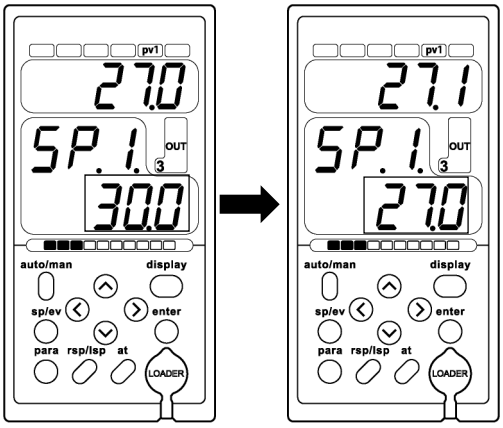


8 Once temperature setting is complete, press the display button.



The display returns to the operating status display.

9 Check to confirm that the temperature setting has changed to the temperature specified.
The temperature setting gradually decreases from 30 °C to the current temperature (27 °C).



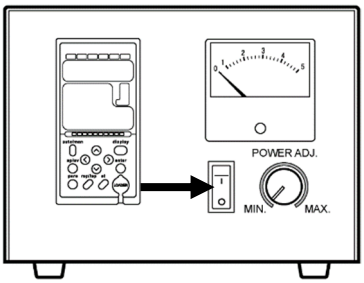
NOTE

- If you press the wrong button or perform an incorrect operation, press the display button to return to the operating status display. Repeat the procedure.

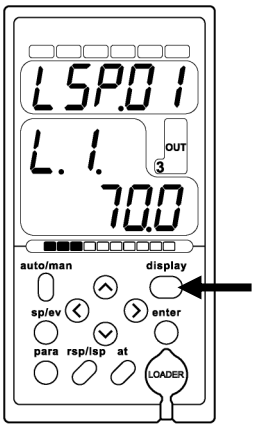
5-2-2 Increasing the heated sample stage temperature

Turn on the power to the temperature controller to begin adjusting the temperature of the heated sample stage.
Here, the temperature setting is 70 °C.

1 Turn on the POWER switch on the front of the temperature controller.



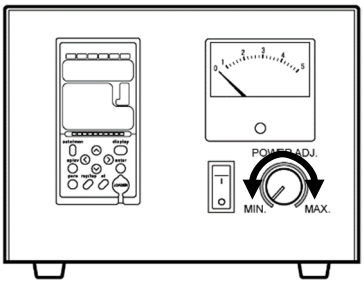
2 Set the temperature controller temperature setting to the required measurement temperature.
Refer to Steps 2 - 7 in '5-2-1 Setting up the temperature controller' to adjust the temperature setting.



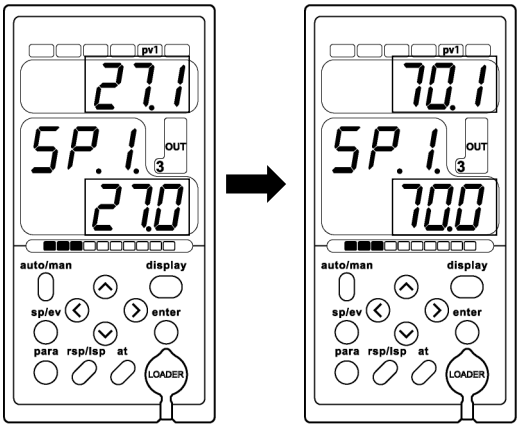
3 Once temperature setting is complete, press the display button.

The display returns to the operating status display.

4 Turn the POWER ADJ. knob on the temperature controller main unit to adjust the temperature while monitoring the temperature increase.



5 Check to confirm that the temperature setting has changed to the temperature specified.



NOTE

- If you press the wrong button or perform an incorrect operation, press the display button to return to the operating status display. Repeat the procedure.
- Use the POWER ADJ. knob on the temperature controller main unit to adjust the speed at which the temperature increases. If the temperature rises too quickly, gradually reduce the speed from MAX to prevent overshooting.

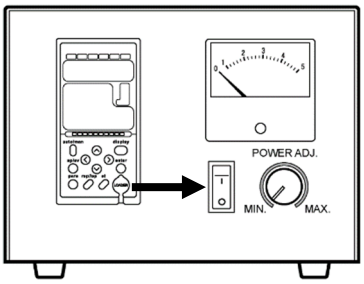
5-2-3 Replacing samples on the heated sample stage

Before replacing samples on the heated sample stage, turn off the power to the temperature controller and set the heated sample stage to room temperature.
Here, the temperature setting is 27 °C.

WARNING

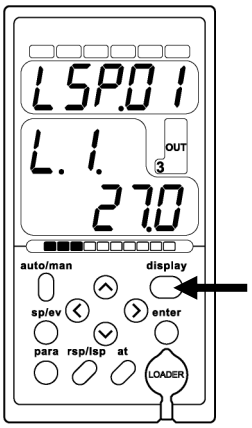
- Allow the heated sample stage to cool before replacing samples.
  Replacing samples while the sample stage is hot may result in burn injuries.

1 **Turn off the POWER switch on the front of the temperature controller.**



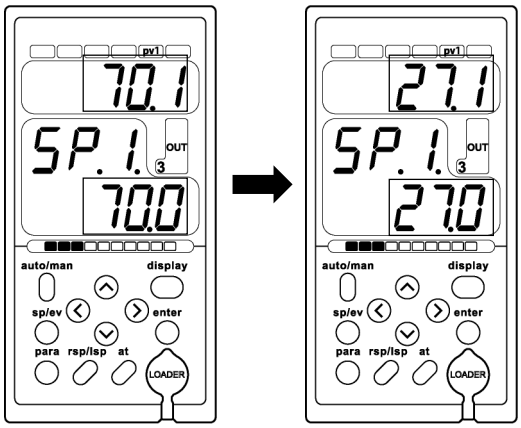
2 **Set the temperature controller temperature setting to the required measurement temperature.**
Refer to Steps 2 - 7 in ‘5-2-1 Setting up the temperature controller’ to adjust the temperature setting.

3 **Once temperature setting is complete, press the display button.**



The display returns to the operating status display.

4 Check to confirm that the temperature setting has changed to the temperature specified.



NOTE

- If you press the wrong button or perform an incorrect operation, press the display button to return to the operating status display. Repeat the procedure.

6

Measurement

6-1 Measurement precautions

Observe the following precautions when performing measurements.
Failure to do so may affect measurements.

- Avoid sample contamination.
  Use tweezers or similar implements to handle samples. Avoid breathing on the samples. Doing so may result in adsorption of moisture from exhaled air.

- Use tweezers or an air blower to remove any dust.
  Dust particles tend to be quite small relative to the areas being measured and will typically not affect measurements.

- Mount the sample in the measurement area. The measurement area on the AC-2S and AC-2S Pro α is a 4 mm × 4 mm square area at the center of the sample stage. The measurement area on the AC-2S Pro β measures 0.4 mm × 0.4 mm (two ellipses with a minor diameter measuring approximately 0.2 mm and a major diameter measuring approximately 0.4 mm) at the center of the sample stage. At least 90 % of the emitted UV light is incident on the measurement area. If a mixture of two or more materials is placed on the surface of the measurement area, photoelectrons will be emitted from all materials. The area around the measurement area will also be irradiated with very low intensity UV light.

- Be sure to adjust the height of the sample stage.
  The height gauge can be used to adjust the height to within ±0.2 mm of the measurement face. The incident UV is directed from the optical fiber to the measurement face at an angle of 30°. This means a height offset of 0.2 mm will result in an offset of 0.35 mm in the incident UV position.

- Plate samples must have sides measuring between 20 and 50 mm and may not exceed 10 mm in thickness. Powder samples must fit in the powder tray. Samples not meeting these requirements cannot be clamped to the sample stage and may fall off during measurement.

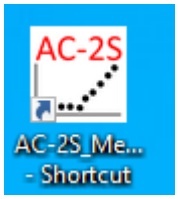
- Proceed carefully when mounting samples similar in size to the measurement area or smaller.
  For example, when measuring the photoemission characteristics from a 4 mm × 4 mm square ITO pattern on a 20 mm × 20 mm square aluminum plate using the AC-2S, approximately 10 % of the UV light irradiated will be incident on the aluminum even if the sample position and stage height are properly adjusted. The photoemission yield of aluminum is at least 50 times that of ITO. The measurement results will indicate the photoemission characteristics of aluminum. In cases like this, apply tape preventing photoemission to mask areas you do not want to measure.

- Measure at areas exhibiting photoelectron count rates not exceeding 4,000 cps.
  Measurement accuracy will be significantly reduced at count rates exceeding 4,000 cps. Use the UV intensity to adjust the photoelectron count rate.

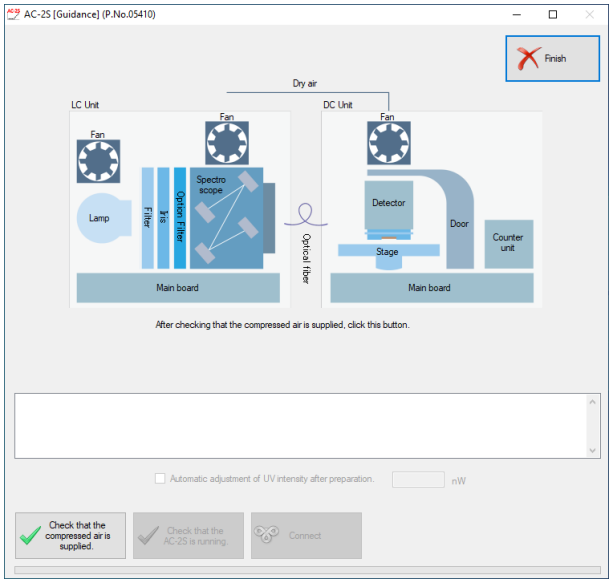
6-2 Launching the AC-2S measurement application

6-6-2 Launching the AC-2S measurement application

1 Double-click the AC-2S measurement application shortcut icon on the control PC desktop.



The AC-2S measurement application starts, and a guidance window appears.

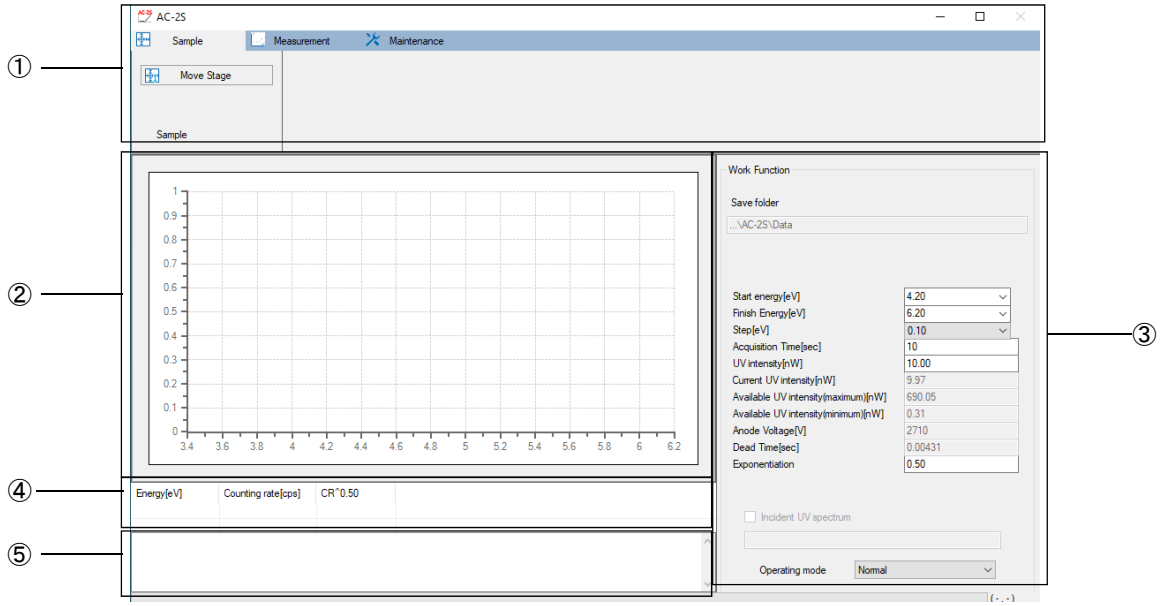


NOTE

- If you do not see the shortcut icon on the control PC desktop, open the Windows Start menu and select [AC-2S_Measure] from the Start menu list.

6-2-2 AC-2S measurement application main window component names and functions

The AC-2S measurement application main window displays measurement conditions and results.



No.	Name	Function
①	Menu display	Displays AC-2S measurement application functions as tabs. Click a tab to display the corresponding menu.
②	Graph	Plots measurement points.
③	Measurement conditions	Displays measurement conditions. The conditions displayed depend on the measurement being performed.
④	Data table	Displays measurements.
⑤	Status pane	Displays measurement status.

6-2-3 Files created by the AC-2S measurement application

The following files are created when the AC-2S measurement application is used to perform measurements:

<Work function measurement results files>

Type	Description
Measurement data file (*.dat)	File containing work function measurement results
Multi data file (*.mdat)	File containing the mean of multiple measurement results This is created if the work function is measured more than once.
Incident UV Spectrum file (*.ldat)	File containing the Incident UV Spectrum

- The measurement data file (*.dat) and multi data file (*.mdat) are saved to a user-specified folder in the \Documents\RikenKeikiPYSA\AC-2S\Data directory.
- If the work function is measured more than once, the software will create folders named after the sample. The corresponding measurement data file (*.dat) and multi data file (*.mdat) are saved to that folder.
- The Incident UV Spectrum file (*.ldat) is saved to the \Documents\RikenKeikiPYSA\AC-2S\UV folder.

<Calibration curve/film thickness measurement results files> Pro α Pro β

Type	Description
Count rate data file (*.sdat)	File containing count rate data for a reference sample
Calibration curve file (*.cdat)	File containing multiple count rate data files This is created if a calibration curve file is created. (Refer to ‘6-6 Creating and editing calibration curve files’.)
Film thickness data file (*.tdat)	File containing film thickness estimated based on the count rate data and calibration curve file.

- The count rate data file (*.sdat), calibration curve file (*.cdat), and film thickness data file (*.tdat) are saved to a user-specified folder in the \Documents\RikenKeikiPYSA\AC-2S\Data\CAL folder.

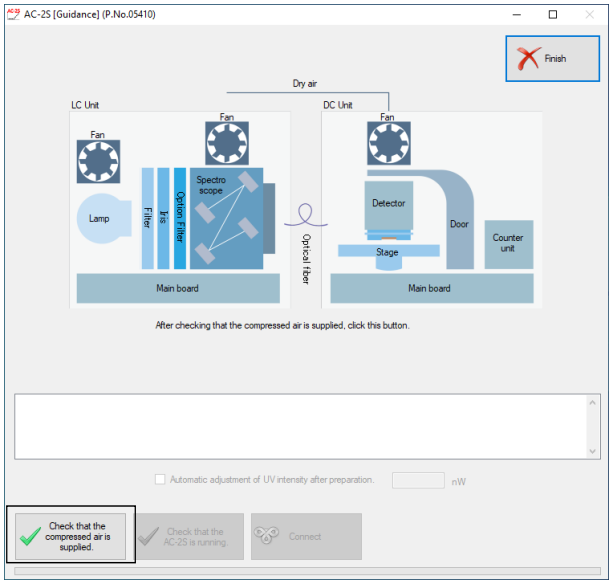
6-3 Main unit preparation

6-3-1 Dry compressed air supply and unit connection

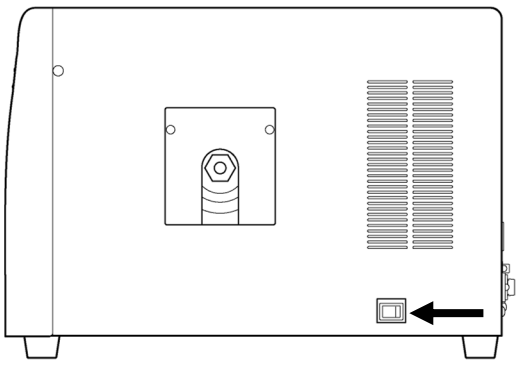
Supply dry compressed air to the AC-2S DC unit. Connect the AC-2S DC unit to the AC-2S LC unit.

1 **Supply dry compressed air to the AC-2S DC unit.**
If you are using a compressor, turn on the power for the compressor.
If you are supplying air via factory pipes, open the supply valve.

2 **Check to confirm that dry compressed air is being supplied, then click the [Check that the compressed air is supplied.] button in the guidance window.**

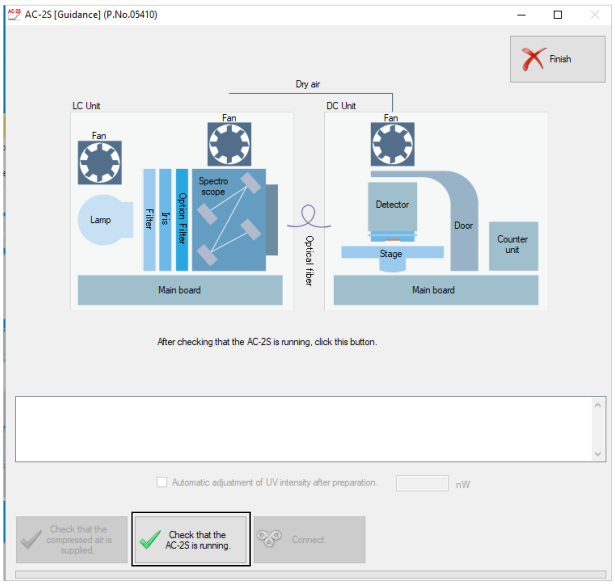


3 **Turn on the power switch on the right side of the AC-2S LC unit.**



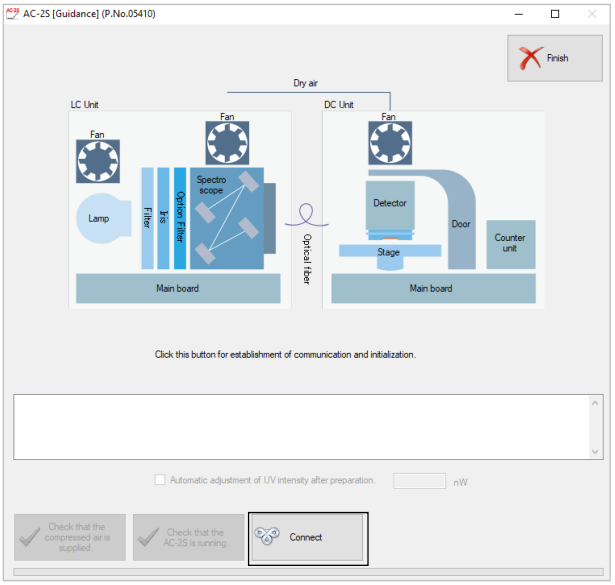
The product will begin warming up. The POWER/STANDBY LED will blink.
The POWER/STANDBY LED will remain continuously lit once the warmup is complete (after approximately 30 minutes).

4 Click the [Check that the AC-2S is running.] button in the guidance window.



The TROUBLE LEDs on the AC-2S LC and AC-2S DC units blink to indicate that the operation is being checked.

5 Click [Connect] in the guidance window once the AC-2S LC and AC-2S DC unit TROUBLE LEDs go out.

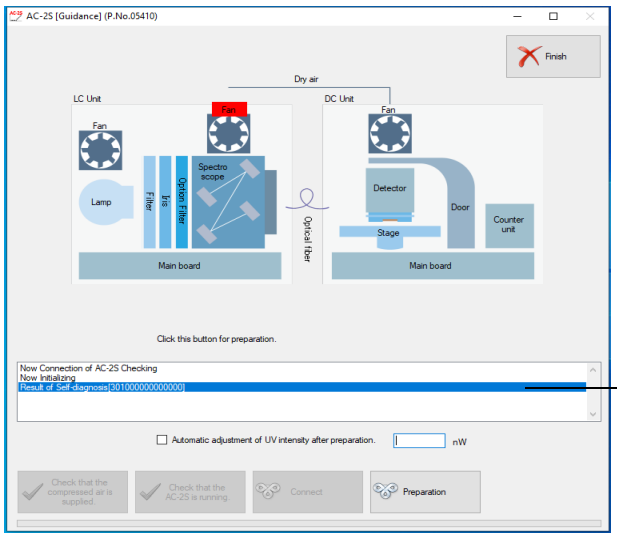


CAUTION

- Do not click the [Connect] button while the TROUBLE LEDs are blinking.
  Clicking the [Connect] button while the TROUBLE LEDs are blinking may cause the system to malfunction.
- Contact Riken Keiki if a message appears indicating that consumable parts need to be replaced.

NOTE

- An error or problem has occurred if the TROUBLE LEDs light up continuously. If this occurs, click the [Connect] button, and notify Riken Keiki of the error location and self-diagnostic result value.
  Example: AC-2S LC unit fan error



Self-diagnosis result

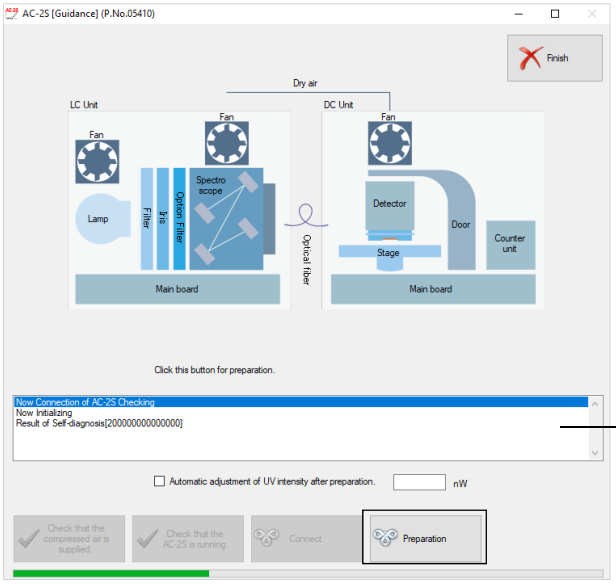
6-3-2 Initializing the UV intensity controller and setting the detector voltage

After connecting the AC-2S LC and AC-2S DC units, initialize the UV intensity controller and set the detector voltage.

<AC-2S>

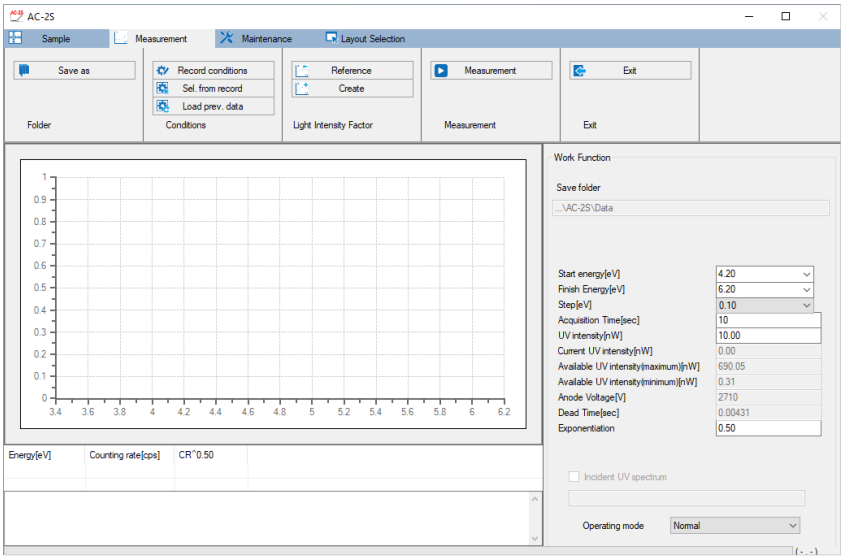
1 Click the [Preparation] button in the guidance window.

The guidance window status pane will indicate the operations currently underway.



Status pane

The AC-2S measurement application main window appears once main unit setup is complete.



NOTE

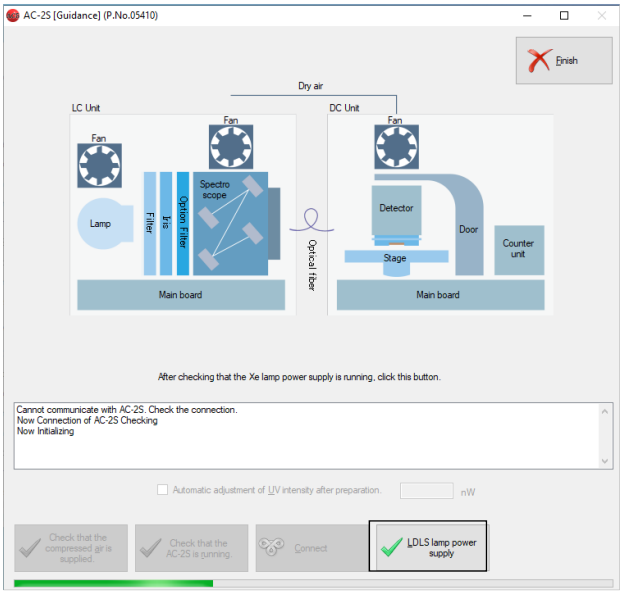
- Check the [Automatic adjustment of UV intensity after preparation] check box in the guidance window, specify UV intensity, and click the [Preparation] button. The UV intensity is set automatically after main unit setup is complete. (Refer to ‘6-4-4 Setting the Incident UV Spectrum’.)

CAUTION

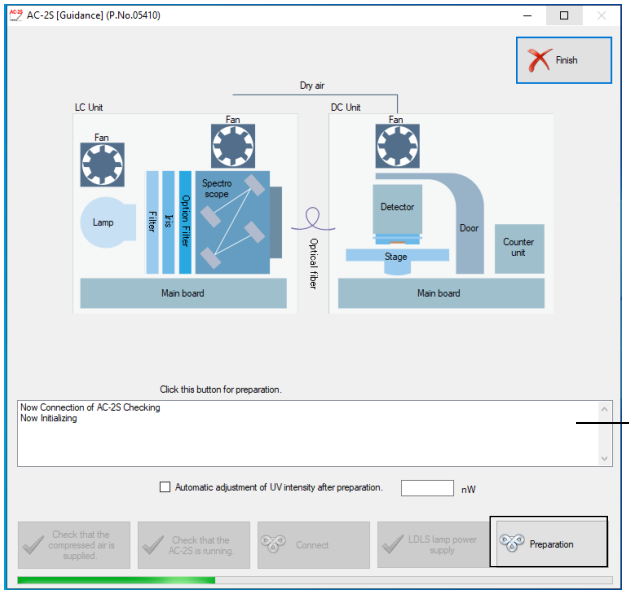
- Depending on operating system specifications, communication with the main unit may not be possible if this application or other software is running while connected or during measurement. Do not perform any other processing on the control PC while this application is communicating with the main unit to establish connection or perform measurements.

<AC-2S Pro α/AC-2S Pro β>

1 Check to confirm that the plasma light source (LDLS) LASER ON LED and LAMP ON are both lit, then click the [LDLS lamp power supply] button in the guidance window.

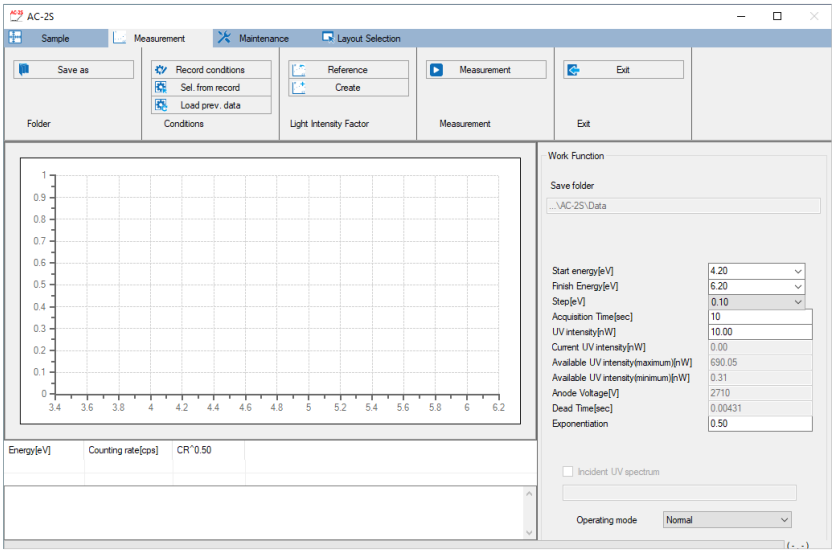


2 Click the [Preparation] button in the guidance window.
The guidance window status pane will indicate the operations currently underway.



Status pane

The main window appears once main unit setup is complete.



NOTE

- Check the [Automatic adjustment of UV intensity after preparation] check box in the guidance window, specify UV intensity, and click the [Preparation] button. The UV intensity is set automatically after main unit setup is complete. (Refer to ‘6-4-4 Setting the Incident UV Spectrum’.)

CAUTION

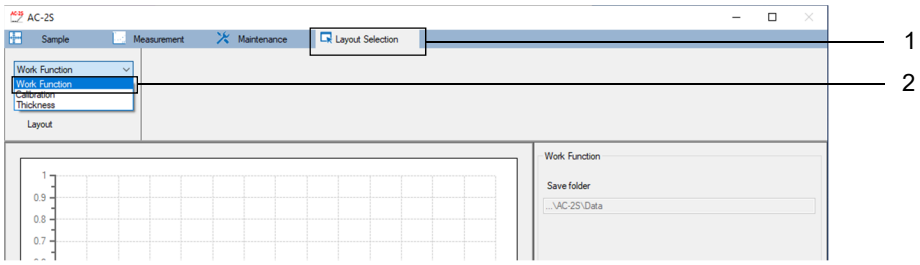
- Depending on operating system specifications, communication with the main unit may not be possible if this application or other software is running while connected or during measurement. Do not perform any other processing on the control PC while this application is communicating with the main unit to establish connection or perform measurements.

6-4 Work function measurement

6-4-1 Selecting the work function Proα Proβ

1 Click the [Layout Selection] tab on the main window.

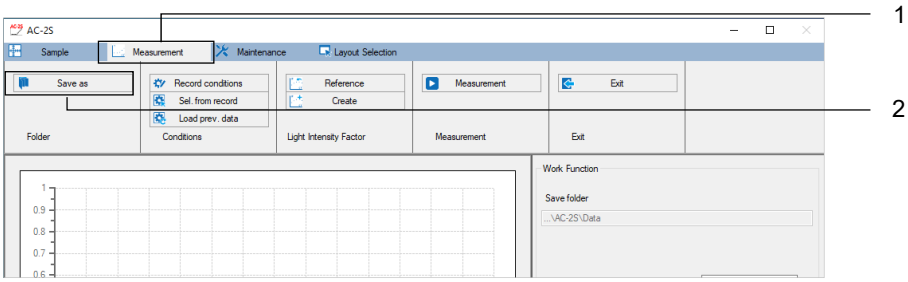
2 Click [∨] for [Layout], then select [Work function].



6-4-2 Setting the measurement data file save destination folder

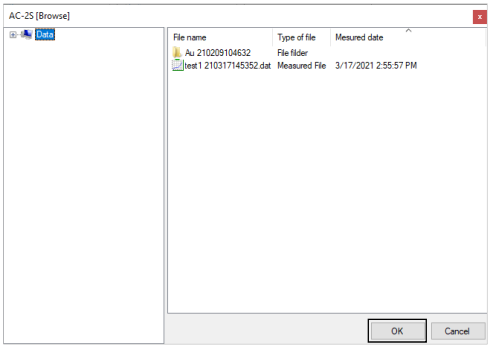
1 Click the [Measurement] tab on the main window.

2 Click the [Save as] button for [Folder].



The browse window appears.

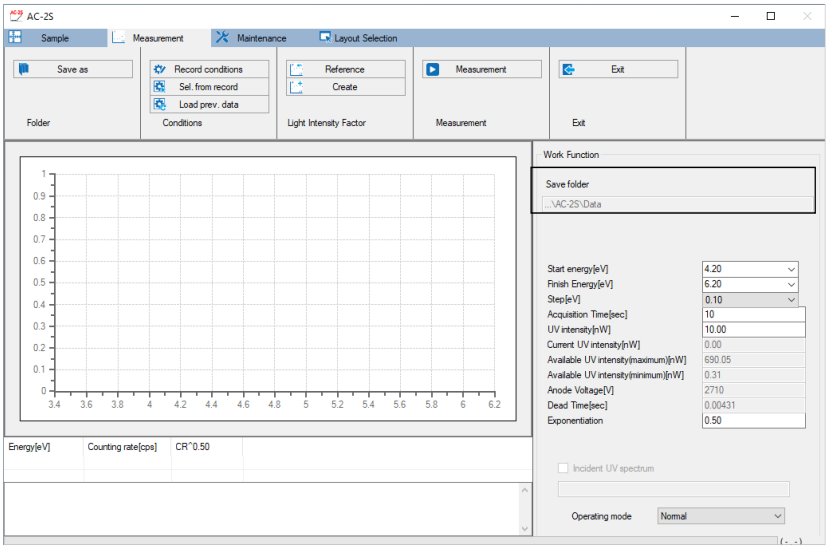
3 Specify the save destination folder, then click the [OK] button.
Specify a folder within the \Documents\RikenKeikiPYSA\AC-2S\Data directory.



NOTE

- To create a new save destination folder from the browse window, right-click on the folder in which the new folder is to be created in tree view on the left side of the browse window, then select [Save as].

The name of the save destination folder is displayed in [Save folder] on the main window.



6-4-3 Setting work function measurement conditions

Set the following measurement conditions:

Setting item	Typical measurement condition	Setting details
Start energy	4.20	Sets the incident UV energy at the start of measurement (units: eV).
End energy	6.20	Sets the incident UV energy at the end of measurement (units: eV).
Step	0.10	Sets measurement intervals from start energy to end energy (units: eV).
Acquisition time	5 - 10	Sets the acquisition time for each energy level (units: seconds).
UV intensity	10.00	Sets the UV intensity for measurement (units: nW). Enter a value between the maximum and minimum allowable UV intensity values.
Exponent	0.50	Sets the exponential value for the vertical axis when plotting data on the graph. Enter a decimal value not exceeding 1.

NOTE

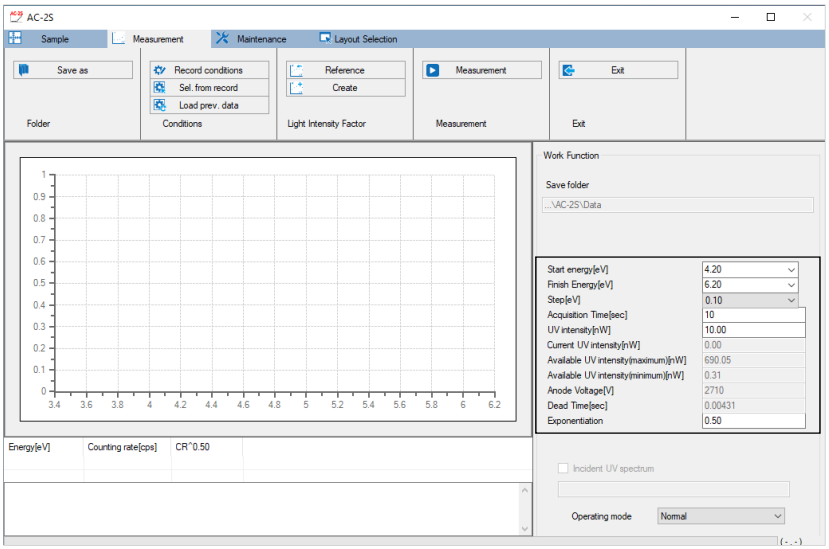
- The appropriate UV intensity depends on the particular sample. To measure the work function of a new sample, uncheck [Incident UV spectrum] on the main window, then perform preliminary measurements using a provisional UV intensity. After obtaining the appropriate UV intensity in the preliminary measurements, use that UV intensity to obtain the Incident UV Spectrum, then measure the work function once again.
  Increasing the step interval for preliminary measurement will reduce the time required.

Set measurement conditions by any of the following methods:

- Direct input
- Select from saved measurement conditions.
- Use same conditions as past measurement data.

<Direct input>

1 Enter the individual measurement conditions for [Work Function].
Select the values for [Start energy [eV]], [End energy [eV]], and [Step [eV]] from the corresponding drop-down lists.



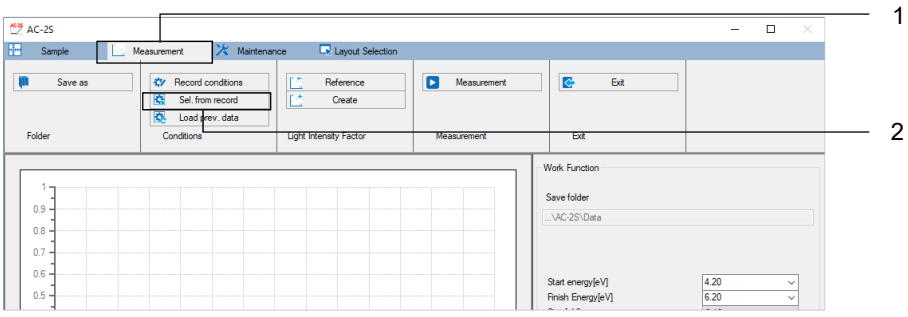
NOTE

- Click the [Record conditions] on the [Measurement] tab to store up to ten set measurement conditions.

<Select from saved measurement conditions>

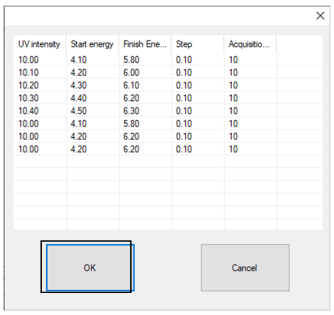
1 Click the [Measurement] tab on the main window.

2 Click the [Sel. from record] button for [Conditions].



A window appears with a list of saved measurement conditions.

3 Select the desired measurement condition, then click the [OK] button.

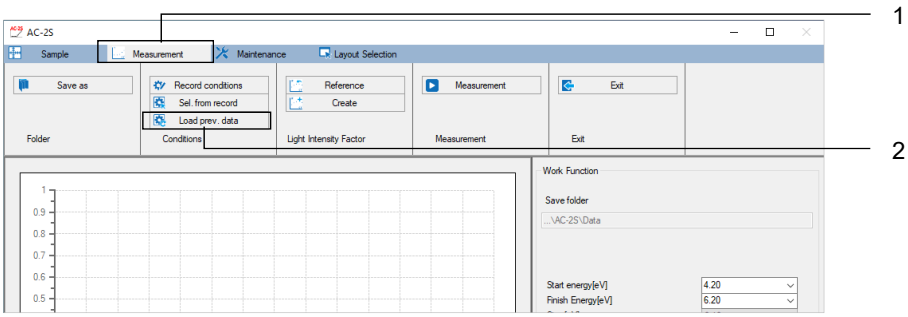


The selected measurement condition is displayed in the measurement condition input box on the main window.
You can edit the measurement condition entered in the main window.

<Use the same condition as for past measurement data>

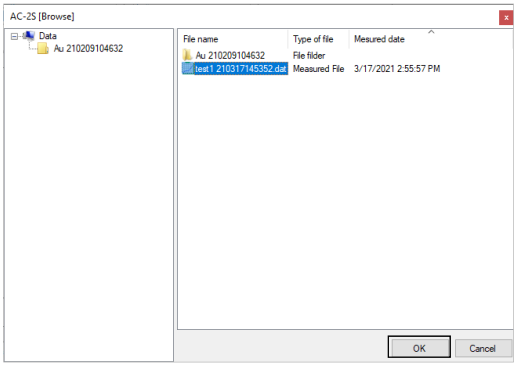
1 Click the [Measurement] tab on the main window.

2 Click the [Load prev. data] button for [Conditions].



The browse window appears.

3 Select the desired data file, then click the [OK] button.



6-4-4 Setting the Incident UV Spectrum

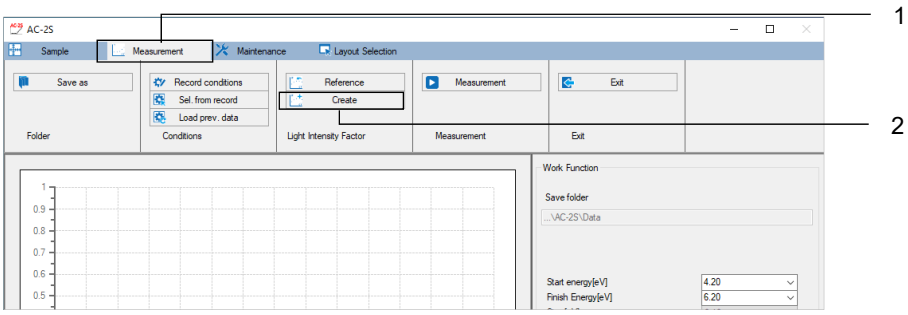
Set the Incident UV Spectrum.
Set the Incident UV Spectrum by any of the following methods:

- Set a new Incident UV Spectrum.
- Use a previously measured Incident UV Spectrum.

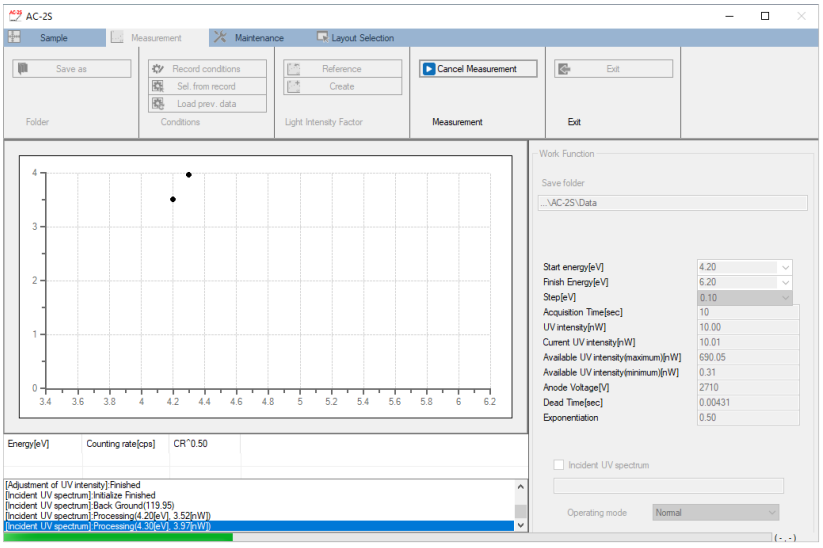
<Set a new Incident UV Spectrum>

1 Click the [Measurement] tab on the main window.

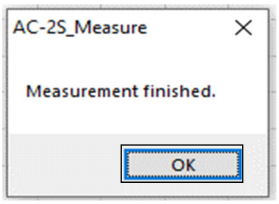
2 Click the [Create] button for [Light Intensity Factor].



Incident UV Spectrum measurement starts. The values are plotted on the graph.



3 Press the [OK] button when the following message appears:



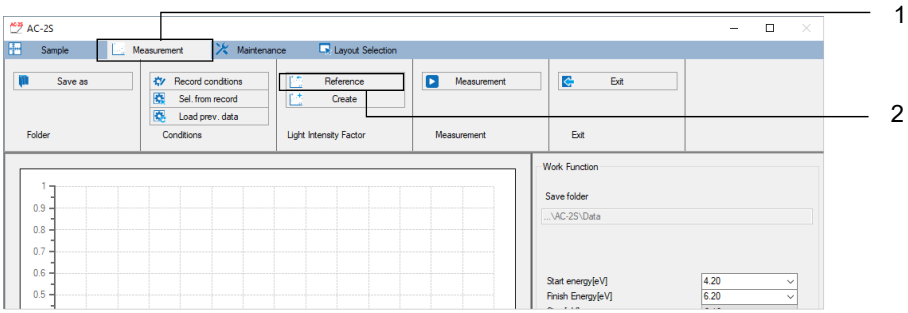
NOTE

- Specifying UV intensity values close to the maximum or minimum value may make it impossible to set a Incident UV Spectrum within ±5 % of the setting.
- Click the [Cancel Measurement] button on the measurement window while Incident UV Spectrum is being measured to abort the measurement.

<Use a previously measured Incident UV Spectrum>

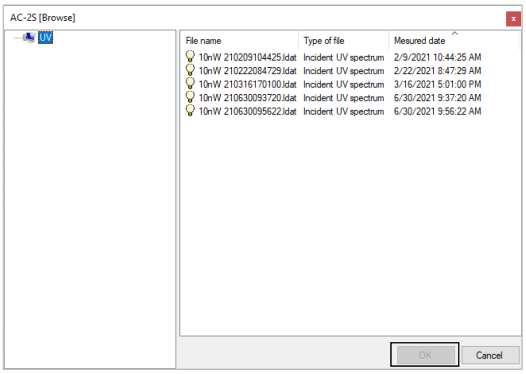
1 Click the [Measurement] tab on the main window.

2 Click the [Reference] button for [Light Intensity Factor].



The browse window appears.

3 Select the desired Incident UV Spectrum file, then click the [OK] button.



CAUTION

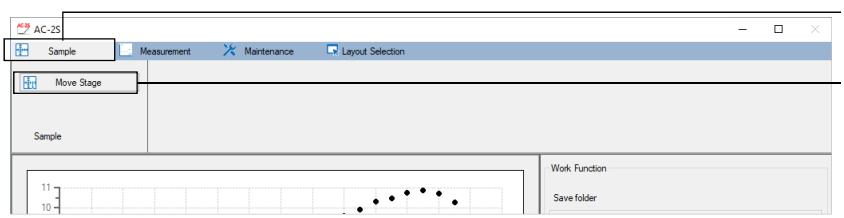
- The Incident UV Spectrum files available for selection are files for which the UV intensity is the same and measurement conditions fall within the measurement range (start energy, end energy, step). A warning will appear if the file was not measured on the same day.

6-4-5 Mounting samples

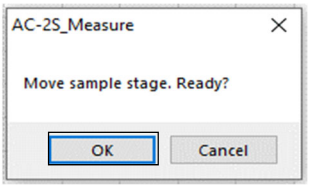
Mount the sample in the AC-2S DC unit.

1 Click the [Sample] tab on the main window.

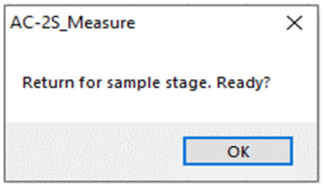
2 Click the [Move Stage] button.



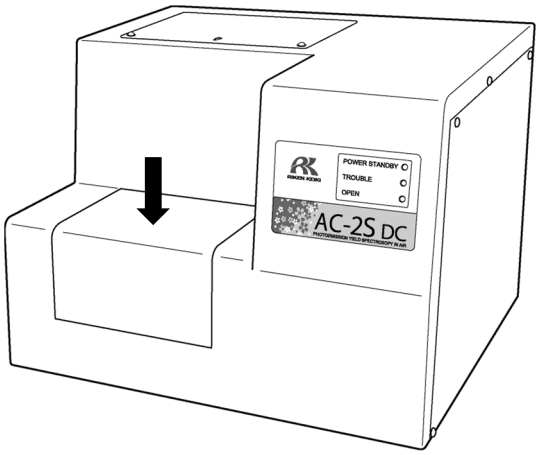
3 Click the [OK] button when the sample stage move confirmation message appears.



The sound of the stage operation ends, and the following message appears.
Do not click the [OK] button here.



4 Gently press the sample inlet cover with your finger to open.
The AC-2S DC unit OPEN LED lights up.

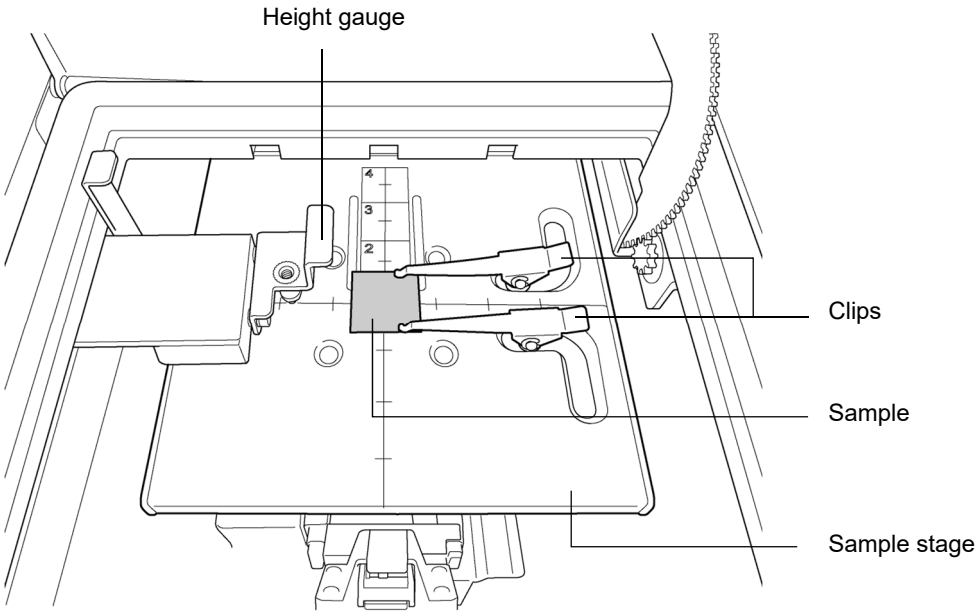


CAUTION

- Failure of the OPEN LED to light up may indicate a fault. Take care if this occurs. The stage may move even when the sample inlet is open.

5 Place the sample at the center of the sample stage, then adjust the height of the height gauge.

6 Clamp the sample with the clips.

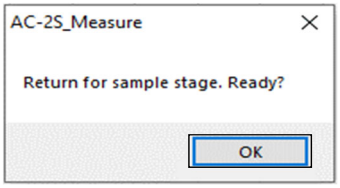


WARNING

- Be sure to adjust the height of the sample using the height gauge.
  If the sample is positioned above the probe on the height gauge, the sample may strike the detector or other parts, potentially damaging the sample or the product.
- Push the height gauge to pull it out from the side of the sample stage.
  Any of the following actions may damage the height gauge:
  - Subjecting the height gauge to a force of 20 N or more from above, below, or diagonally
  - Pulling out the height gauge by the tip (pin).

7 Close the sample inlet cover.
The AC-2S DC unit OPEN LED goes out.

8 Click the [OK] button on the message window.



<High-temperature measurement> Pro α Pro β

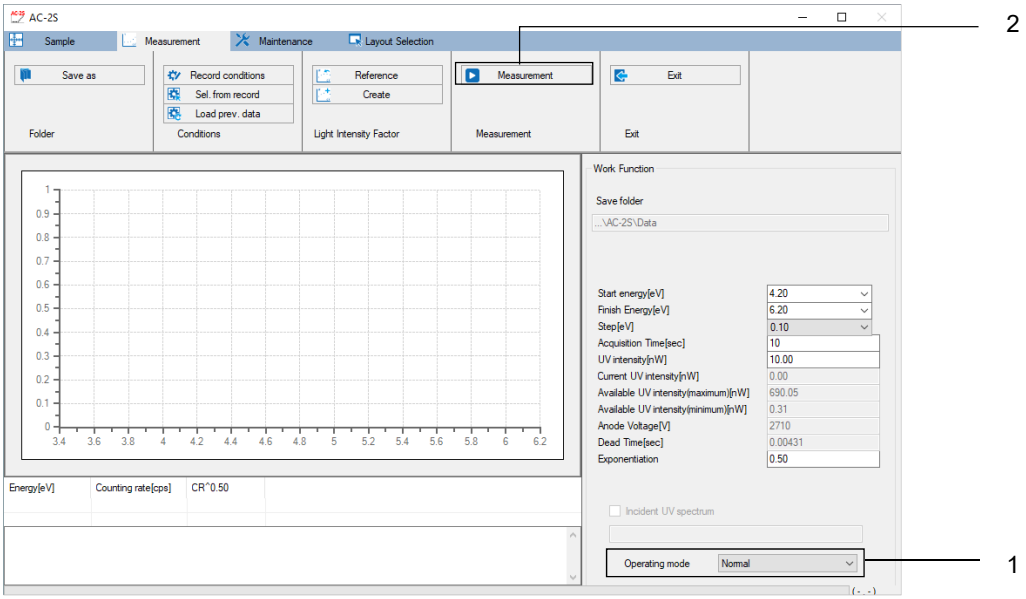
For high temperature measurements, set the sample stage temperature after mounting the sample.
For more information on sample stage temperature settings, refer to ‘5-2 Heated sample stage temperature adjustment’.

6-4-6 Starting single-point measurement

Single-point measurement involves irradiating and measuring a single point on the sample with UV light.

1 Click [∨] for [Operating mode] on the main window, then select [Normal].

2 Click the [Measurement] button for [Measurement].



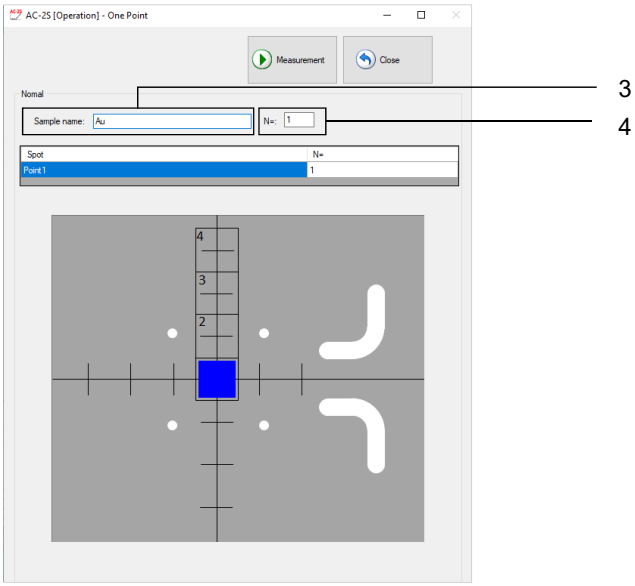
The measurement start window appears.

NOTE

- Check [Incident UV spectrum] to correct UV intensity. Uncheck [Incident UV spectrum] to correct UV intensity later.
  For more information on setting the Incident UV Spectrum, refer to '6-4-4 Setting the Incident UV Spectrum'.

3 Enter the sample name for [Sample name].

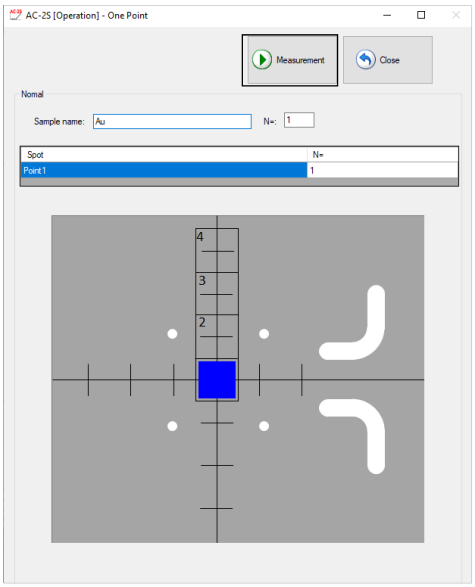
4 Enter the number of measurements (1 - 1000) for [N=].



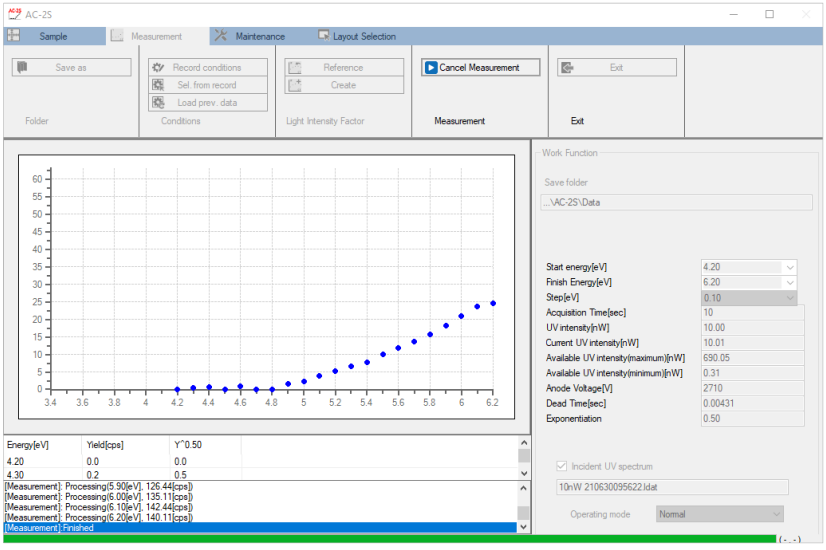
NOTE **Pro β**

- The position of the sample must be fine-tuned when mounting small samples on the AC-2S Pro β. Failure to do so may result in a sample being offset from the center of the sample stage. (Refer to '<Fine adjust sample position>' in this section.)

5 Click the [Measurement] button.



Measurement starts. The count is plotted in sequence for each energy on the main window.



The horizontal axis of the graph represents incident UV energy in units of eV. The vertical axis represents the exponent for photoelectron yield. The upper limit of the vertical axis is automatically set to approximately 4000^n, where n is the exponent. For example, if n is 0.5, the upper limit of the vertical axis will be approximately 65.

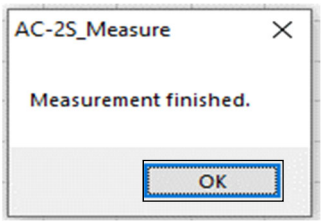
NOTE

- Click the [Cancel Measurement] button on the measurement window while the work function is being measured to abort the measurement.

CAUTION

- Depending on operating system specifications, communication with the main unit may not be possible if this application or other software is running while connected or during measurement. Do not perform any other processing on the control PC while this application is communicating with the main unit to establish connection or perform measurements.

6 Click the [OK] button when measurement has ended and the following message appears.



NOTE

- For low UV intensity values or if the measurement energy range has not been appropriately set, revise the settings for [UV intensity [nW]], [Start energy [eV]], and [End energy [eV]] in the measurement conditions before repeating measurement.

7 Remove the sample.

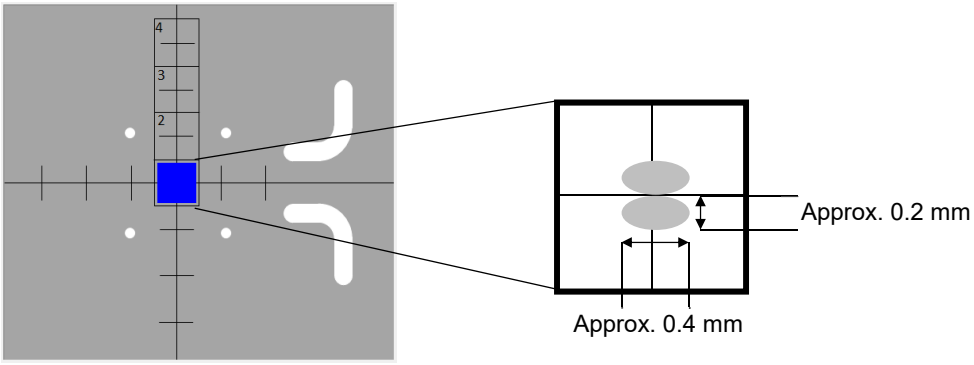
Remove the sample. Refer to '6-4-5 Mounting samples'.

NOTE

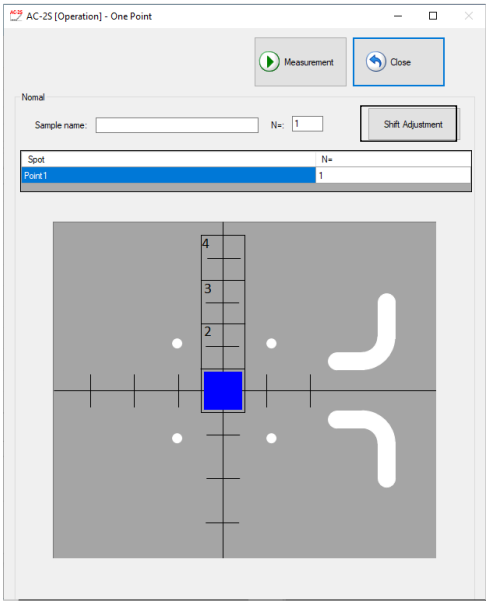
- The measurement results are saved to the specified destination folder. (Refer to '6-4-2 Setting measurement data file save destination folder'.)
- The measurement results are saved as measurement data files (*.dat). If measurement is performed more than once, the software will create folders named after the sample. The corresponding measurement data file (*.dat) and multi data file (*.mdat) are saved to that folder.
- The Incident UV Spectrum file (*.ldat) is saved to the \Documents\RikenKeikiPYSA\AC-2S\UV folder.

<Fine adjust sample position> Pro β

The position of small samples must be fine-tuned if there is any risk that the sample will be offset from the center of the sample stage.
The measurement area on the AC-2S Pro β consists of two ellipses (with a minor diameter measuring approximately 0.2 mm and a major diameter measuring approximately 0.4 mm) at the center of the sample stage.



1 Click the [Shift Adjustment] button on the measurement start window.

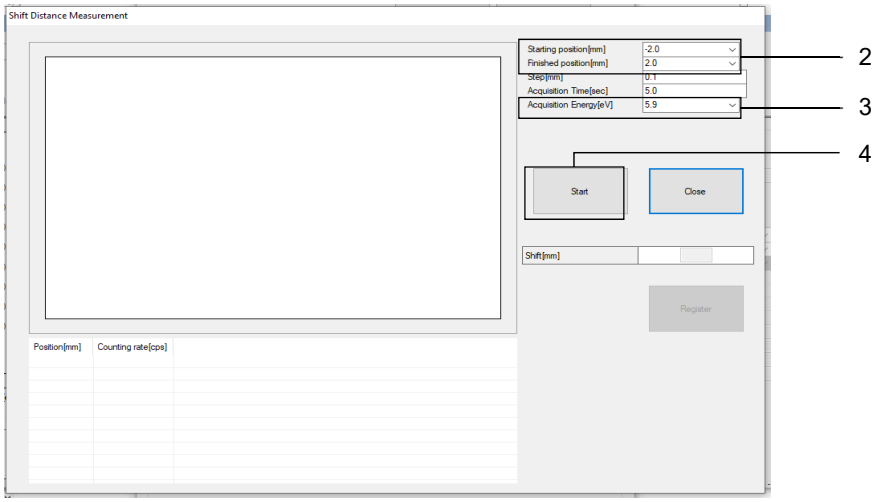


The shift adjustment window is displayed.

2 Click [∨] for [Starting position [mm]] and [Finished position [mm]], then select the shift amount for the measurement start or end positions.
The shift amount can be set in the range -2.0 to 2.0.

3 Click [∨] for [Acquisition Energy [eV]], then select the measurement energy.
Leave the values for [Step [mm]] and [Acquisition Time [sec]] unchanged.

4 Click the [Start] button.



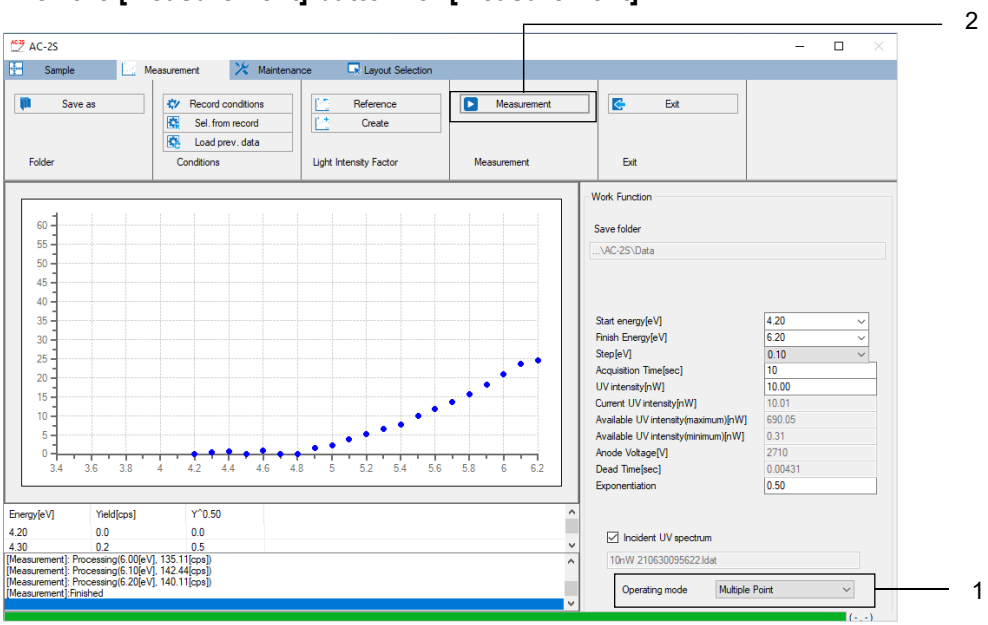
The sample position is fine adjusted.

6-4-7 Starting multi-point measurement

Multi-point measurement involves irradiating and measuring multiple points on the sample with UV light. Up to four points can be specified.

1 Click [∨] for [Operating mode] on the main window, then select [Multiple Point].

2 Click the [Measurement] button for [Measurement].



The measurement start window appears.

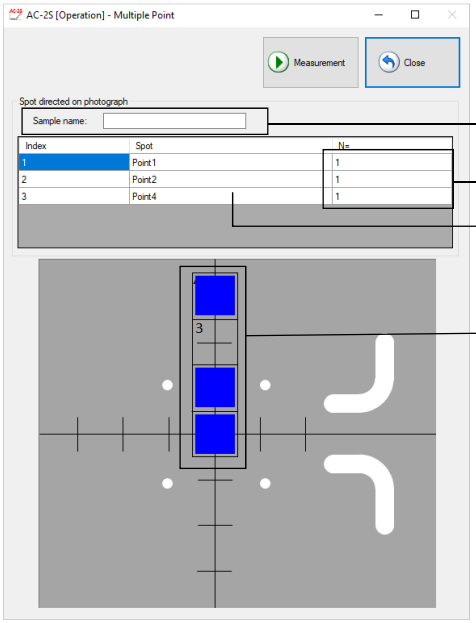
NOTE

- Check [Incident UV spectrum] to correct UV intensity. Uncheck [Incident UV spectrum] to correct UV intensity later.
  For more information on setting the Incident UV Spectrum, refer to ‘6-4-4 Setting the Incident UV Spectrum’.

3 Enter the sample name for [Sample name].

4 Click to select the measurement position(s) on the measurement start window.
Click areas [1] to [4] on the sample stage view to select the desired measurement positions. Blue squares indicate the selected measurement positions. (In the example shown below, measurement positions [1], [2], and [4] are selected.)

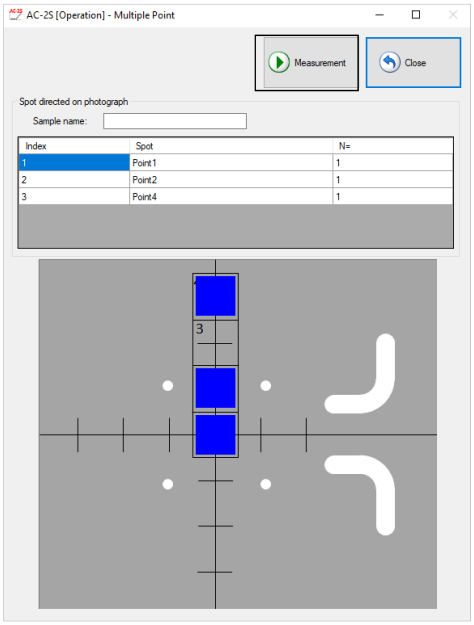
5 Enter the number of measurements for [N=] for each measurement position.



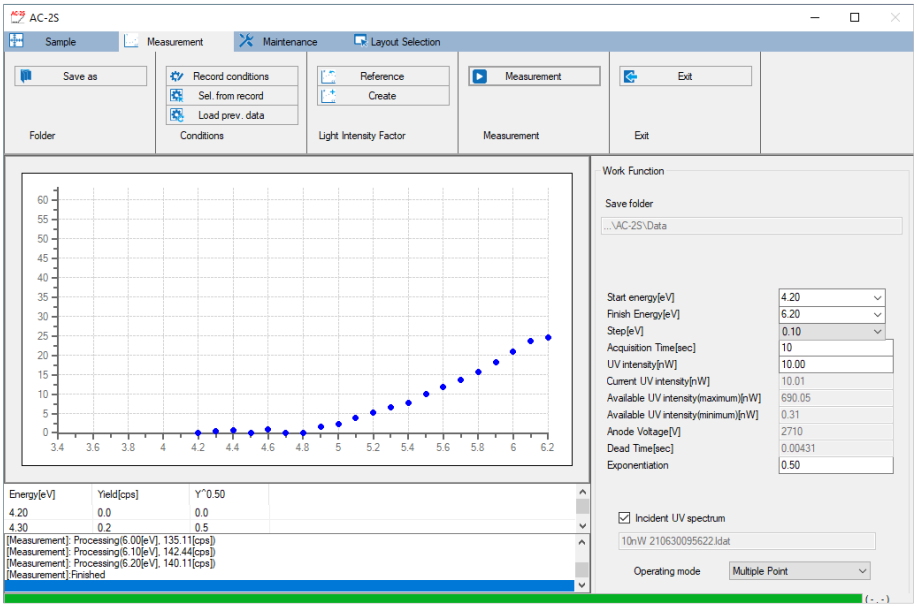
NOTE

- In the measurement start window, click and select a measurement position in sample stage view to display the measurement positions from [Point 1] to [Point 4] in [Spot] for [Spot directed on photograph]. You can edit the names of the measurement positions.

6 Click the [Start] button.



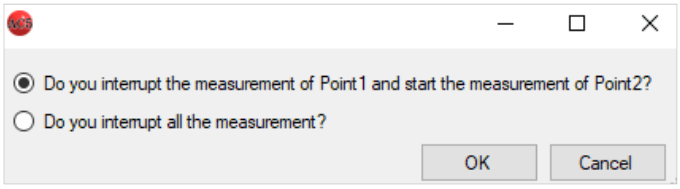
Measurement starts. The count is plotted in sequence for each energy on the main window.



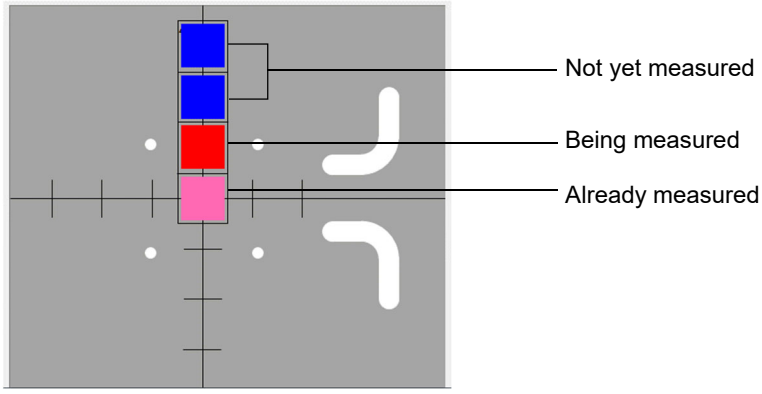
The horizontal axis of the graph represents incident UV energy in units of eV. The vertical axis represents the exponent for photoelectron yield. The upper limit of the vertical axis is automatically set to approximately 4000^n, where n is the exponent. For example, if n is 0.5, the upper limit of the vertical axis will be approximately 65.

NOTE

- The following window appears if you click the [Cancel Measurement] button on the measurement window while measuring the work function.
  Select the preferred measurement abort procedure, then click the [OK] button.



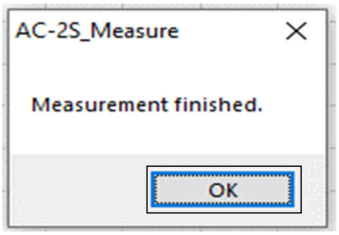
- The color of the square indicates the measurement status at each measurement position.
  Blue indicates a position not yet measured. Red indicates a position currently being measured. Pink indicates a position that has already been measured.



CAUTION

- Depending on operating system specifications, communication with the main unit may not be possible if this application or other software is running while connected or during measurement. Do not perform any other processing on the control PC while this application is communicating with the main unit to establish connection or perform measurements.

7 Click the [OK] button when measurement has ended and the following message appears.



NOTE

- For low UV intensity values or if the measurement energy range has not been appropriately set, revise the settings for [UV intensity [nW]], [Start energy [eV]], and [End energy [eV]] in the measurement conditions before repeating measurement.

8 Remove the sample.

Remove the sample. Refer to ‘6-4-5 Mounting samples’.

NOTE

- The measurement results are saved to the specified destination folder. (Refer to ‘6-4-2 Setting measurement data file save destination folder’.)
- The measurement results are saved as measurement data files (*.dat). If measurement is performed more than once, the software will create folders named after the sample. The corresponding measurement data file (*.dat) and multi data file (*.mdat) are saved to that folder.
- The Incident UV Spectrum file (*.Idat) is saved to the \Documents\RikenKeikiPYSA\AC-2S\UV folder.

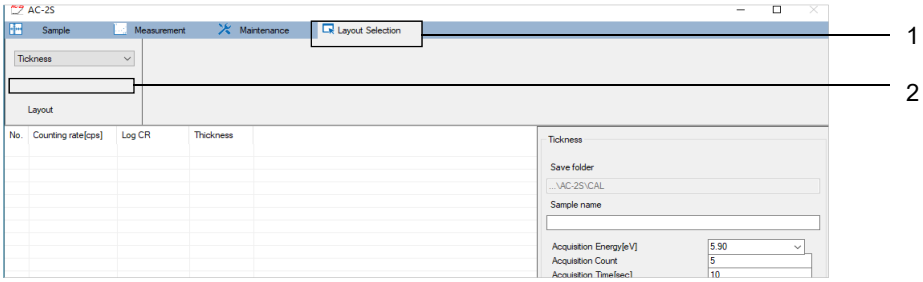
6-5 Calibration curve measurement Pro α Pro β

Measure the calibration curve for a sample of known film thickness.

6-5-1 Selecting calibration curve measurement

1 Click the [Layout Selection] tab on the main window.

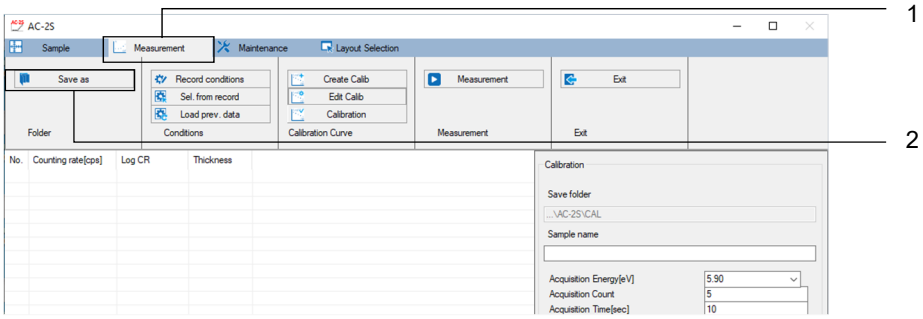
2 Click [∨] for [Layout], then select [Calibration curve].



6-5-2 Setting the count rate data file save destination folder

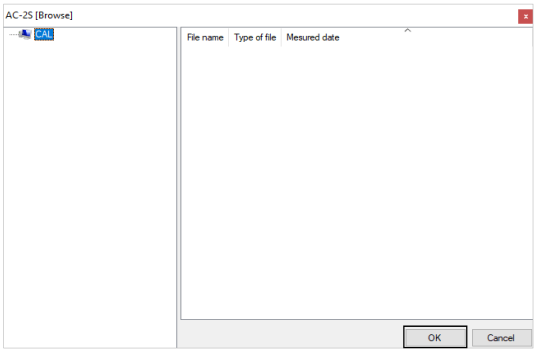
1 Click the [Measurement] tab on the main window.

2 Click the [Save as] button for [Folder].



The browse window appears.

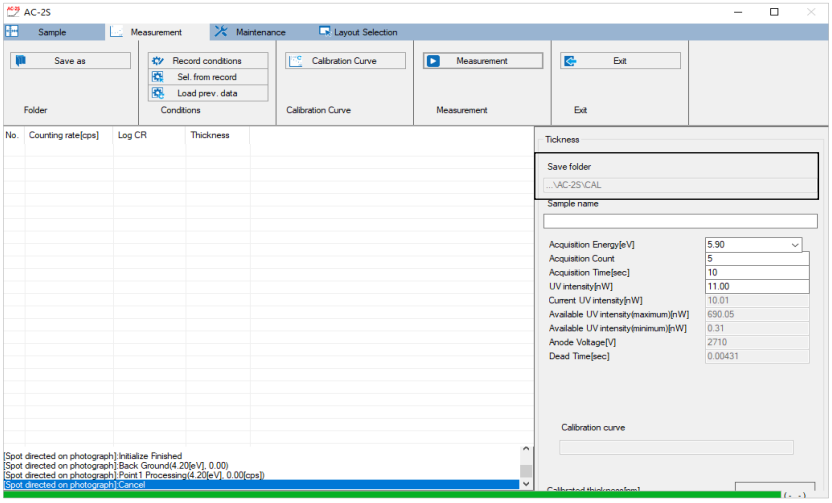
3 Specify the save destination folder, then click the [OK] button.
Specify a folder within the \Documents\RikenKeikiPYSA\AC-2S\Data\CAL directory.



NOTE

- To create a new save destination folder from the browse window, right-click on the folder in which the new folder is to be created in the folder tree view list on the left side of the browse window, then select [Save as].

The name of the save destination folder is displayed in [Save folder] on the main window.



6-5-3 Setting calibration curve measurement conditions

Set the following measurement conditions:

Setting item	Setting details
Sample name	Sets the name of the sample to be measured.
Acquisition Energy	Sets the energy for measuring calibration curves (units: eV). Example: 5.90 eV
Acquisition Count	Sets the number of calibration curve measurements. Example: 5
Acquisition Time	Sets the acquisition time for each energy level (units: seconds). Example: 10 seconds
UV Intensity	Sets the UV intensity for measurement (units: nW). Enter a value between the maximum and minimum allowable UV intensity values.
Thickness	Sets the film thickness of the reference sample (units: nm).

NOTE

- Use the sample and tweezers provided when using the AC-2S measurement application for the first time. Measure as specified in this manual. Set the required measurement conditions. Refer to the examples provided.

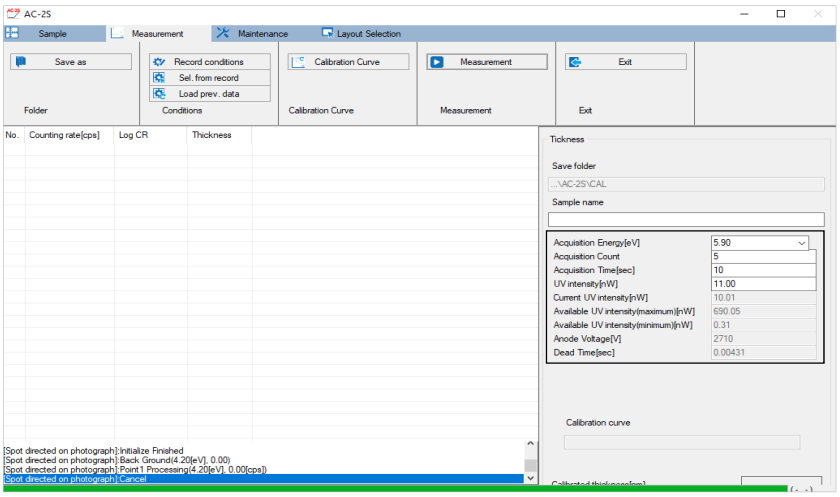
Set measurement conditions by any of the following methods:

- Direct input
- Select from saved measurement conditions.
- Use same conditions as past measurement data.

<Direct input>

1 Enter the individual measurement conditions for [Calibration].

Select the value for [Acquisition Energy [eV]] from the drop-down list.



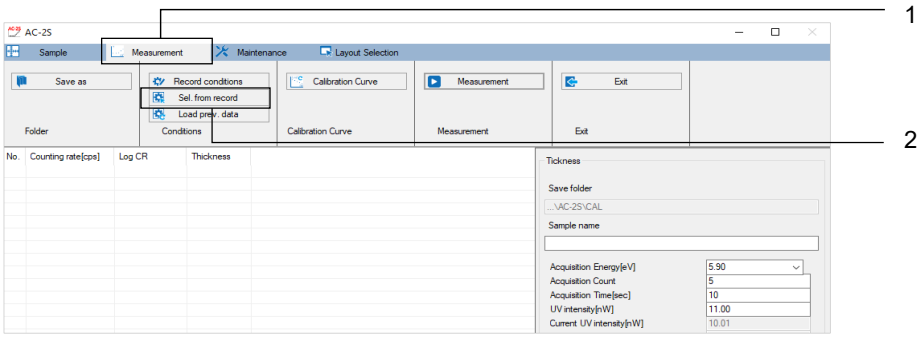
NOTE

- Click the [Record conditions] on the [Measurement] tab to store up to ten set measurement conditions.

<Select from saved measurement conditions>

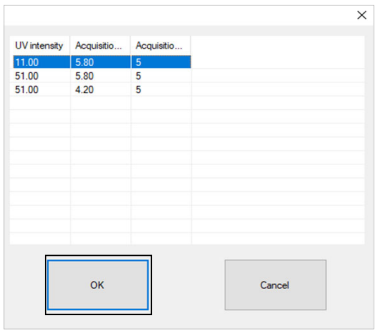
1 Click the [Measurement] tab on the main window.

2 Click the [Sel. from record] button for [Conditions].



A window appears with a list of saved measurement conditions.

3 Select the desired measurement condition, then click the [OK] button.

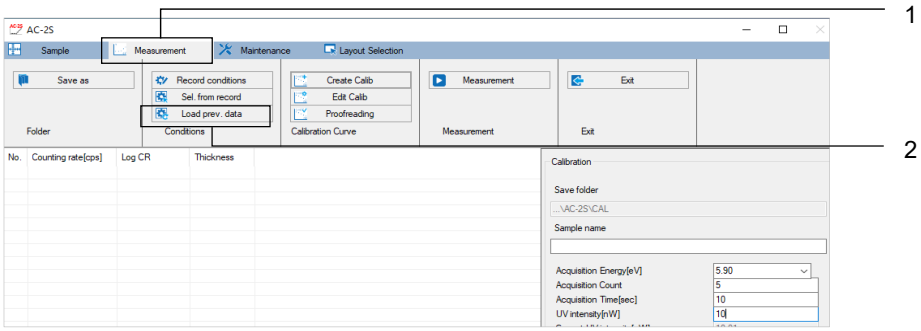


The selected measurement condition is displayed in the measurement condition input box on the main window.
You can edit the measurement condition entered in the main window.

<Use the same condition as for past measurement data>

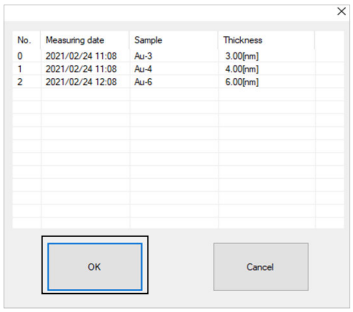
1 Click the [Measurement] tab on the main window.

2 Click the [Load prev. data] button for [Conditions].



This displays a list of count rate data files.

3 Select the desired file, then click the [OK] button.



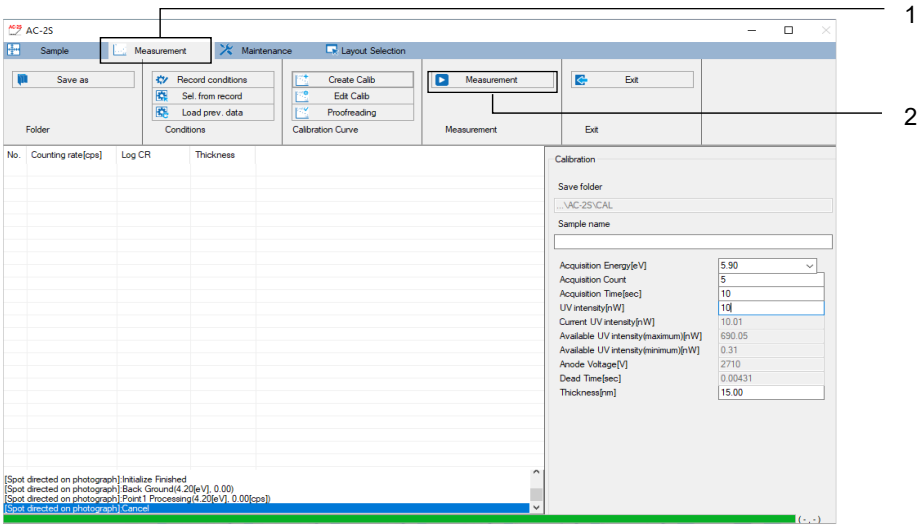
6-5-4 Mounting samples

Mount the sample.
Mount the sample in the AC-2S DC unit. Refer to ‘6-4-5 Mounting samples’.

6-5-5 Starting calibration curve measurement

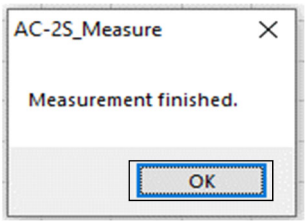
1 Click the [Measurement] tab on the main window.

2 Click the [Measurement] button for [Measurement].



Calibration curve measurement starts.

3 Click the [OK] button when measurement has ended and the following message appears.



The count rate data file (*.sdat) is saved to the specified save destination folder. (Refer to ‘6-5-2 Setting count rate data file save destination folder’.)

4 Remove the sample.

Remove the sample. Refer to ‘6-4-5 Mounting samples’.

NOTE

- At least two calibration curve results (count rate data files) for a reference sample of known film thickness are required to create a calibration curve file.
  To continue and measure the calibration curve for a different reference sample, measure in the same way as described from ‘6-5-1 Selecting calibration curve measurement’ to ‘6-5-5 Starting calibration curve measurement’.

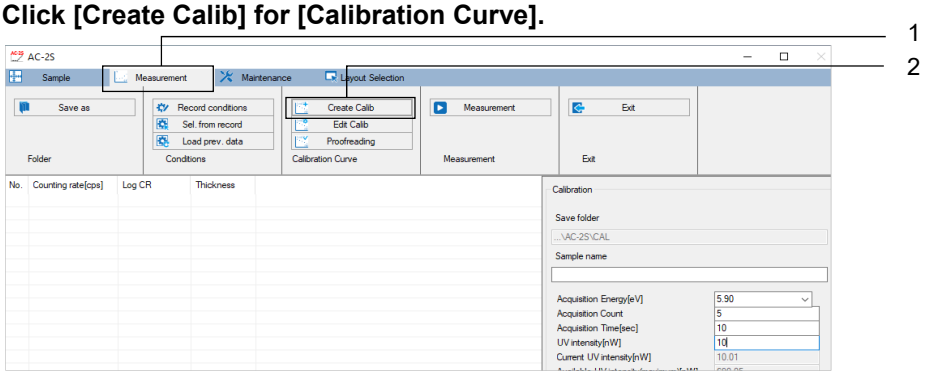
6-6 Creating and editing calibration curve files Pro α Pro β

6-6-1 Creating calibration curve files

Create a calibration curve file based on measurements of at least two reference samples of known film thickness.
The calibration curve is a file containing multiple count rate data files.

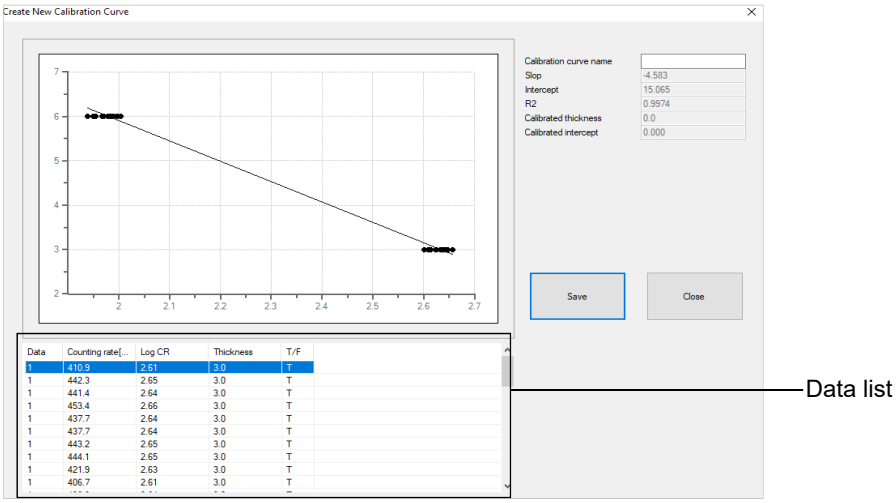
1 Click the [Measurement] tab on the main window.

2 Click [Create Calib] for [Calibration Curve].



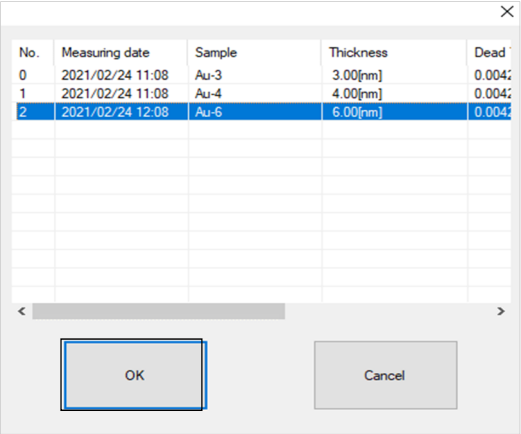
The create new calibration curve window appears.

3 Right-click on the calibration curve data list, then select [Add data].



The browse window appears.

4 Click and select the desired count rate data file, then click the [OK] button.
Only one file can be selected at a time.

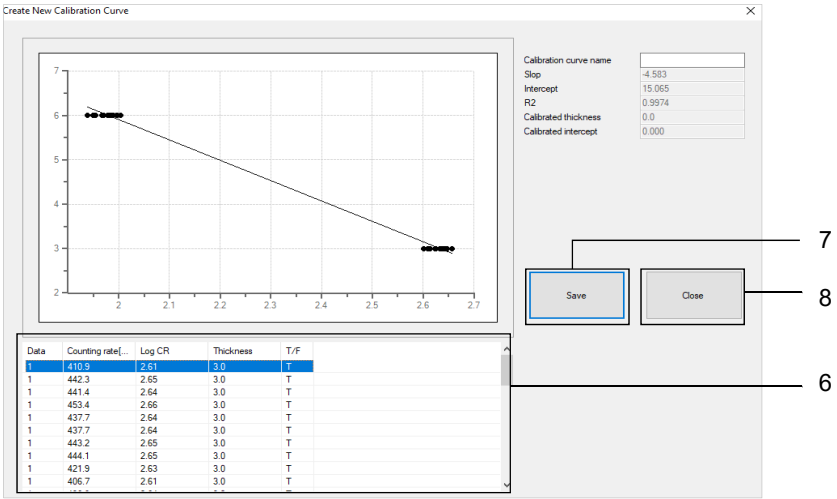


5 Repeat steps 3 to 4 to select the count rate data files you wish to include in the calibration curve file.

6 Right-click on the calibration curve data list, then select [plot].
This creates a calibration curve file.

7 Click the [Save] button.
The calibration curve file (*.cdat) is saved.

8 Click the [Close] button.
The create new calibration curve window closes.



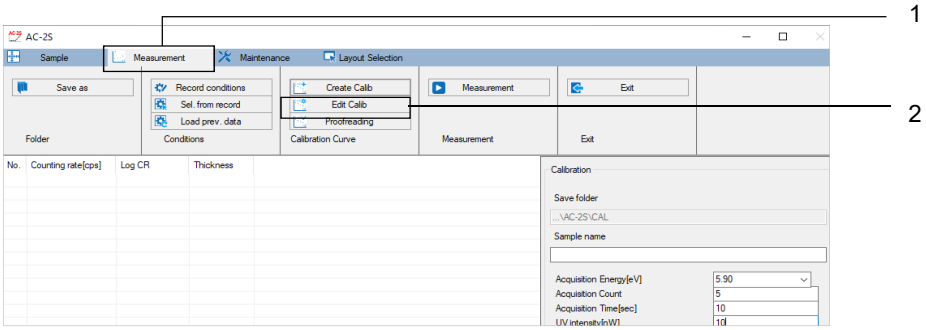
6-6-2 Editing calibration curve files

CAUTION

- Calibration curve files cannot be edited after they are calibrated. (Refer to '6-6-3 Calibrating calibration curve files'.)

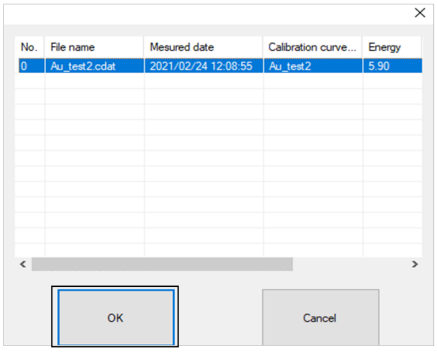
1 Click the [Measurement] tab on the main window.

2 Click [Edit Calib] for [Calibration Curve].



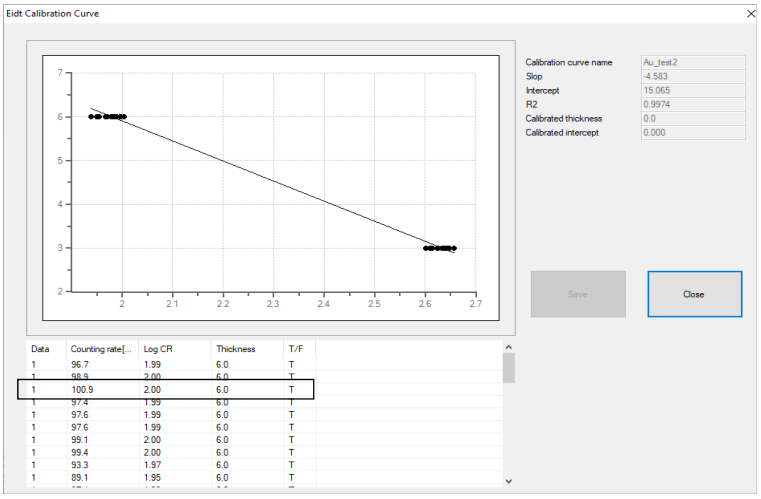
The browse window appears.

3 Select the calibration curve file you wish to edit, then click the [OK] button.



The data for the selected calibration curve appears in the edit calibration curve window.

4 Click and select the calibration curve data you wish to edit from the calibration curve data list.



5 Right-click on the selected calibration curve data to edit.

The following editing operations are available:

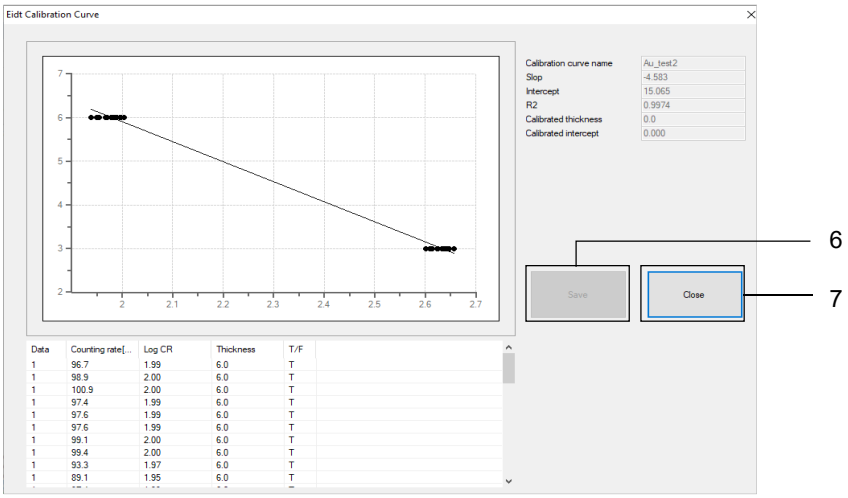
Right-click menu	Editing details
Add data	Adds a different count rate data file to the file currently being edited. Select the desired count rate data file in the browse window.
T/F	Enables and disables calibration curve data.
Plot	Replots a calibration curve graph.

6 Click the [Save] button once editing is complete.

The calibration curve file is saved.

7 Click the [Close] button.

The edit new calibration curve window closes.



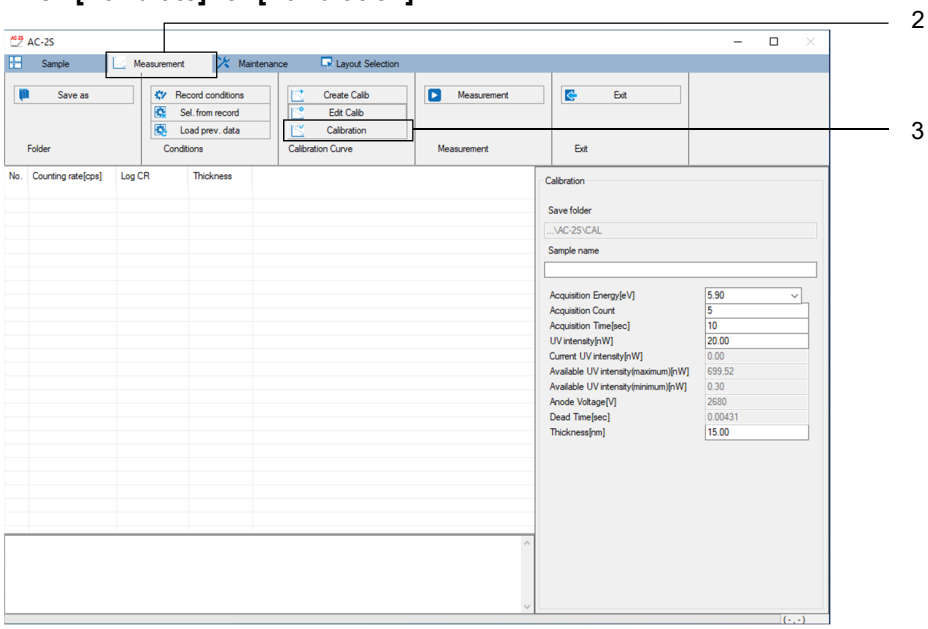
6-6-3 Calibrating calibration curve files

Remeasure calibration curves to calibrate a calibration curve file. A calibration sample is required to calibrate calibration curves. Calibration consists of single-point calibration. Multi-point calibration is not possible.

1 **Measure the calibration curve for the sample to be used for calibration. (Refer to '6-5 Calibration curve measurement'.)**

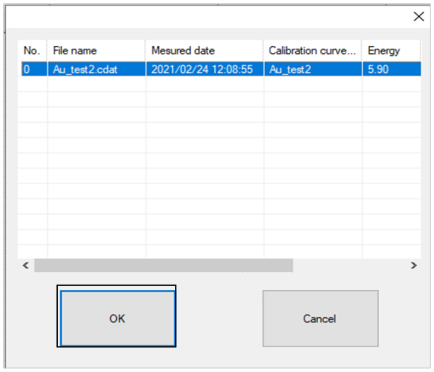
2 **Click the [Measurement] tab on the main window.**

3 **Click [Calibrate] for [Calibration].**



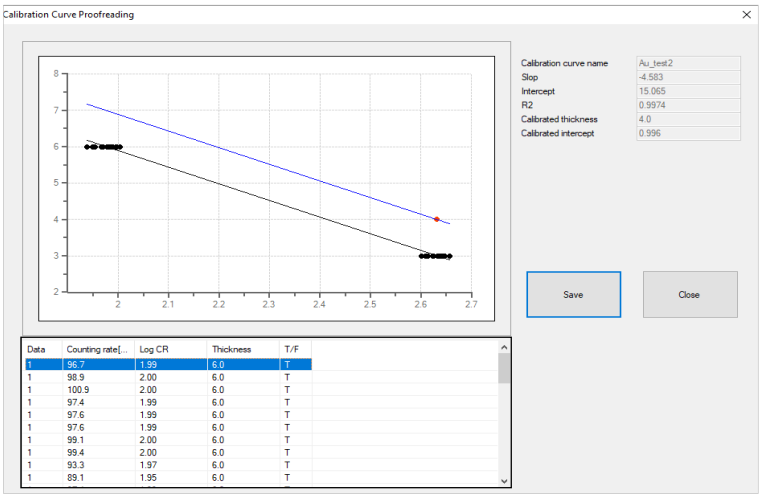
The browse window appears.

4 **Select the calibration curve file you wish to calibrate, then click the [OK] button.**



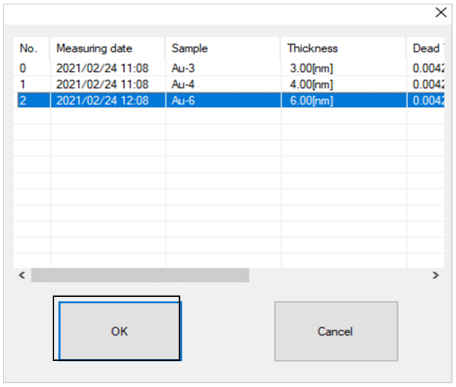
The data for the selected calibration curve is displayed in the calibration curve calibration window.

5 Right-click on the calibration curve data list, then select [Select calibration data].

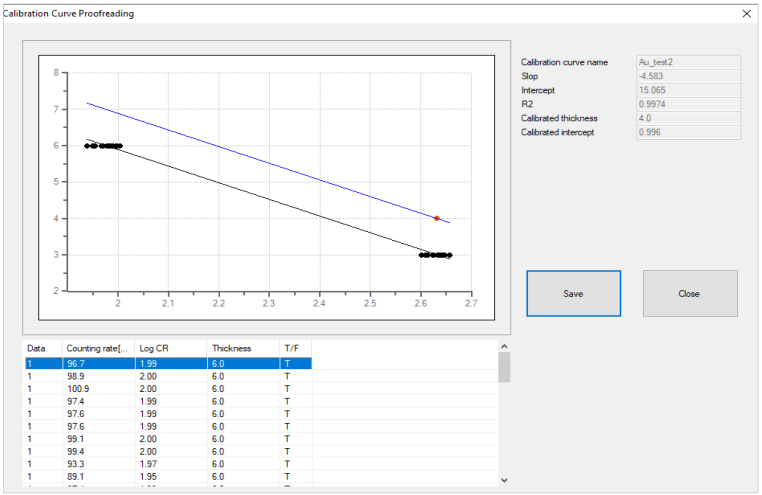


The browse window appears.

6 Select the count rate data file for calibration measured in Step 1, then click the [OK] button.



The mean value of the data in the selected count rate data file is input as [0] for [Data]. The calibrated calibration curve is plotted on the graph.

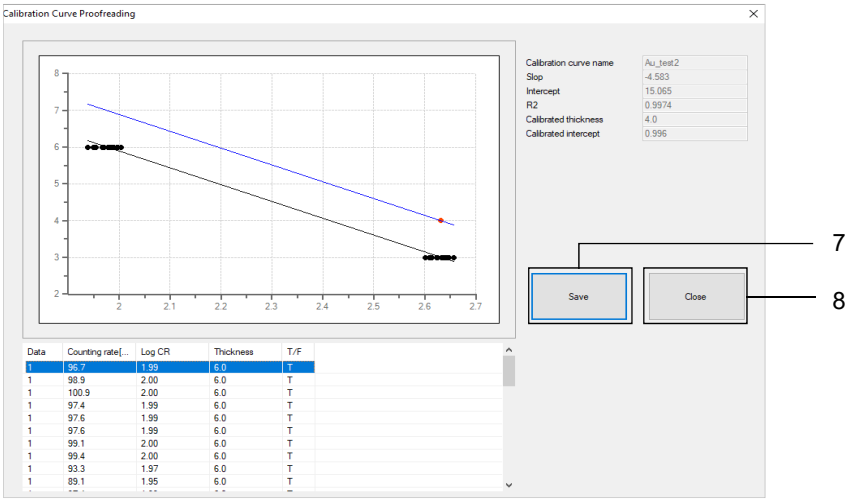


NOTE

▶ To cancel calibration, right-click on the calibration curve data list, then select [Clear Calibration].

7 Click the [Save] button.
The calibration curve file is saved.

8 Click the [Close] button.
The calibration curve calibration window closes.



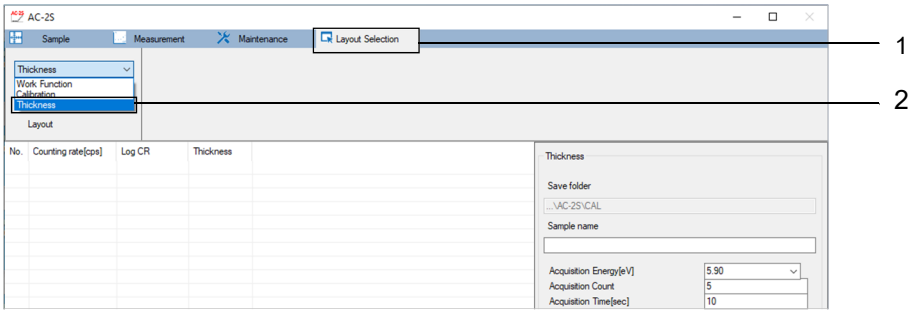
6-7 Film thickness measurement Pro α Pro β

Measure film thickness using the count rate data file or calibration curve file.

6-7-1 Selecting film thickness measurement

1 Click the [Layout Selection] tab on the main window.

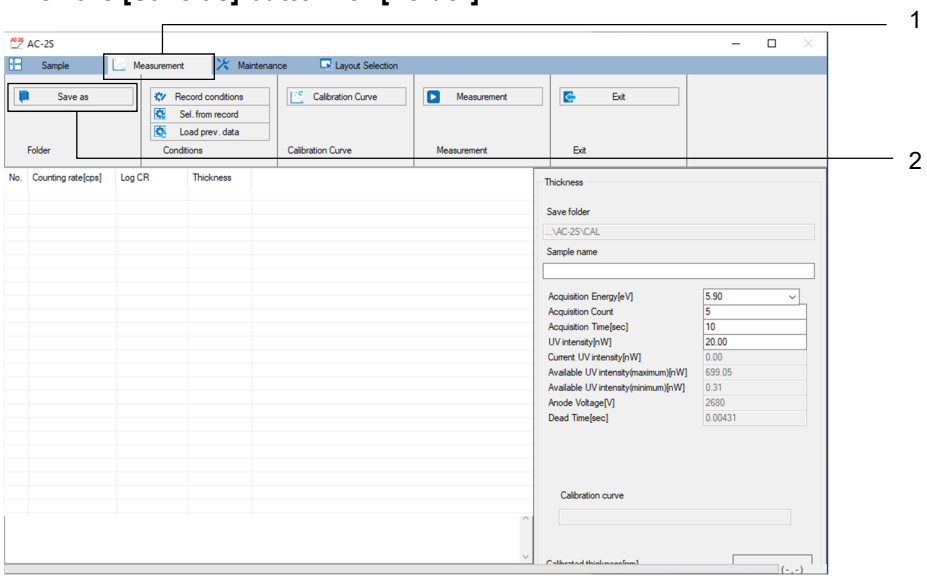
2 Click [∨] for [Layout], then select [Thickness].



6-7-2 Setting the film thickness data file save destination folder

1 Click the [Measurement] tab on the main window.

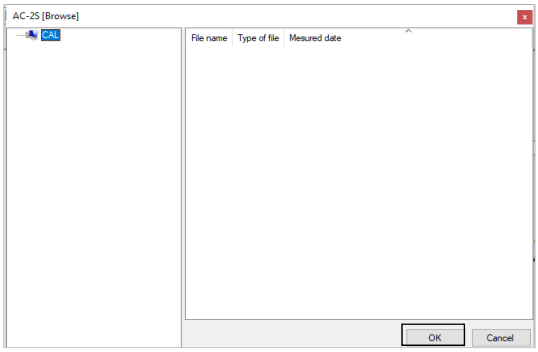
2 Click the [Save as] button for [Folder].



The browse window appears.

3 Specify the save destination folder, then click the [OK] button.

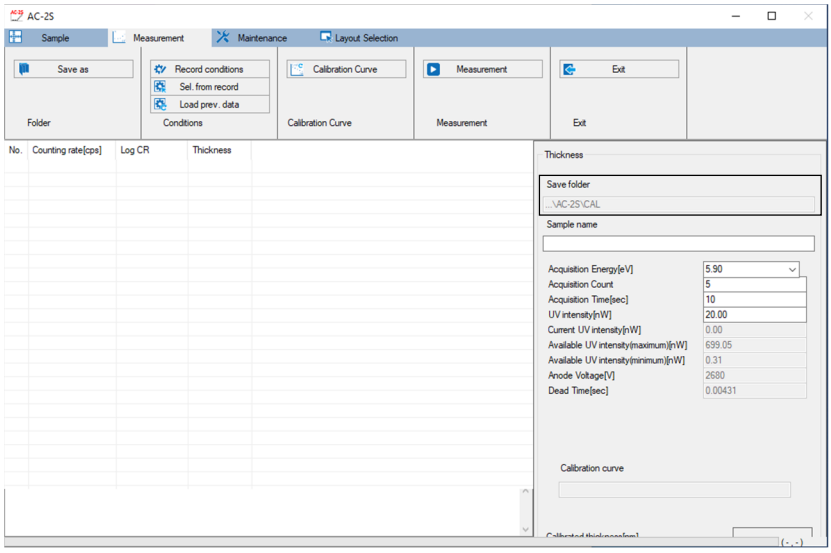
Specify a folder within the \Documents\RikenKeikiPYSA\AC-2S\Data\CAL directory.



NOTE

- To create a new save destination folder from the browse window, right-click on the folder in which the new folder is to be created in the folder tree view list on the left side of the browse window, then select [Save as].

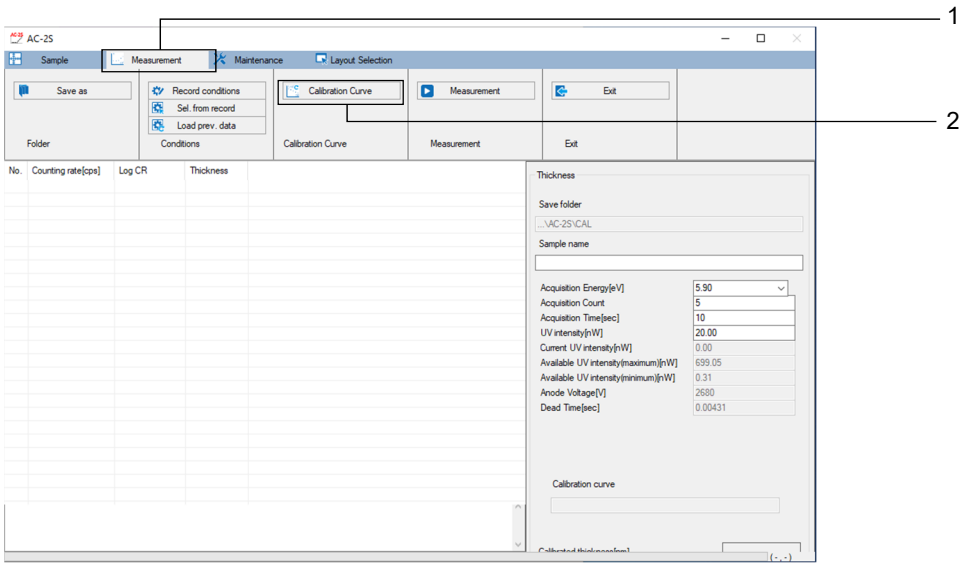
The name of the save destination folder is displayed in [Save folder] on the main window.



6-7-3 Calling up calibration curve files

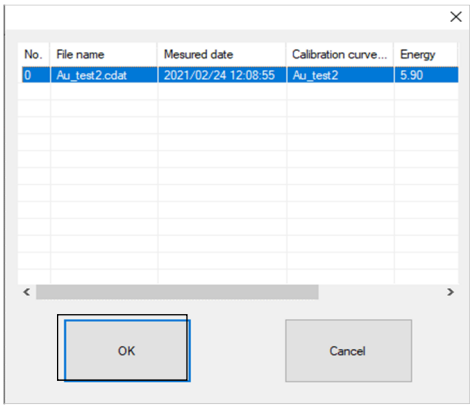
1 Click the [Measurement] tab on the main window.

2 Click [Calibration Curve] for [Calibration Curve].



The browse window appears.

3 Select the desired calibration curve file, then click the [OK] button.



6-7-4 Setting film thickness measurement conditions

Set the following measurement conditions:

Setting item	Setting details
Sample name	Sets the name of the sample to be measured.
Acquisition Energy	Sets the energy for measuring calibration curves (units: eV). Example: 5.90 eV
Acquisition Count	Sets the number of calibration curve measurements. Example: 5
Acquisition Time	Sets the acquisition time for each energy level (units: seconds). Example: 10 seconds
UV Intensity	Sets the UV intensity for measurement (units: nW). Enter a value between the maximum and minimum allowable UV intensity values.

NOTE

▶ Use the sample and tweezers provided when using the AC-2S measurement application for the first time. Measure as specified in this manual. Set the required measurement conditions. Refer to the examples provided.

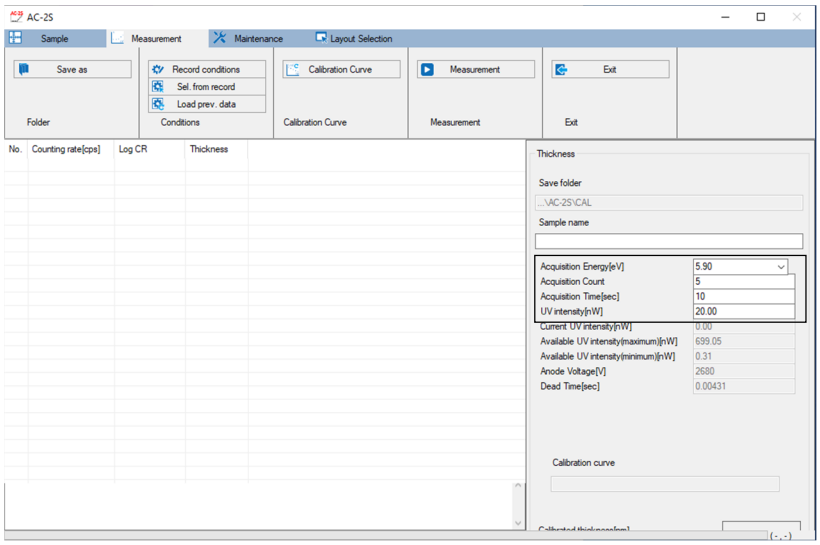
Set measurement conditions by any of the following methods:

- Direct input
- Select from saved measurement conditions.
- Use same conditions as past measurement data.

<Direct input>

1 Enter the individual measurement conditions for [Thickness].

Select the value for [Acquisition Energy [eV]] from the drop-down list.



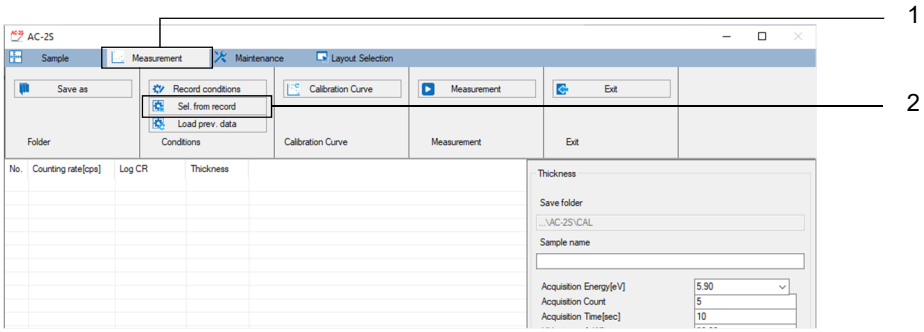
NOTE

▶ Click the [Record conditions] on the [Measurement] tab to store up to ten set measurement conditions.

<Select from saved measurement conditions>

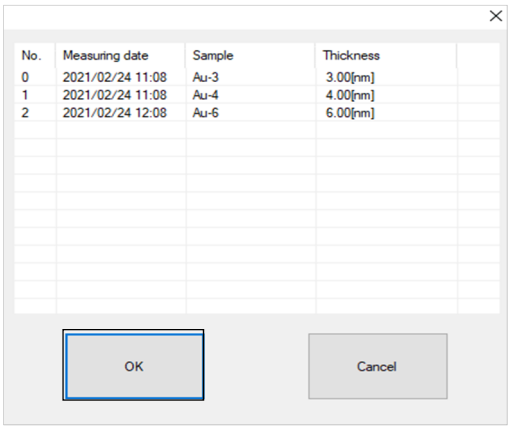
1 Click the [Measurement] tab on the main window.

2 Click the [Sel. from record] button for [Conditions].



A window appears with a list of saved measurement conditions.

3 Select the desired measurement condition, then click the [OK] button.

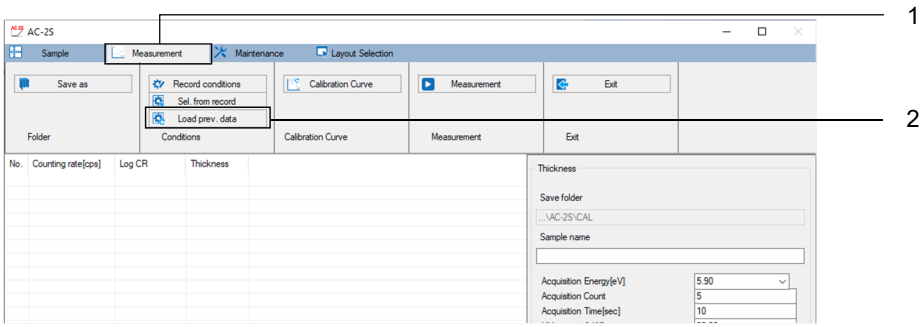


The selected measurement condition is displayed in the measurement condition input box on the main window.
You can edit the measurement condition entered in the main window.

<Use the same condition as for past measurement data>

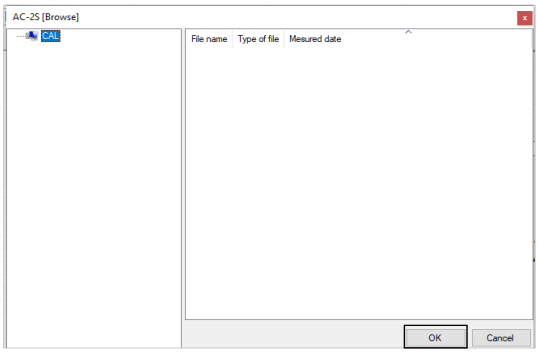
1 Click the [Measurement] tab on the main window.

2 Click the [Load prev. data] button for [Conditions].



The browse window appears.

3 Select the desired film thickness data file, then click the [OK] button.



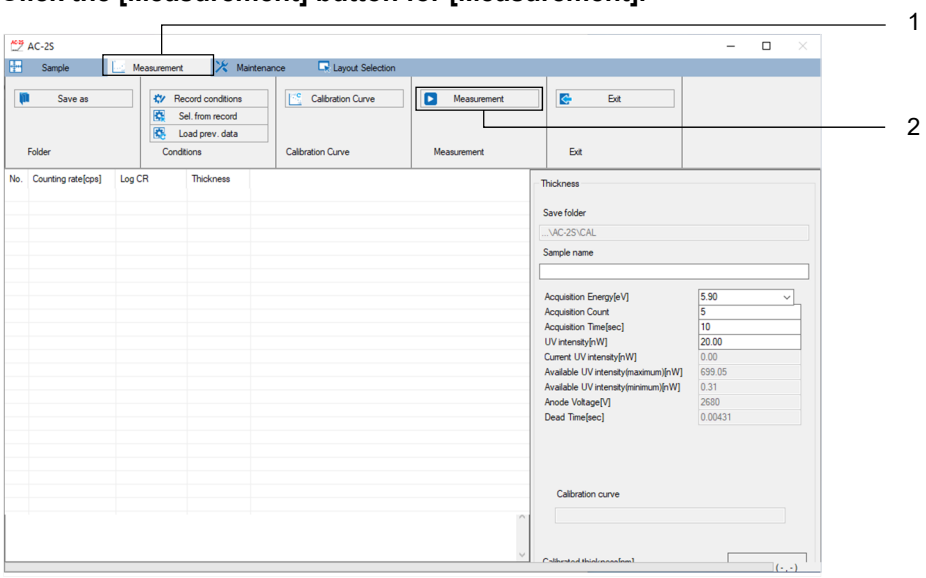
6-7-5 Mounting samples

Mount the sample.
Mount the sample in the AC-2S DC unit. Refer to ‘6-4-5 Mounting samples’.

6-7-6 Starting film thickness measurement

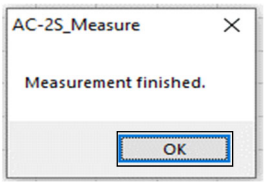
1 Click the [Measurement] tab on the main window.

2 Click the [Measurement] button for [Measurement].



Calibration curve measurement starts.

3 Click the [OK] button when measurement has ended and the following message appears.



The film thickness data file (*.tdat) is saved to the specified save destination folder. (Refer to ‘6-7-2 Setting film thickness data file save destination folder’.)

4 Remove the sample.

Remove the sample. Refer to ‘6-4-5 Mounting samples’.

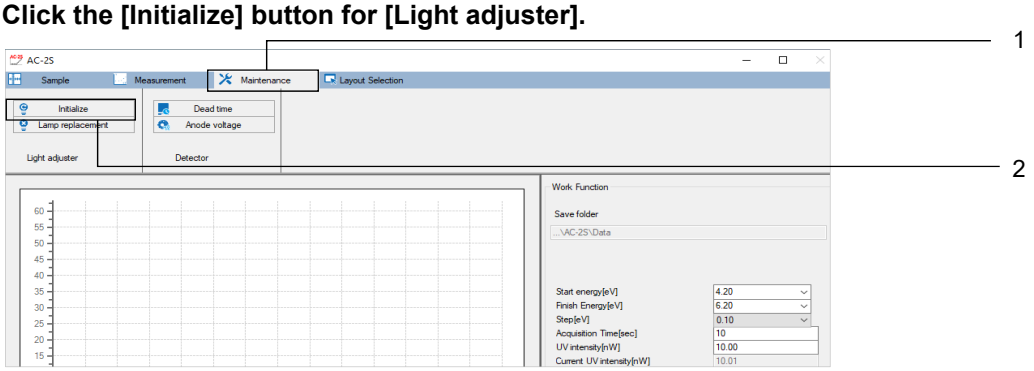
6-8 UV intensity controller and detector maintenance

If measurements are performed continuously for 24 hours or longer or if the temperature or atmospheric pressure changes, initialize the UV intensity controller and reset the anode voltage.

6-8-1 Initializing the UV intensity controller

1 Click the [Maintenance] tab on the main window.

2 Click the [Initialize] button for [Light adjuster].

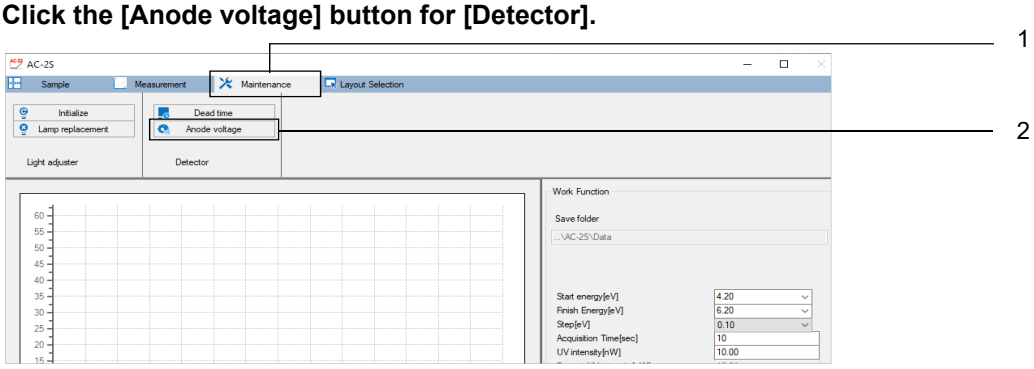


The UV intensity controller is initialized automatically.

6-8-2 Resetting the anode voltage

1 Click the [Maintenance] tab on the main window.

2 Click the [Anode voltage] button for [Detector].



The anode voltage is automatically reset.

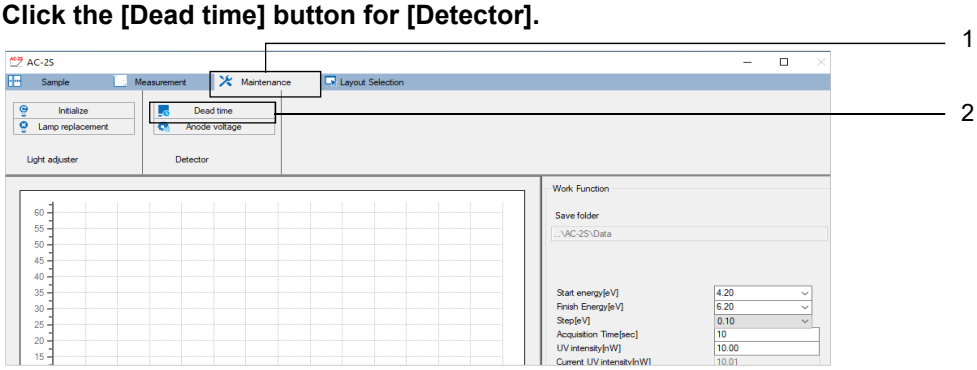
6-8-3 Readjusting the dead time

Readjust the detector dead time. Readjusting the dead time takes approximately 30 minutes.
For more information on dead time, refer to '14-1-1 Photoelectron detection principle'.

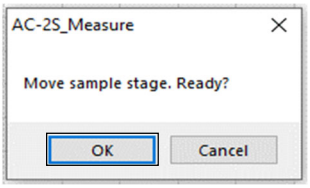
* Dead time readjustments are performed at Riken Keiki when the detector is replaced. This procedure is not performed by the end user.

1 Click the [Maintenance] tab on the main window.

2 Click the [Dead time] button for [Detector].

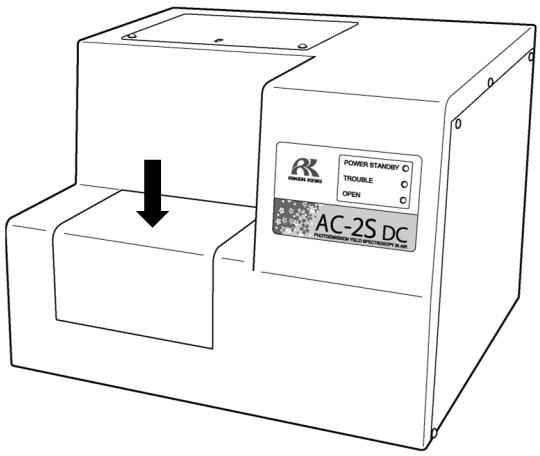


3 Click the [OK] button when the sample stage move confirmation message appears.



The sample stage moves to the sample replacement position.

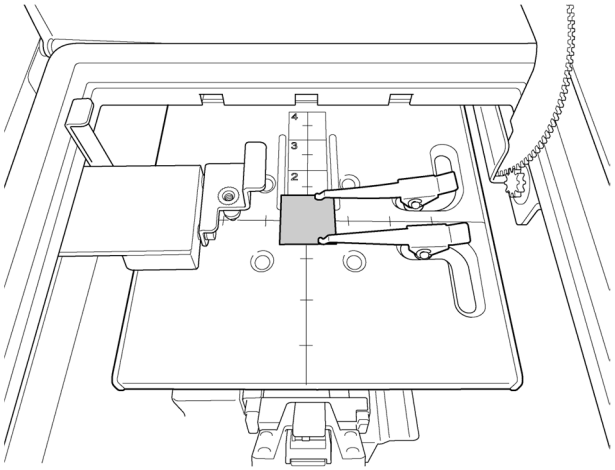
4 Gently press the sample inlet cover with your finger to open.
The AC-2S DC unit OPEN LED lights up.



CAUTION

- Failure of the OPEN LED to light up may indicate a fault. Take care if this occurs. The stage may move even when the sample inlet is open.

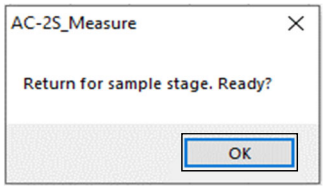
5 Mount the provided sample on the sample stage.



6 Close the sample inlet cover.

The AC-2S DC unit OPEN LED goes out.

7 Click the [OK] button on the message window.



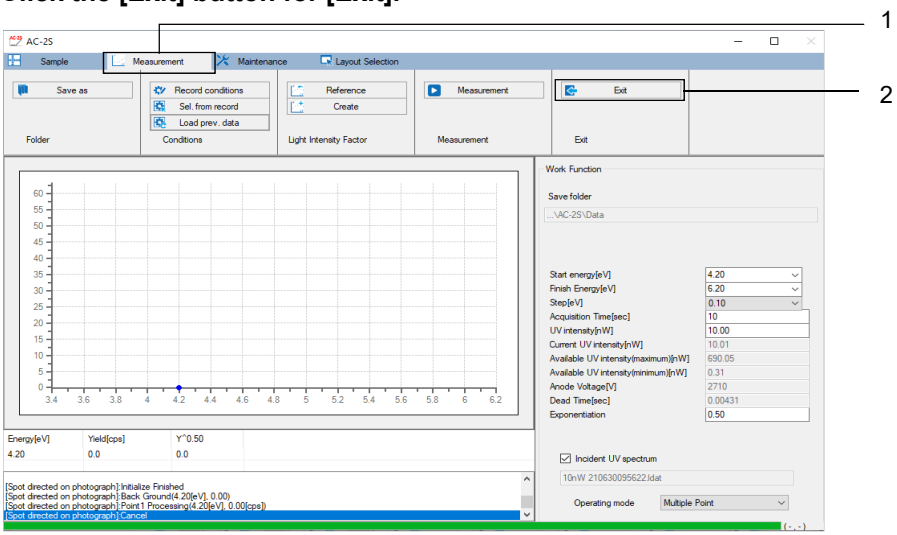
The dead time is readjusted.

6-9 Quitting measurement

<AC-2S>

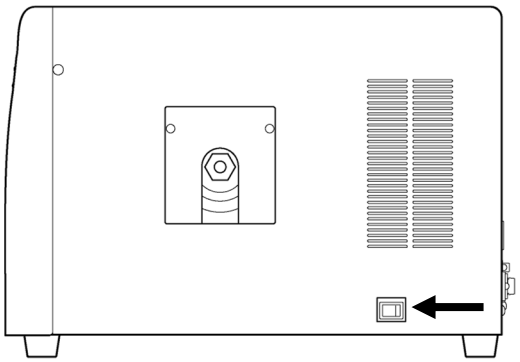
1 Click the [Measurement] tab on the main window.

2 Click the [Exit] button for [Exit].



The AC-2S measurement application closes.

3 Turn off the power switch on the right side of the AC-2S LC unit.

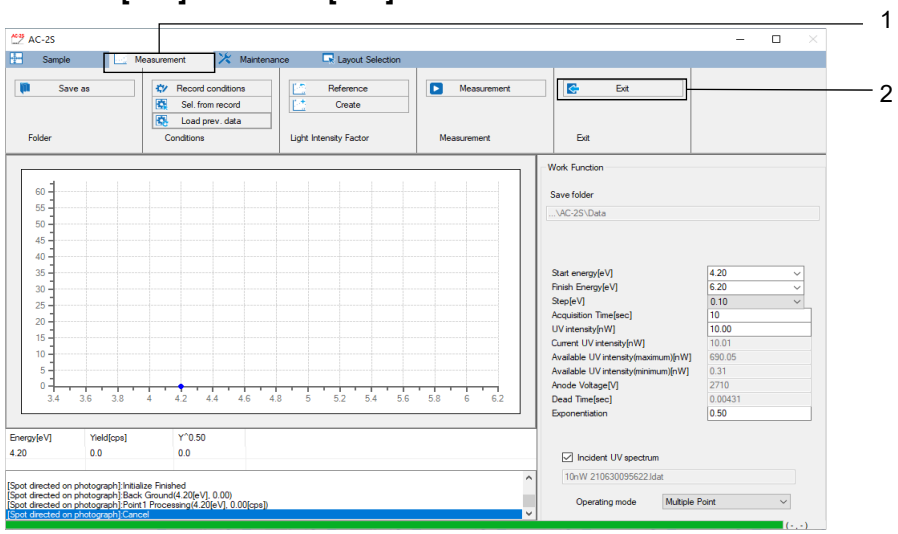


4 Shut off the dry compressed air supply.

<AC-2S Pro α/AC-2S Pro β>

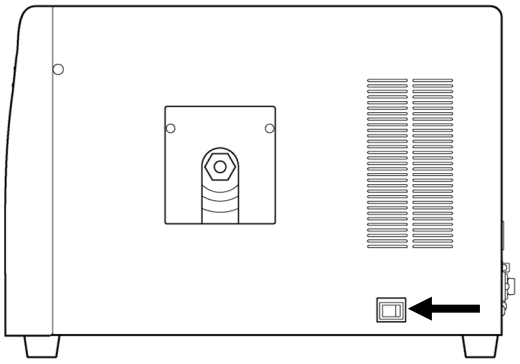
1 Click the [Measurement] tab on the main window.

2 Click the [Exit] button for [Exit].



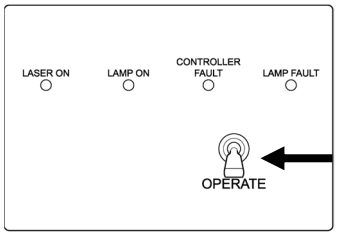
The AC-2S measurement application closes.

3 Turn off the power switch on the right side of the AC-2S LC unit.



4 Shut off the dry compressed air supply.

5 Flip down the OPERATE switch on the plasma light source (LDLS) to turn the power off.



The LAMP ON LED goes out.

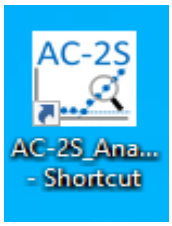
7

Analysis

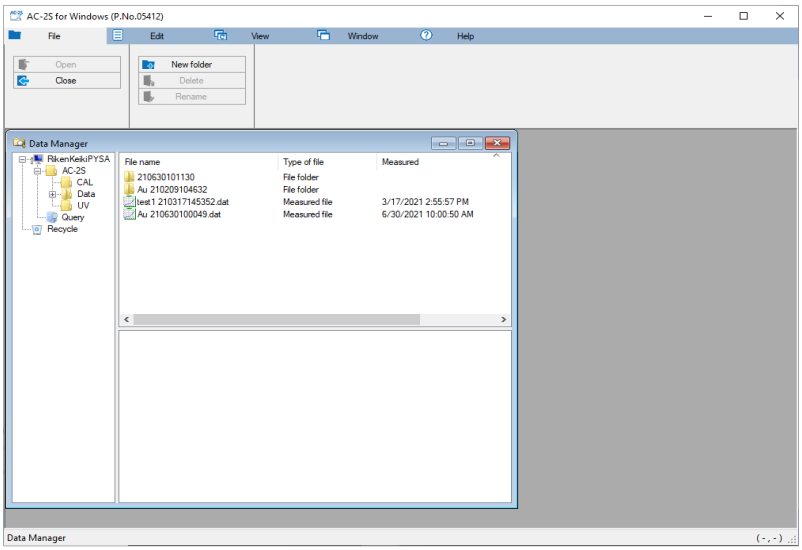
7-1 Launching the AC-2S analysis application

7-1-1 Launching the AC-2S analysis application

1 Double-click the AC-2S analysis application shortcut icon displayed on the control PC desktop.



The AC-2S analysis application main window appears.

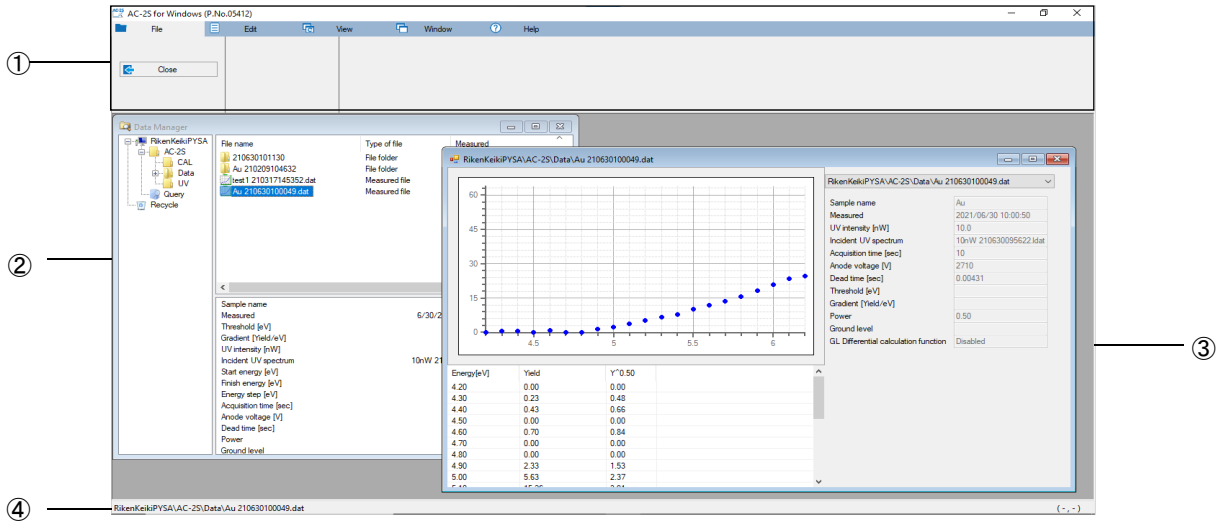


NOTE

- If you do not see the shortcut icon on the control PC desktop, open the Windows Start menu and select [AC-2S_Analyze] from the Start menu list.

7-1-2 AC-2S analysis application main window component names and functions

The AC-2S analysis application main window contains the Data Manager and graph form windows.



No.	Name	Function
①	Menu display	Displays AC-2S analysis application functions as tabs. Click a tab to display the corresponding menu.
②	Data Manager	Manages files handled by the AC-2S analysis application. For more information on Data Manager, refer to '7-5 File management'.
③	Graph form	Displays the graph, measurement conditions, and data list for the file selected in Data Manager. Modify graph X and Y axis settings, supplementary line spacing, and other settings here. (Refer to '7-4 Customizing the graph display'.)
④	Status bar	Displays the file name of the data in the top-most window. This also displays the coordinates of the cursor position when a graph is displayed. Click the [Status Bar] button on the [View] tab of the main window to show/hide the status bar.

7-1-3 Files handled by the AC-2S analysis application

The following files can be handled using the AC-2S analysis application:

<Work function measurement results files>

Type	Description
Measurement data file (*.dat)	File containing work function measurement results.
Multi data file (*.mdat)	File containing the mean of multiple measurement results. This file is created in the following cases: ・When more than one measurement is performed with the AC-2S measurement application ・When calculating the mean for multiple measurement results with the AC-2S analysis application
Differential results file (*.ddat)	File containing the density of states calculated from measurement results. This file is created when estimating the density of states for a multi data file using the analysis application.
Incident UV Spectrum file (*.ldat)	File containing the Incident UV Spectrum.

- The measurement data file (*.dat) and multi data file (*.mdat) are saved to a user-specified folder in the \Documents\RikenKeikiPYSA\AC-2S\Data folder.
- The Incident UV Spectrum file (*.ldat) is saved to the \Documents\RikenKeikiPYSA\AC-2S\UV folder.

<Calibration curve/film thickness measurement results files> Pro α Pro β

Type	Description
Count rate data file (*.sdat)	File containing count rate data for a reference sample.
Calibration curve file (*.cdat)	File containing multiple count rate data files. This file is created when creating a calibration curve file using the measurement application. (Refer to '6-6 Creating and editing calibration curve files'.)
Film thickness data file (*.tdat)	File containing film thickness estimated based on count rate data and calibration curve file.

- The count rate data file (*.sdat), calibration curve file (*.cdat), and film thickness data file (*.tdat) are saved to a user-specified folder in the \Documents\RikenKeikiPYSA\AC-2S\Data\CAL folder.

NOTE

- Only the files described above are displayed in Data Manager in the AC-2S analysis application. Files with file format errors may not appear in Data Manager.
- Existing product data must be converted using the Riken Keiki conversion software.
- We recommend backing up files periodically.

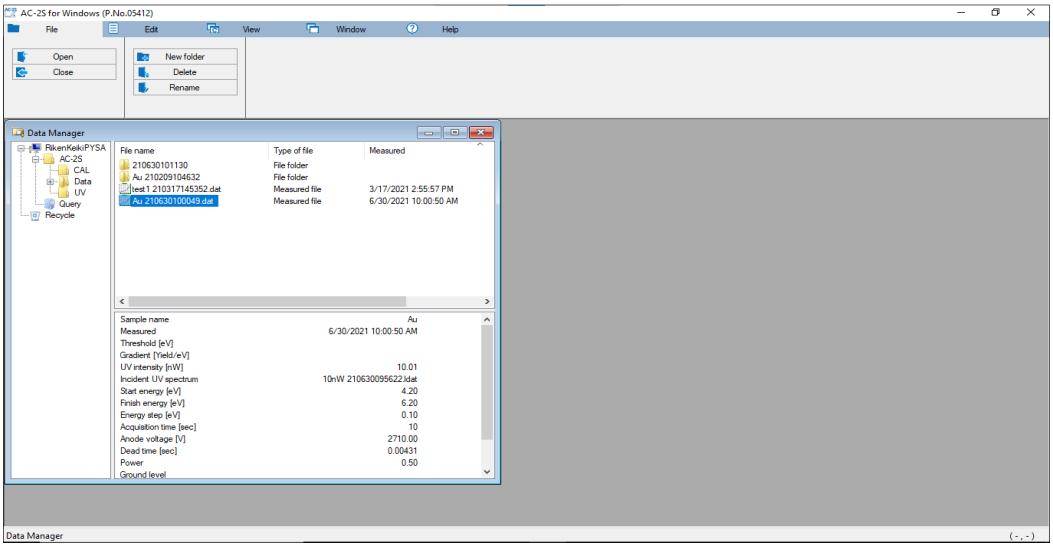
7-2 Opening measurement results files

Open a file measured with the AC-2S measurement application to display the graph in the graph form window.

7-2-1 Plotting measurement results on a graph

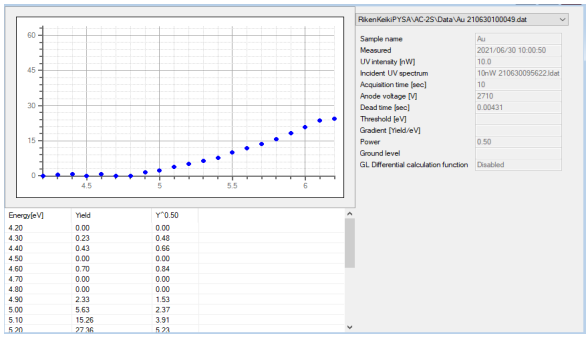
1 Click and select the file to be displayed as a graph in Data Manager.

2 Right-click on the selected file, then select [Open].
You can also click the [File] tab in the main window, then click the [Open] button to open the files.

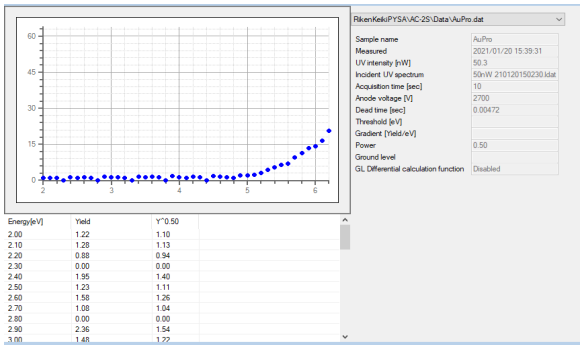


The graph for the selected file is displayed in the graph form window.

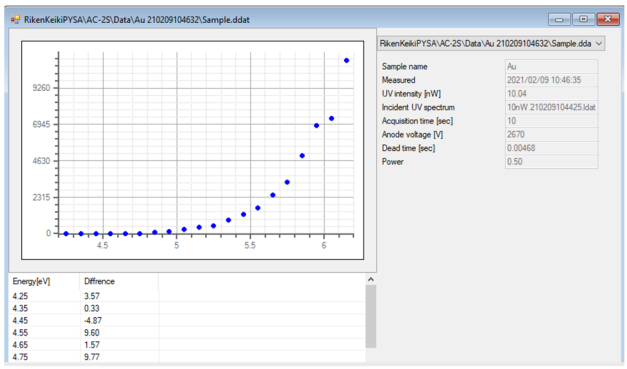
・Measurement data file display example **AC-2S** **Pro β**



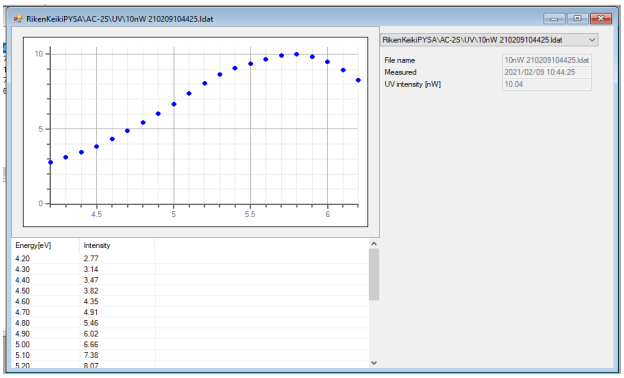
・Measurement data file display example **Pro α**



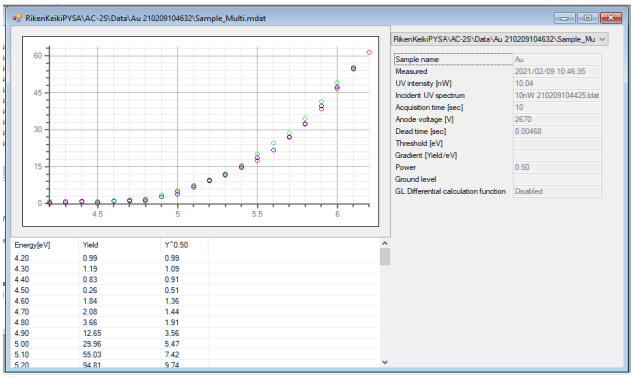
・Differential results file display example



・Incident UV Spectrum file display example



・Multi data file display example

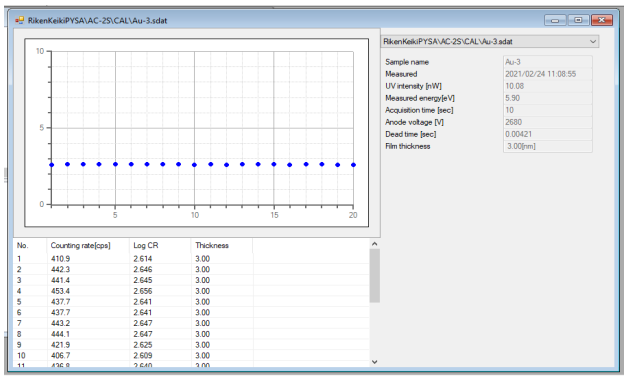


NOTE

▶ With multi data files, right-click on the graph and select [Details] to display the individual data used to calculate the mean.

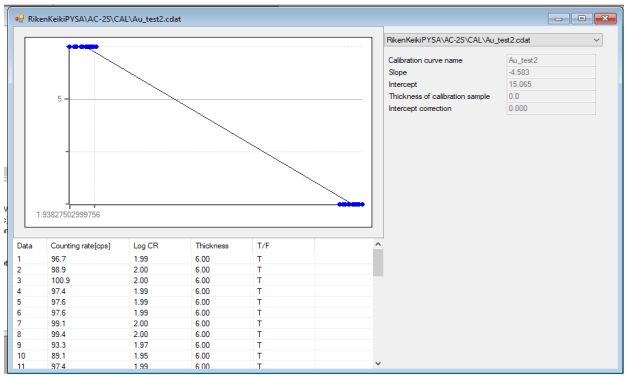
・Count rate data file display example **Pro α** **Pro β**

Horizontal axis: Cycles (No. value), Vertical axis: Log CR



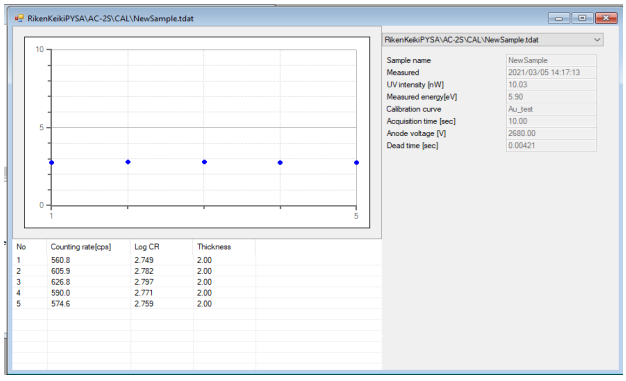
・Calibration curve file display example **Pro α** **Pro β**

Horizontal axis: Log CR, Vertical axis: Thickness



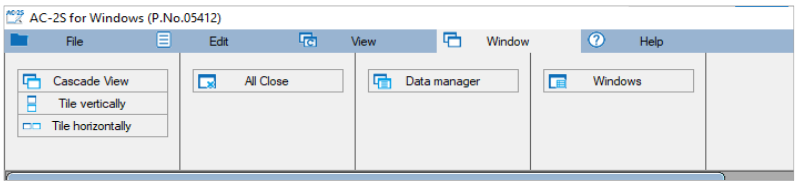
・Film thickness data file display example **Pro α** **Pro β**

Horizontal axis: Cycles (No. value), Vertical axis: Log CR



NOTE

- Multiple open windows displayed in the main window of the AC-2S analysis application can be displayed tiled, cascaded, or as a list.
  Click the [Window] tab in the main window, then click the [Tile vertically], [Tile horizontally], or [Windows] button as required.
  Click the [All Close] button to close all windows displayed in the main window.

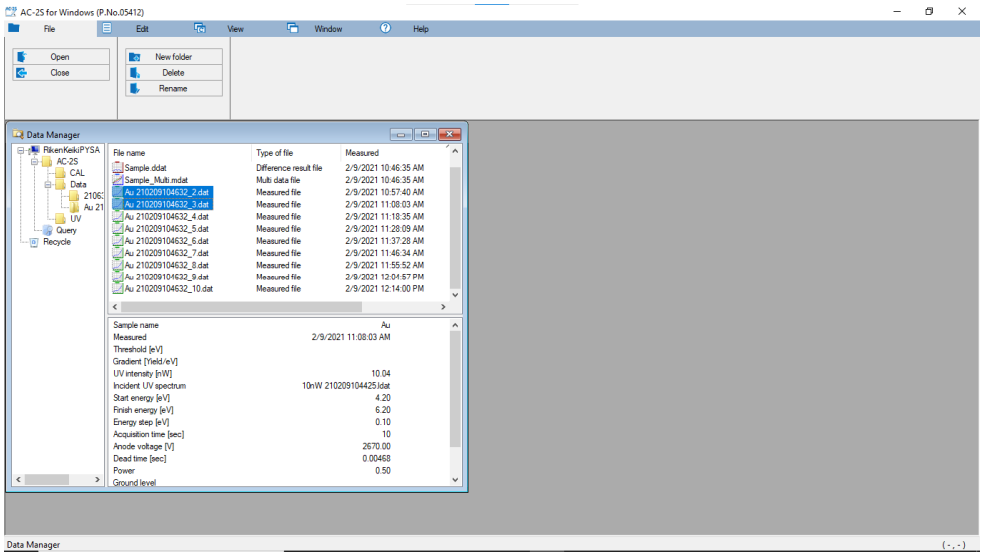


7-2-2 Plotting multiple measurement results on a single graph

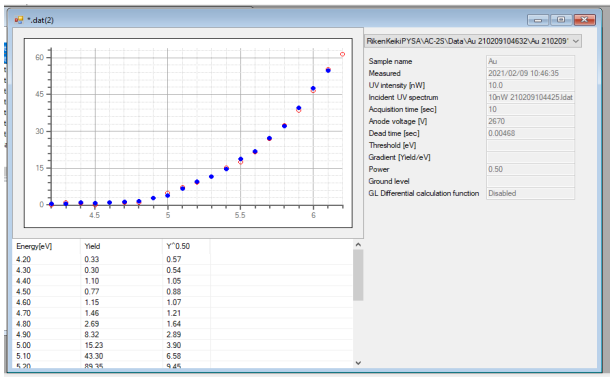
Up to ten files of the same type can be displayed simultaneously on a single graph.

1 **Select the multiple files to be displayed as a graph in Data Manager.**
Select files of the same type.
Click on the required files while pressing the Ctrl key to select multiple files.
Click two files while pressing the Shift key to select all files between the two files.

2 **Right-click on the selected files, then select [Open].**
You can also click the [File] tab in the main window, then click the [Open] button to open the files.

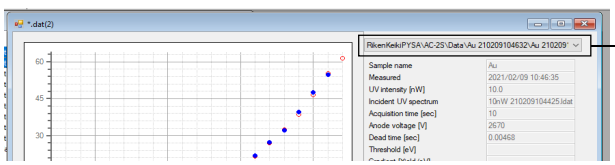


The graphs for the multiple selected files are displayed simultaneously in the graph form window.



NOTE

- Right-click on the graph and select [Add] to open and display another file as an overlaid graph.
- Right-click on a graph and select [Remove] to close the selected graph.
- Click [∨] for the file name to the right of the graph display to switch the currently selected file.



Indicates the currently selected file.

7-3 Analyzing measurement results

7-3-1 Changing the Incident UV Spectrum

The Incident UV Spectrum can be changed by selecting a different file or UV intensity correction can be disabled.

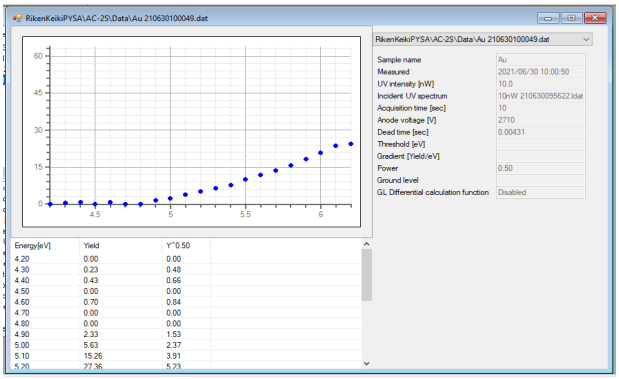
CAUTION

You can change the Incident UV Spectrum in the following situations:

- The UV intensity is the same.
- All measurement data energy values are included.
- Measurements were performed on the same date.

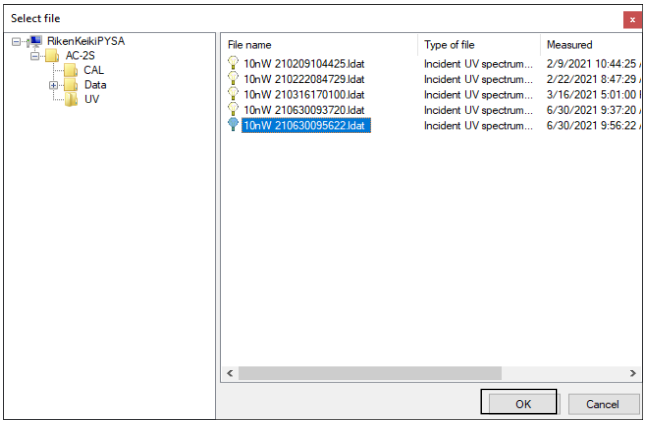
1 Open the file for changing the Incident UV Spectrum. (Refer to '7-2-1 Plotting measurement results on a graph'.)

2 Right-click on the graph, then select [UV intensity correction], then [Change].



The browse window appears.

3 Select a Incident UV Spectrum file, then click the [OK] button.



NOTE

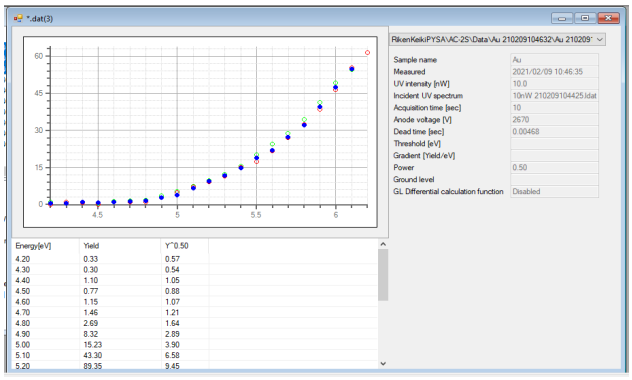
- To disable UV intensity correction for measurement results, right-click on the graph, then select [UV intensity correction], then [Delete].

7-3-2 Calculating the mean of measurement results

To calculate the mean value of measurement results, select the multiple measurement data files for which you wish to calculate the mean. Calculating the mean for measurement data creates a multi data file (*.mdat).

1 **Open the multiple measurement data files. (Refer to '7-2-2 Plotting multiple measurement results on a single graph'.)**

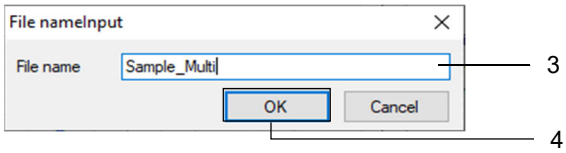
2 **Right-click on the graph, then select [Average].**



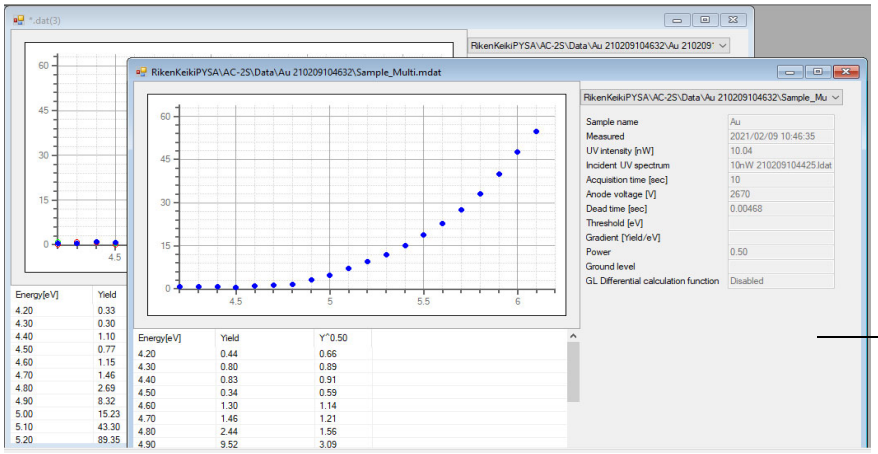
The file name input window appears.

3 **Enter the file name for the multi data file in [File name].**

4 **Click the [OK] button.**



A multi data file is created. The mean value is displayed in a separate graph form window.



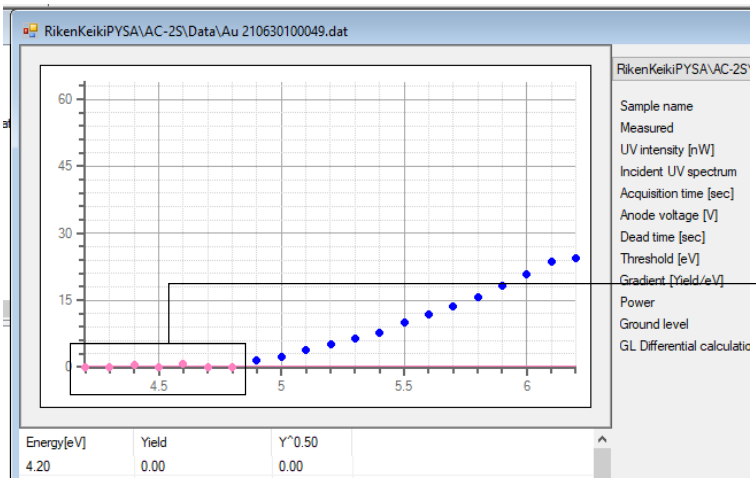
7-3-3 Calculating the photoemission threshold

Select the corresponding ground level and regression line on the graph, then recalculate the photoemission threshold and slope.

1 **Either open one measurement data file or open a multi data file and display the mean value. (Refer to '7-2-1 Plotting measurement results on a graph' and '7-3-2 Calculating the mean of measurement results'.)**

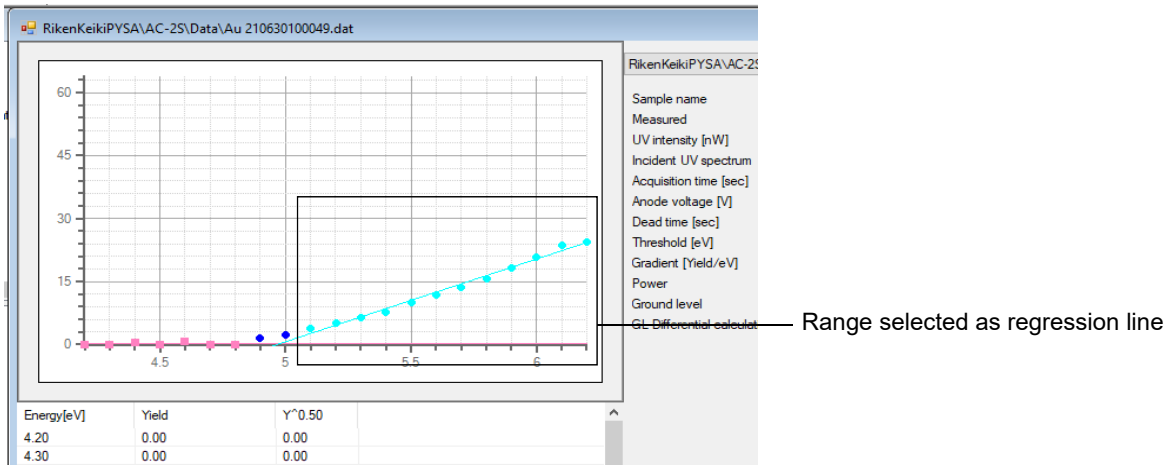
2 **Drag and select the range to specify the ground level on the graph.**
Measurement points within the selected range are indicated in black.
While pressing the Ctrl key, click the selected measurement points to exclude/add them.

3 **Right-click on the graph, then select [Ground level].**
The measurement points within the selected range are indicated in pink. The ground level (photoemission threshold) is indicated by a pink line.



4 **Drag and select the range to specify the regression line on the graph.**
Measurement points within the selected range are indicated in black.
While pressing the Ctrl key, click the selected measurement points to exclude/add them.

5 **Right-click on the graph, then select [Regression line].**
The measurement points within the selected range are indicated in light blue. The regression line (photoemission slope) is indicated by a light blue line.



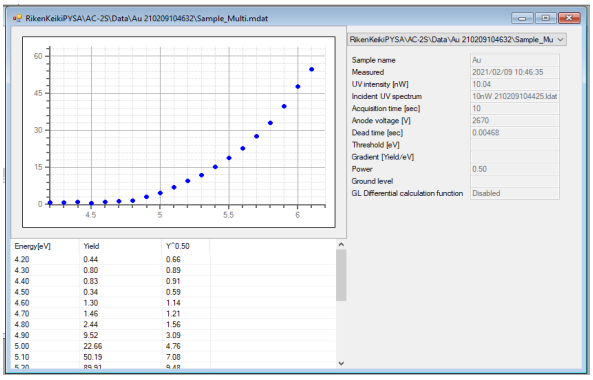
6 **Save the recalculated threshold value and slope in a measurement data file or multi data file. (Refer to '7-3-5 Saving analysis results'.)**

7-3-4 Estimating density of states

Create a multi data file with the mean calculated for the measurement data files, then estimate the density of states. Estimating the density of states creates a differential results file (*.ddat).

1 **Open multiple measurement data files and calculate the mean value. (Refer to '7-3-2 Calculating the mean of measurement results'.)**

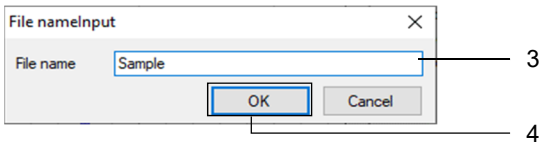
2 **Right-click on the graph, then select [Density of states].**



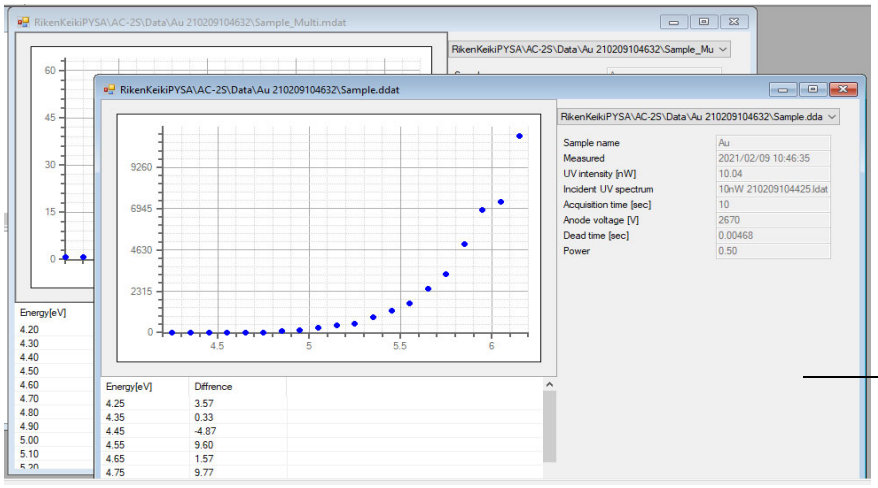
The file name input window is displayed.

3 **Enter the file name for the differential results file in [File name].**

4 **Click the [OK] button.**

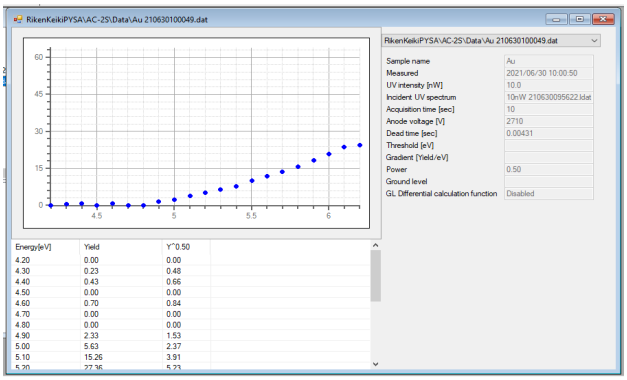


This creates a differential results file. The estimated density of states is displayed in a separate graph form window.



7-3-5 Saving analysis results

1 Right-click on the graph, then select [Save].



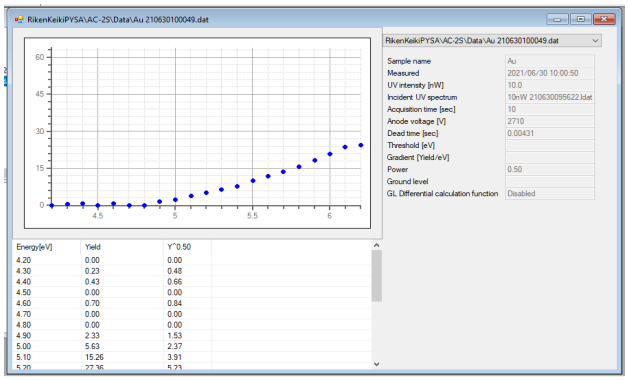
Saving the analysis results overwrites earlier results.

7-4 Customizing the graph display

7-4-1 Changing the X- and Y-axis maximum and minimum values

Change the graph axis settings.

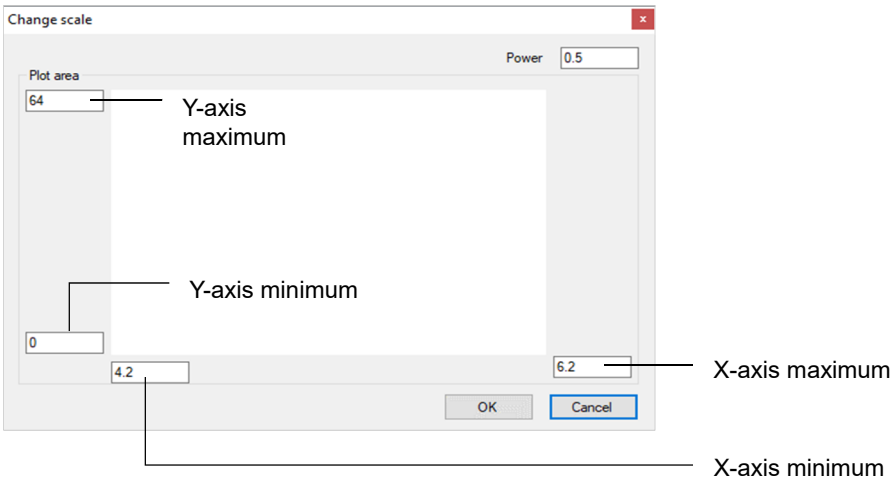
1 Right-click on the graph, then select [Change scale].



The Change scale window appears.

2 Enter the respective X- and Y-axis maximum and minimum values for [Plot area].

3 Click the [OK] button.



NOTE

- Select a measurement data file or multi data file graph to edit the [Power] value. The power value will differ depending on the particular sample. The value is typically 0.5 for metal samples and 0.3 (1/3) for semiconductor samples. A value of 0.5 is typically used for organic substances.
- Right-click on the graph, then select [Default scale]. This will reset the range plotted before the measurement.
- To save the settings for the range plotted, right-click on the graph and select [Save].

7-4-2 Changing grid lines

The following grid line settings can be modified:

- Show [On]/hide [Off] grid lines
- X-axis grid line and X-axis supplementary grid line interval
- Y-axis grid line and Y-axis supplementary grid line interval

<Grid line interval>

The grid line is determined by the maximum and minimum values for the axis together with the specified step.

For example, if the X-axis is from 4.2 eV to 6.2 eV in 0.1 eV steps, and the Y-axis is from 0 to 63, setting the number of grid lines as follows will give the following grid line intervals:

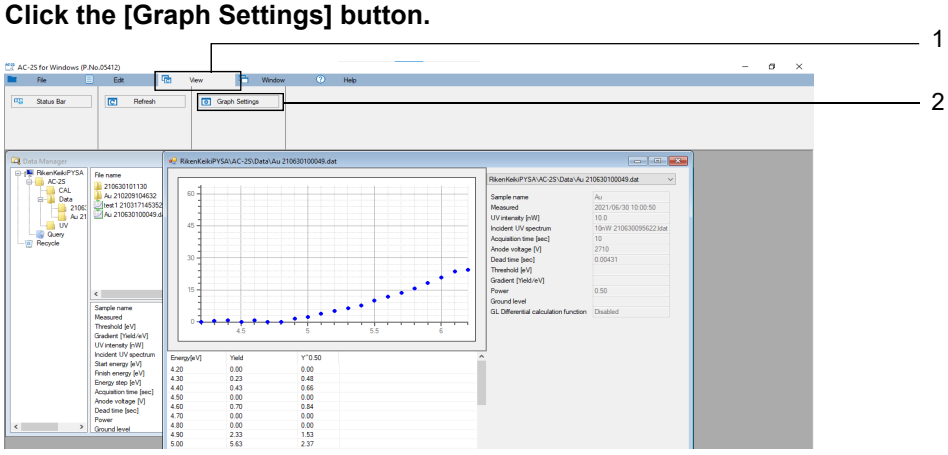
X-axis grid line: 5, X-axis supplementary grid line: 5

Y-axis grid line: 5, Y-axis supplementary grid line: 5

- X-axis supplementary grid line interval:
  (6.2 - 4.2) ÷ 0.1 ÷ 5 ÷ 10 = 0.4
  After rounding, the X-axis supplementary grid lines are set to every step (0.1 eV).
- X-axis grid line interval:
  1 × 10 = 10
  X-axis grid lines are therefore set to every 10 steps (1 eV).
- Y-axis supplementary grid line interval:
  (63 - 0) ÷ 1 ÷ 5 ÷ 10 = 1.26
  After rounding, Y-axis supplementary grid lines are set to every 2 steps (2).
- Y-axis grid line interval:
  2 × 10 = 20
  This means Y-axis grid lines are drawn every 20 steps (20).

1 Click the [View] tab on the main window.

2 Click the [Graph Settings] button.

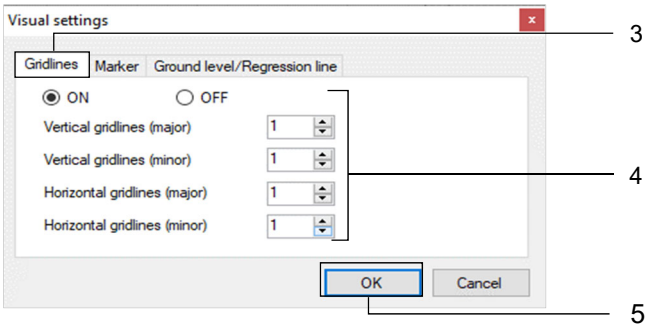


The Visual Settings window appears.

3 Click the [Gridlines] tab on the Visual Settings window.

4 Edit the grid line settings.

5 Click the [OK] button.

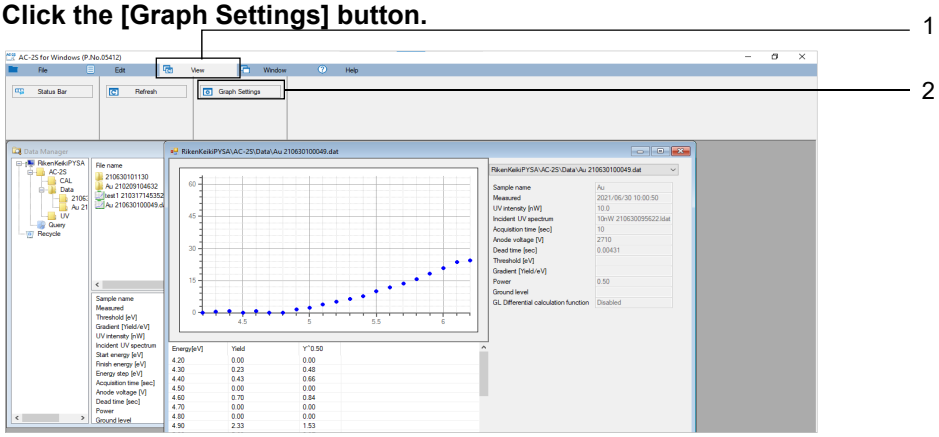


7-4-3 Changing line graph dots

The line graph plot color and size can be modified.

1 Click the [View] tab on the main window.

2 Click the [Graph Settings] button.



The Visual Settings window appears.

3 Click the [Marker] tab on the Visual Settings window.

4 Set the line graph plot size in [Size].

5 Click and select the desired line graph color.

The numbers (1 - 10) on the colors indicate the data numbers when multiple data points are overlaid on a graph.

[S] indicates selected points, [B] indicates points specified as the ground level, and [R] indicates points specified as the regression line.

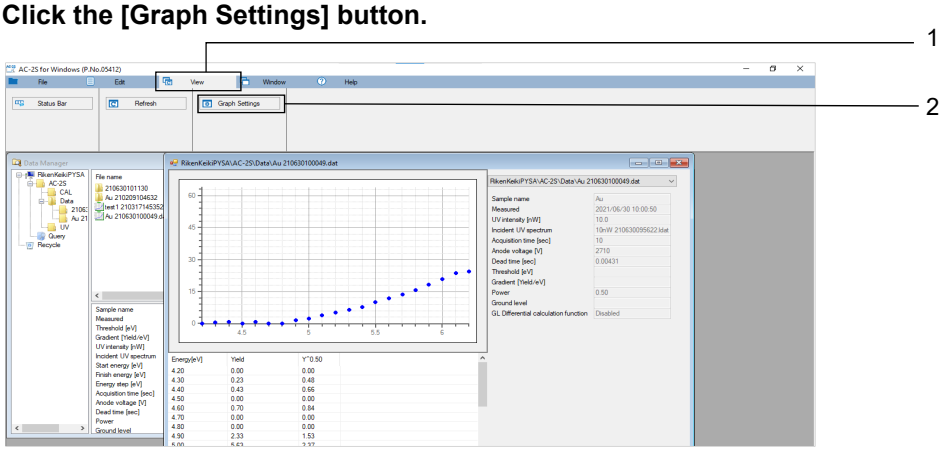
6 Click the [OK] button.

7-4-4 Changing the ground level and regression line graph display

You can change the thickness of the ground level line and regression line. You can also change the default settings for the ground level differential display.

1 Click the [View] tab on the main window.

2 Click the [Graph Settings] button.



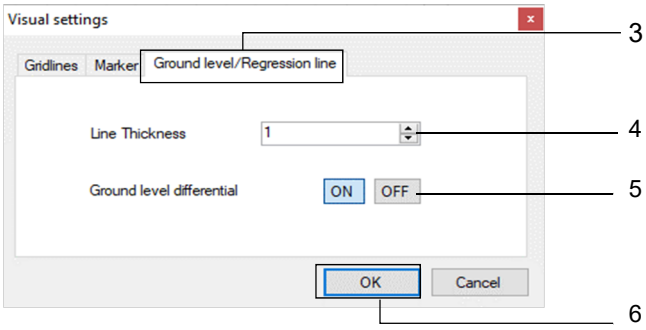
The Visual Settings window appears.

3 Click the [Ground level/Regression line] tab on the Visual Settings window.

4 Set the regression line thickness in [Line Thickness].

5 Select [ON] or [OFF] for [Ground level differential].
The selected item becomes the default value for the ground level differential display and is displayed in light blue.

6 Click the [OK] button.

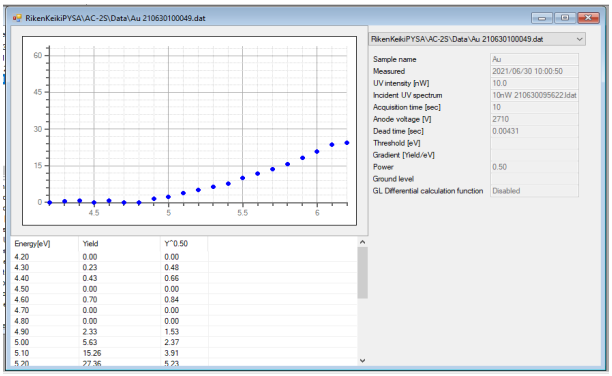


NOTE

- To switch each graph ground level differential display, right-click on the graph, then select [Ground level differential]. Select [ON] or [OFF] for the ground level differential display for the selected graph.

7-4-5 Renaming samples

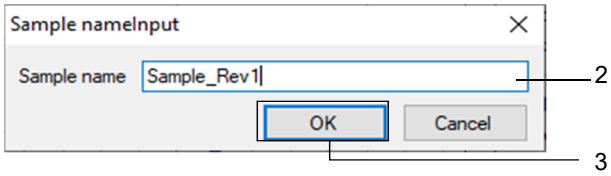
1 Right-click on the graph, then select [Change the sample name].



The sample name input window appears.

2 Enter the new sample name.

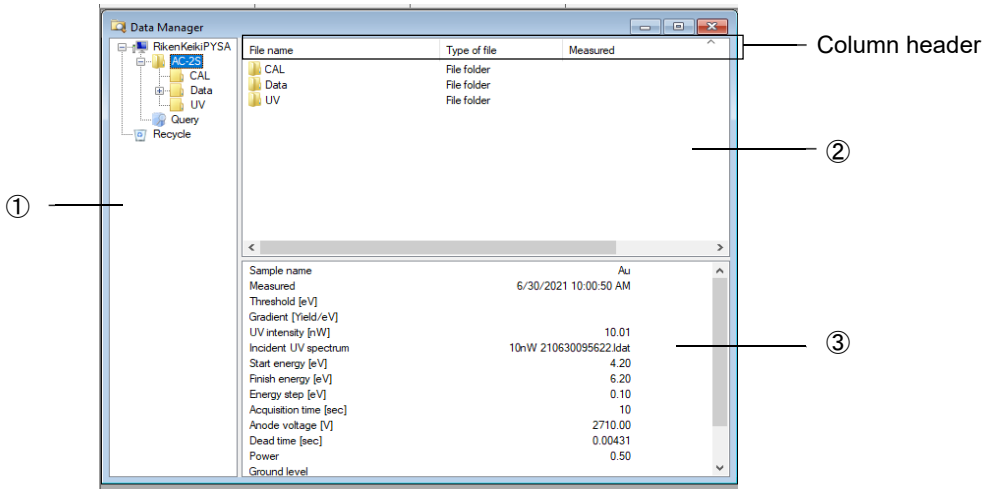
3 Click the [OK] button.



7-5 File management

7-5-1 Data Manager component names and functions

Data Manager is the window used to manage files handled by the AC-2S analysis application.
Data Manager displays files found in the \Documents\RikenKeikiPYSA\AC-2S folder.



No.	Name	Function
①	Tree view	Displays folders and files arranged hierarchically. Displays only files and folders saved to \Documents\RikenKeikiPYSA\AC-2S.
②	List view	Displays folders and files in tree view. When the AC-2S analysis application is launched, files are displayed in ascending order of measurement date and time. Click the corresponding column header to resort files in that column. Clicking a column header toggles the display between ascending and descending order.
③	File information	Displays file information for the data selected in list view.

CAUTION

- Do not use with other applications (e.g., Windows Explorer). File operations in Data Manager use the Windows clipboard.
- Perform operations on files in the AC-2S folder using Data Manager from within the AC-2S analysis application.
- You can use Explorer or other applications for backup operations.

NOTE

▶ If you accidentally close Data Manager, click the [Window] tab in the AC-2S analysis application and click the [Data Manager] button to reopen.

7-5-2 Viewing data

You can view the following data in Data Manager:
The data that can be viewed depends on the particular file.

<Work function measurement results files>

	Measurement data file	Multi data file	Differential results file	Incident UV Spectrum file
Sample name	○	○	○	○
Measurement date and time	○	○	○	○
Measurement UV intensity [nW]	○	○	○	○
Incident UV Spectrum name	○	○	○	○
Measurement start energy [eV]	○	○	○	○
Measurement end energy [eV]	○	○	○	○
Step [eV]	○	○	○	○
Aquisition time [s]	○	○	○	×
Anode voltage [V]	○	○	○	×
Dead time [s]	○	○	○	×
Threshold [eV]	○	○	×	×
Slope	○	○	×	×
Exponent	○	○	×	×
Ground level	○	○	×	×
GL differential display	○	○	×	×
Background count rate	○	○	×	×

<Calibration curve/film thickness measurement results files> Pro α Pro β

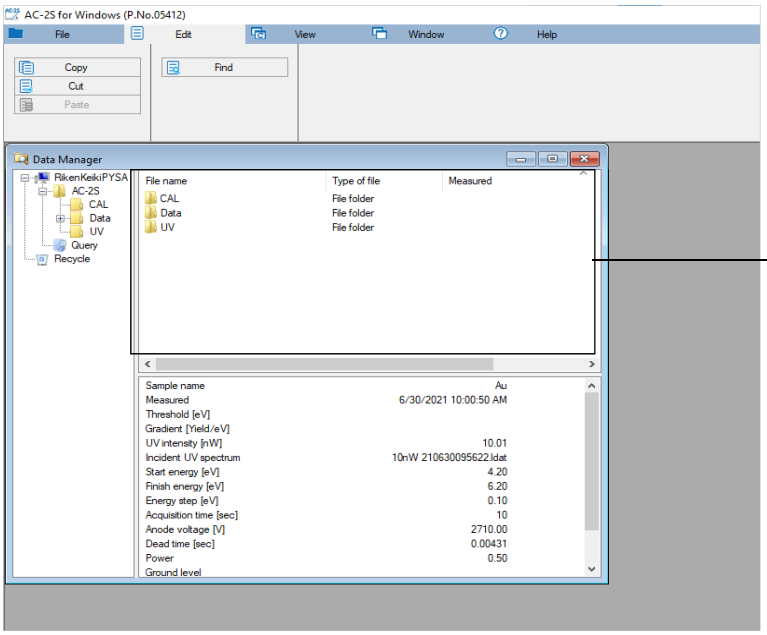
	Count rate data file	Calibration curve file	Film thickness data file
Sample name	○	○	○
Measurement date and time	○	○	○
Measurement UV intensity [nW]	○	○	○
Measurement energy [eV]	○	○	○
Aquisition time [s]	○	○	○
Calibration curve	×	×	○
Anode voltage [V]	○	×	○
Dead time [s]	○	×	○
Background count rate	○	×	○
Slope	×	○	×
Section	×	○	×
Calibration film thickness	×	○	×
Section correction	×	○	×

7-5-3 Searching for files

Search for files by file type, measurement date, and other parameters.
The search will target files located in the folder selected in list view in Data Manager.

<Searching by file type>

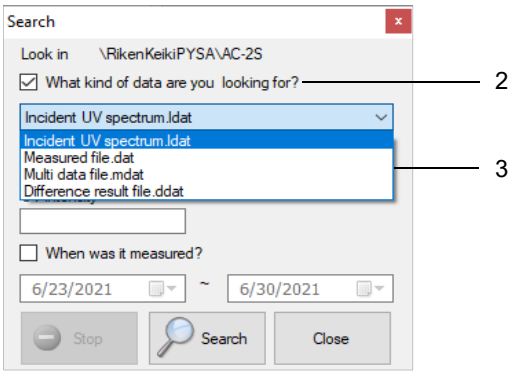
1 **Right-click on list view in Data Manager, then select [Search].**
You can also click the [Edit] tab in the main window and click the [Find] button to display the search window.



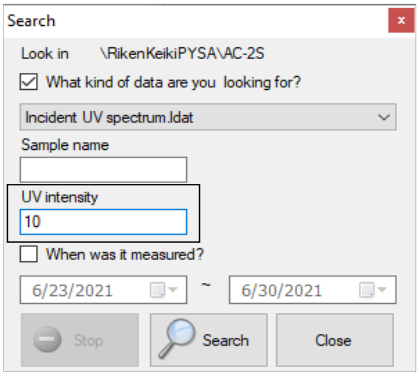
The search window appears.

2 **Check [What kind of data are you looking for?].**

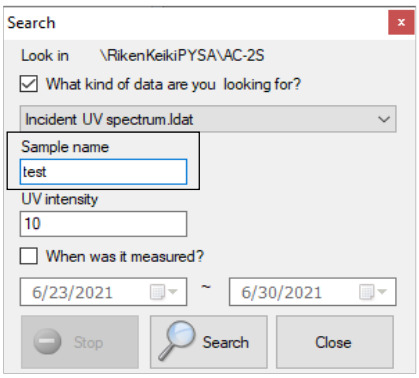
3 **Click [▽], then select the desired file from the file list.**



If [Incident UV spectrum.ldat] is selected, you can search for files by specifying [UV intensity].



If file types other than [Incident UV spectrum.ldat] are selected, search for files by specifying [Sample name].



4 Click the [Search] button.

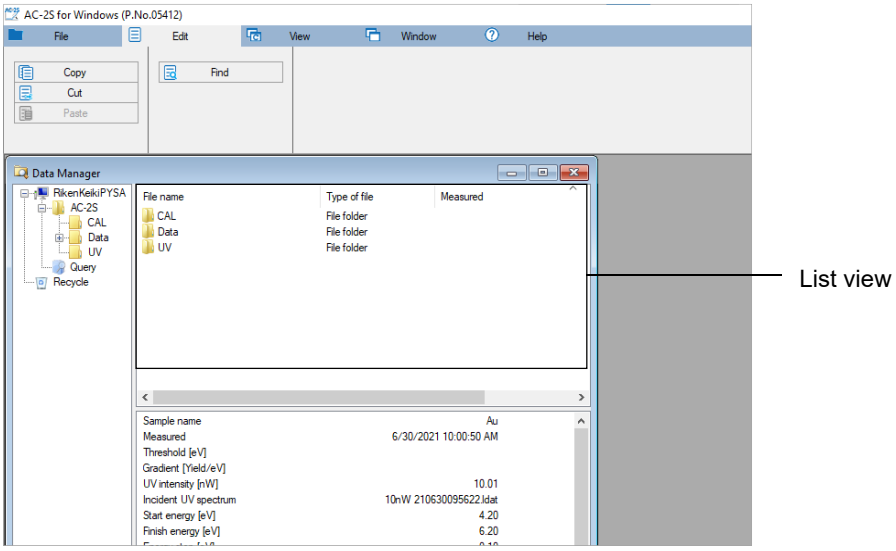
The files retuned by the search function are displayed in list view in Data Manager.

<Searching by measurement date>

You can search for files by specifying the period in which they were measured.

1 Right-click on list view in Data Manager, then select [Search].

You can also click the [Edit] tab in the main window and click the [Find] button to display the search window.



The search window appears.

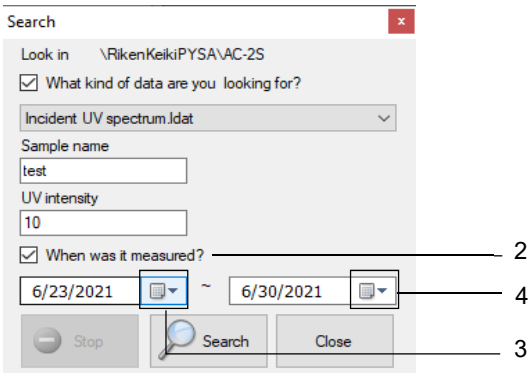
2 Check [When was it measured?].

3 Set the start date for the period in which to search.

Click [▼], then select the start date on the calendar window.

4 Set the end date for the period in which to search.

Click [▼], then select the end date on the calendar window.



5 Click the [Search] button.

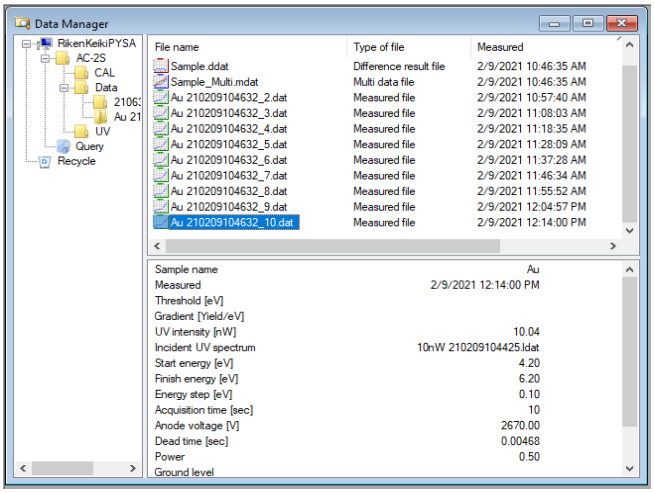
The files retuned by the search function are displayed in list view in Data Manager.

NOTE

- You can search for files by specifying search parameters for [What kind of data are you looking for?] and [When was it measured?].

7-5-4 Renaming files

1 Click and select the file to rename in tree view or list view in Data Manager.

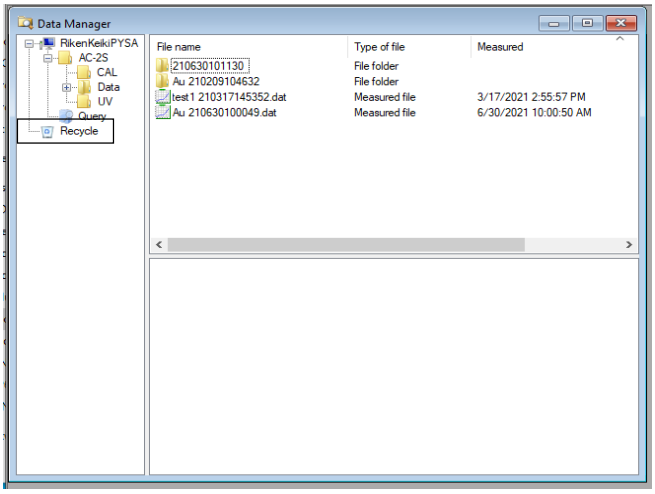


2 Right-click on the file name, then select [Rename].

3 Enter the new file name.

7-5-5 Deleting files

Files and folders deleted within Data Manager are moved to [Recycle] in tree view (the AC-2S recycle bin). Deleting files or folders from [Recycle] moves them to the Windows recycle bin.



1 Click and select a file or folder to delete in tree view or list view in Data Manager.

2 Right-click on the file or folder, then select [Delete].

7-6 Outputting measurement results

Measurement results data, measurement conditions, and graphs can be copied to the clipboard for use in other applications.

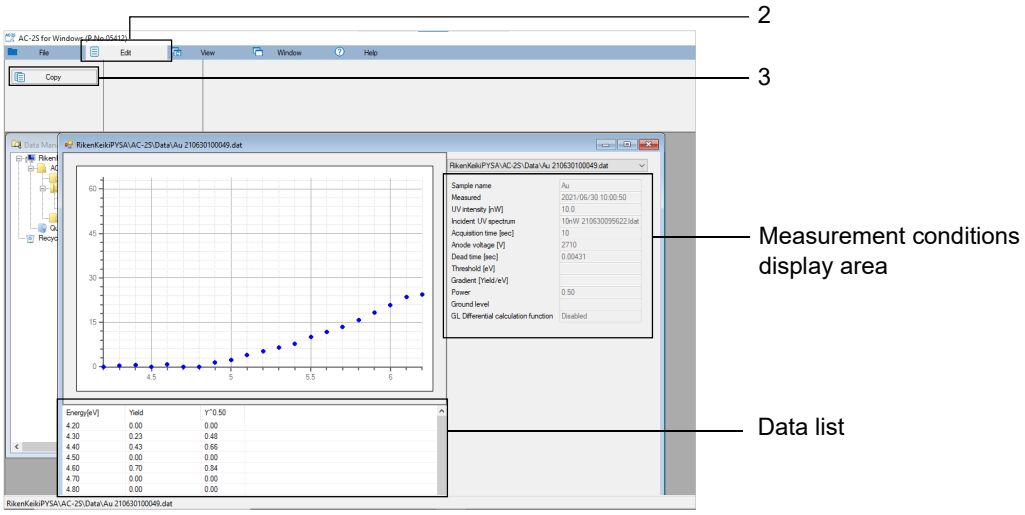
7-6-1 Outputting data and measurement conditions

Measurement results data and measurement conditions can be copied as text data for use in other applications.

1 **Click the data list or measurement conditions display area in the graph form window.**
To copy data, click the data list. To copy measurement conditions, click the measurement conditions display area.

2 **Click the [Edit] tab on the main window.**

3 **Click the [Copy] button.**
The data or measurement conditions are copied to the clipboard as text data.
You can also copy data or measurement conditions to the clipboard by pressing the C key and Ctrl key at the same time.



4 **Launch another application and paste the contents of the clipboard.**

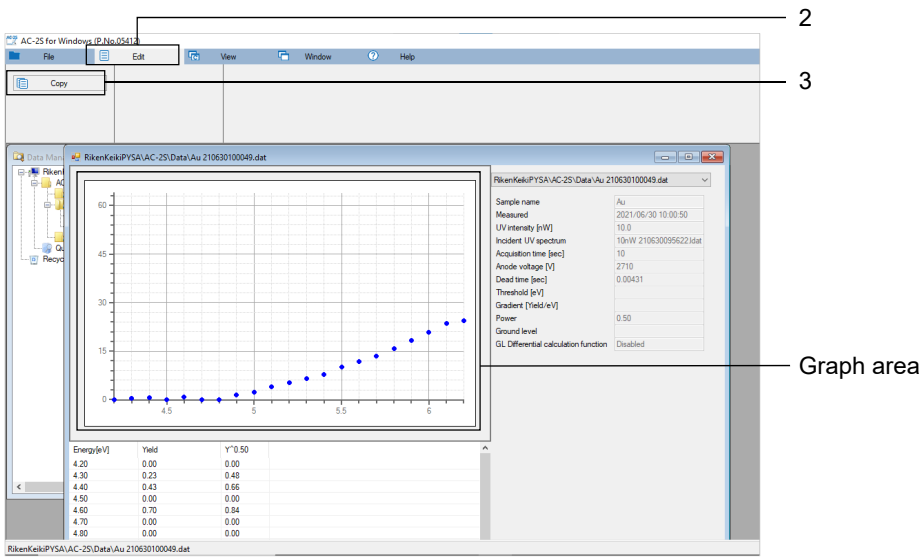
7-6-2 Outputting graphs

Measurement results graphs can be copied for use in other applications.
If pasted into Word or PowerPoint, the measurement results are output as graphics.
If pasted into Excel, the measurement results are output as graph data. However, they can be output as graphics by selecting [Bitmap] for [Paste Special] when pasting.

1 **Click the graph area in the graph form window.**

2 **Click the [Edit] tab on the main window.**

3 **Click the [Copy] button.**
You can also copy data or measurement conditions to the clipboard by pressing the C key and Ctrl key at the same time.



4 **Launch another application and paste the contents of the clipboard.**

NOTE

- Right-click on the graph and select [Image output] to output a graph as a BMP, PNG, or JPEG format image file.
- Right-click on the graph and select [File conversion] to output a graph as a CSV format file.

7-6-3 Bulk outputting data, measurement conditions, and graphs

Data, measurement conditions, and graphs can be output as PDF format files.

1 **Right-click on the graph form window, then select [Bulk output].**
Data, measurement conditions, and graphs are output as PDF format files.

NOTE

- Right-click on the graph form window, then select Bulk copy] to copy data, measurement conditions, and graphs.
  If pasted into Word, Excel, or PowerPoint, data and measurement conditions are output as text data.
  Graphs can be output as graphics by selecting [Bitmap] for [Paste Special].

7-7 Graph right-click operation list

<Work function measurement results files>

Right-click operation	Measurement data file (single)	Measurement data file (multiple)	Multi data file (single)	Multi data file (multiple)	Differential results file (single)	Differential results file (multiple)	Incident UV Spectrum file (single)	Incident UV Spectrum file (multiple)	Description
Ground level	○	△	○	△	×	×	×	×	Calculates the ground level based on data in the selected area.
Regression line	○	△	○	△	×	×	×	×	Calculates the regression line based on data in the selected area.
Clear data	○	△	○	△	×	×	×	×	Clears the ground level line and regression line.
GL Differential calculation function	○	△	○	△	×	×	×	×	Switches the ground level differential display.
Incident UV spectrum	○	△	×	×	×	×	×	×	—
Change	○	×	×	×	×	×	×	×	Changes the Incident UV Spectrum.
Delete	○	×	×	×	×	×	×	×	Disables UV intensity correction.
Save	○	△	○	△	○	△	○	△	Saves analysis results.
Change the sample name	○	△	○	△	×	×	×	×	Renames the sample.
Add	○	○	○	○	○	○	○	○	Displays the data overlaid.
Remove	△	○	△	○	△	○	△	○	Excludes the selected data.
Average	△	○	×	×	×	×	×	×	Calculates the mean. A multi data file is created and displayed in a separate window.
Density of states	×	×	○	△	×	×	×	×	Estimates the density of states. A differential results file is created and displayed in a separate window.
Details	×	×	○	△	×	×	×	×	Displays the data used to calculate the mean.
Change scale	○	○	○	○	○	○	○	○	Sets the axis maximum and minimum values.
Default scale	○	○	○	○	○	○	○	○	Returns axis maximum and minimum values to their default values.
File conversion	○	○	○	○	○	○	○	○	Outputs data in CSV format.
Bulk output	○	△	×	×	×	×	×	×	Outputs graphs, data, and parameters in PDF format.
Bulk copy	○	△	○	△	○	△	○	△	Copies graphs, data, and parameters in a batch operation.

○: Enabled △: Disabled (grayed out) ×: Not displayed

<Calibration curve/film thickness measurement results files> Pro α Pro β

Right-click operation	Count rate data file	Calibration curve file	Film thickness data file	Description
Save	○	×	○	Saves analysis results.
Change the sample name	○	×	○	Renames the sample.
Change scale	○	○	○	Sets the axis maximum and minimum values.

○: Enabled △: Disabled (grayed out) ×: Not displayed

8

Data conversion

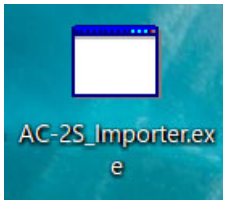
8-1 Overview of the AC-2S data conversion application

The AC-2S data conversion application converts data measured with Riken Keiki AC Series products (AC-2, AC-3, and AC-5) to a data format compatible with the AC-2S analysis application.

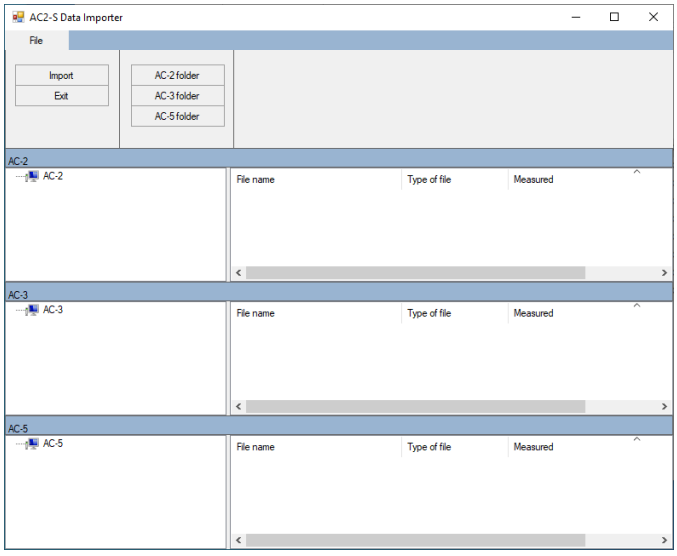
8-2 Basic file conversion operations

8-2-1 Launching the AC-2S data conversion application

1 Double-click the AC-2S conversion application shortcut icon displayed on the control PC desktop.



The AC-2S conversion application main window appears.

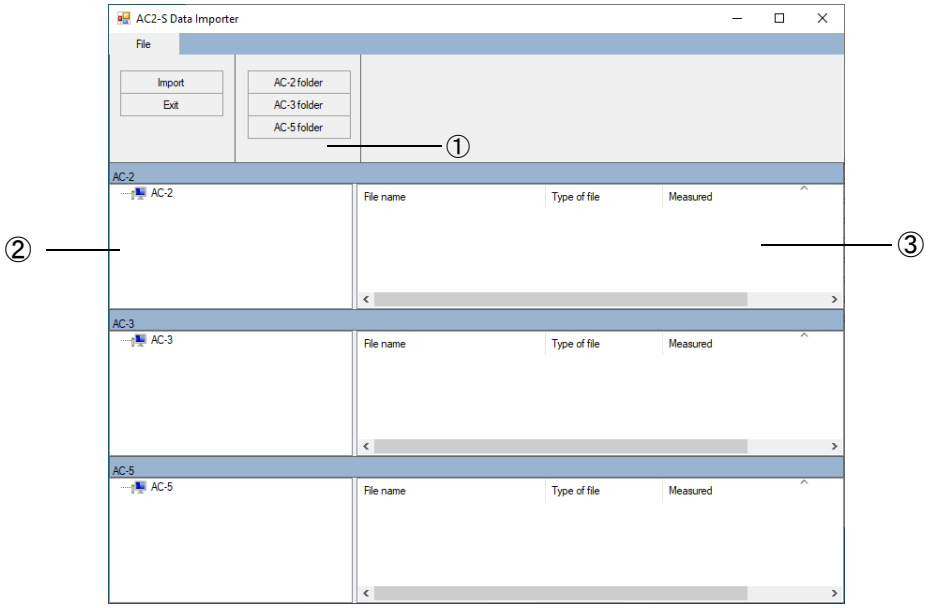


NOTE

- If you do not see the shortcut icon on the control PC desktop, open the Windows Start menu and select [AC-2S_Importer.exe] from the Start menu list.

8-2-2 AC-2S data conversion application window component names and functions

The AC-2S data conversion application window displays AC-2, AC-3, and AC-5 data.



No.	Name	Function
①	Menu display	Displays the AC-2S data conversion application operations.
②	Tree view	Displays folders and files for data before conversion in hierarchical format.
③	List view	Displays folders and files in tree view.

8-2-3 Files supported by the AC-2S data conversion application

The following files can be handled using the AC-2S conversion conversion:

<AC-2, AC-3, AC-5, and AC-2S work function measurement results files>

Type	Description
AC-5 measurement data file (*.dat)	File containing AC-5 work function measurement results.
AC-2 measurement data database (*.mbd)	Database file containing AC-2 work function measurement results.
AC-3 measurement data database (*.mbd)	Database file containing AC-2 work function measurement results.
AC-2S measurement data file (*.dat)	File containing AC-2S work function measurement results.

AC-2S measurement data files (*.dat) are saved to a user-specified folder in the \Documents \RikenKeikiPYSA\AC-2S\Data folder.

NOTE

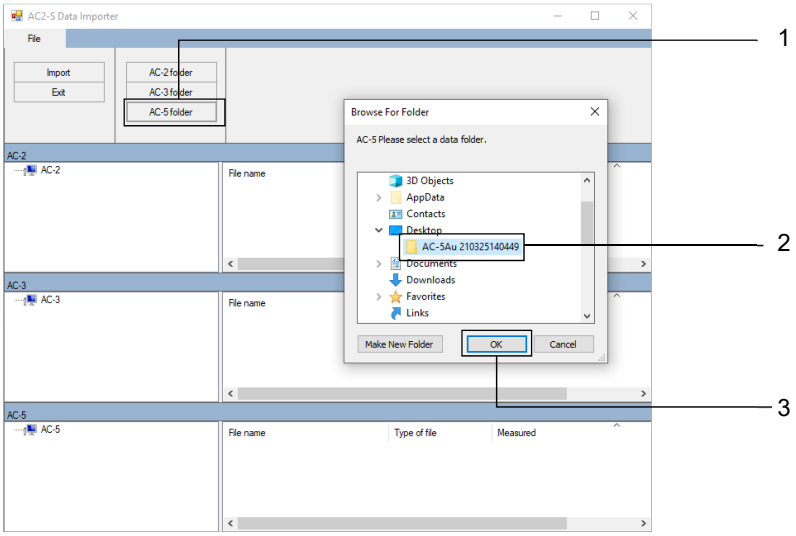
- AC-5 and AC-2S measurement data files are text files with the same file extension (*.dat) but different file structures. Do not save these files together in the same folder.
- By default, AC-2 measurement data files are saved as AC-2.mdb, while AC-3 measurement data files are saved as AC-3.mdb. These database files have the same file extensions. Be careful to avoid mixing them. Do not save these files to the same folder.
- We recommend backing up measurement data files periodically.

8-3 Converting to AC-2S format (AC-5 measurement data files)

1 **Click the [AC-5 folder] button on the AC-2S data conversion window.**
The folder selection window appears.

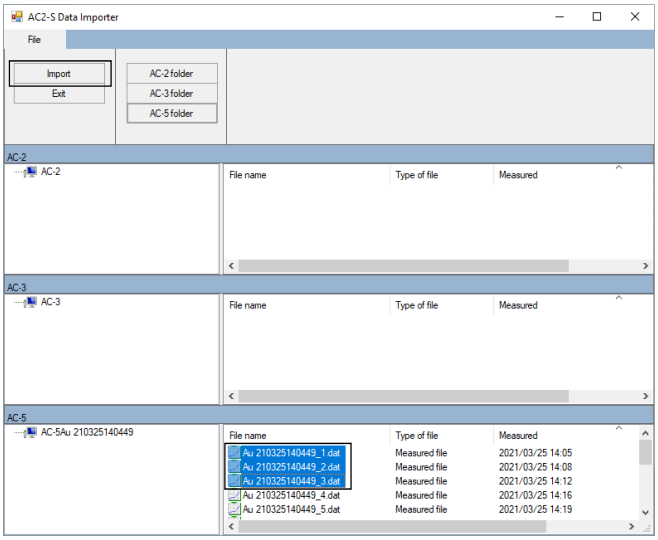
2 **Select the folder containing the AC-5 measurement data file (*.dat).**

3 **Click the [OK] button.**



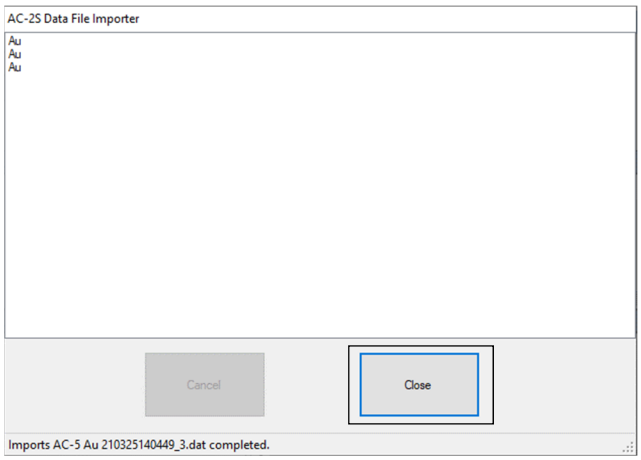
The selected folder and AC-5 measurement data files contained within the folder are displayed in [AC-5] tree view and list view.

4 **Select the data you wish to convert, then click the [Import] button.**



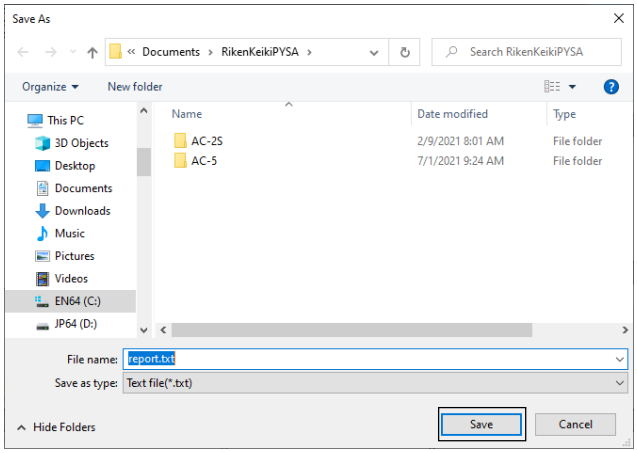
The selected AC-5 data is converted to AC-2S format and saved to \Documents\RikenKeikiPYSA\AC-5.
A report of the files converted is displayed on the AC-2S data conversion window.

5 Check the report details, then click the [Close] button.

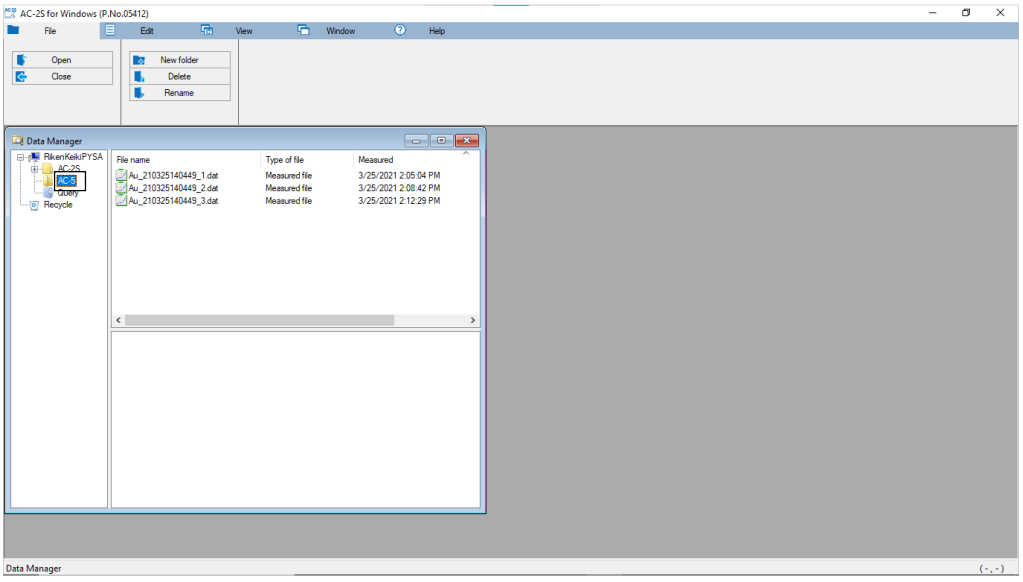


The file selection window appears.

6 Select the report file save destination, then click the [Save] button.



7 Launch the AC-2S data analysis application and confirm that the AC-5 data converted to AC-2S format has been saved.

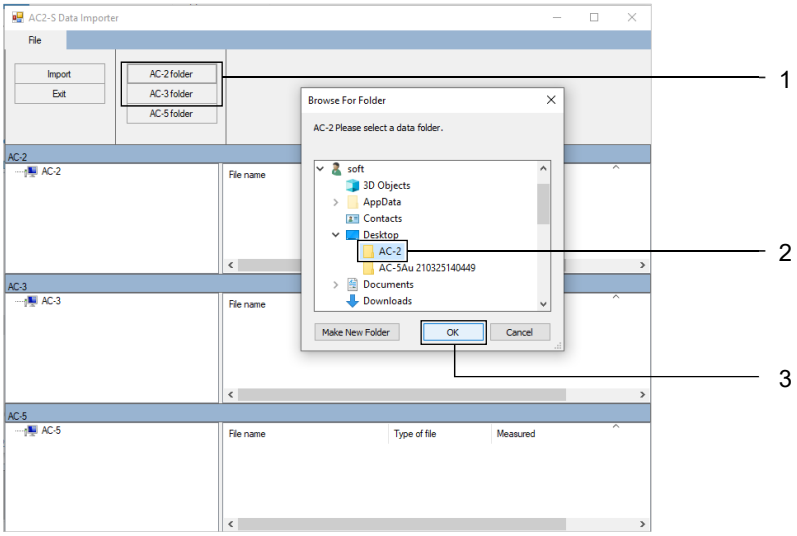


8-4 Converting to AC-2S format (AC-2/AC-3 measurement data files)

1 Click the [AC-2 Folder] or [AC-3 folder] button on the AC-2S data conversion window.
The folder selection window appears.

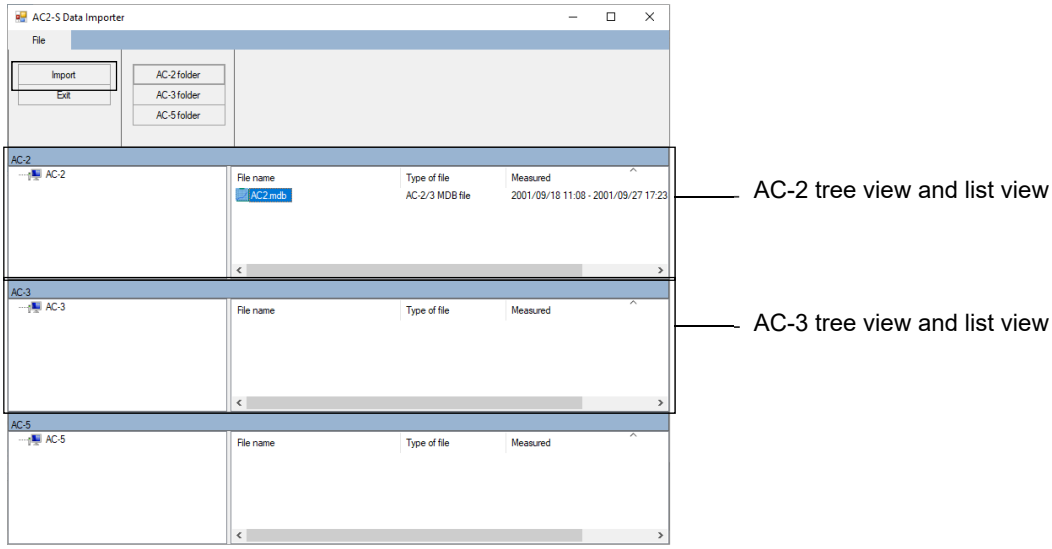
2 Select the database (*.mdb) containing the AC-2 or AC-3 measurement data file.

3 Click the [OK] button.



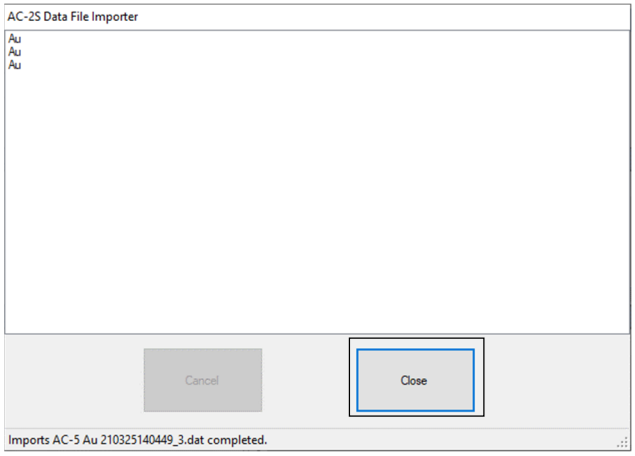
The selected folder and the AC-2 or AC-3 measurement data files located in the folder are displayed in [AC-2] or [AC-3] tree view and list view.

4 Select the data you wish to convert, then click the [Import] button.



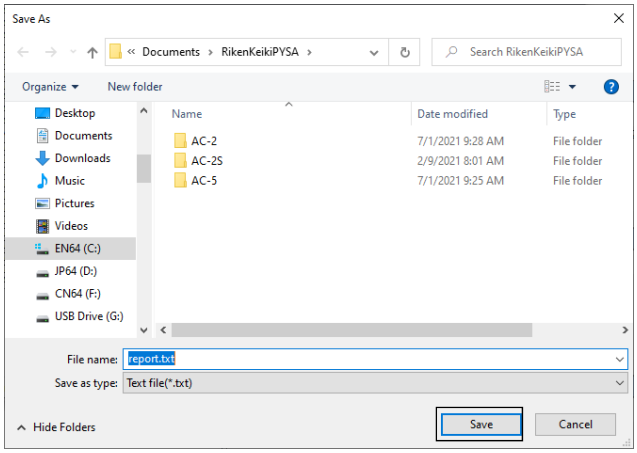
The selected AC-2 or AC-3 data is converted to AC-2S format and saved to \Documents \RikenKeikiPYSA\AC-2 or \Documents\RikenKeikiPYSA\AC-3.
A report of the files converted is displayed on the AC-2S data conversion window.

5 Check the report details, then click the [Close] button.

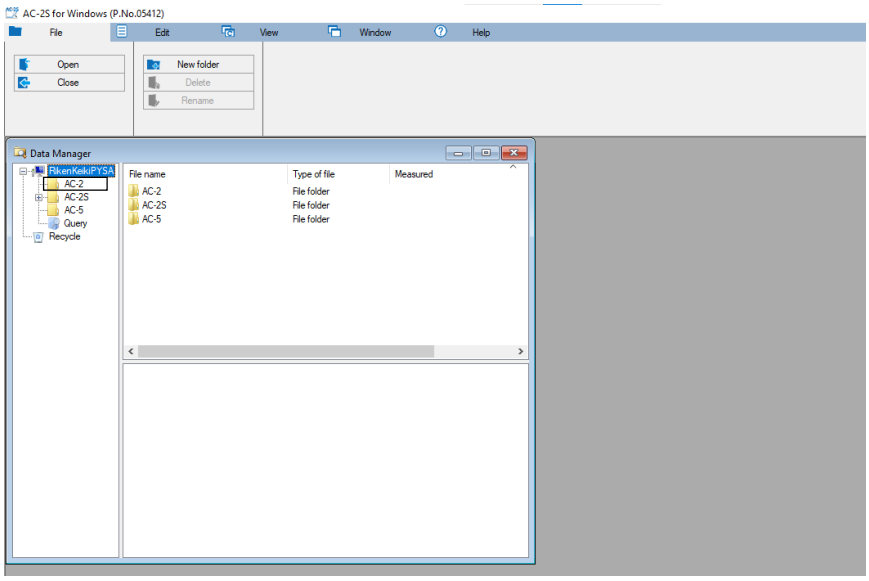


The file selection window appears.

6 Select the report file save destination, then click the [Save] button.

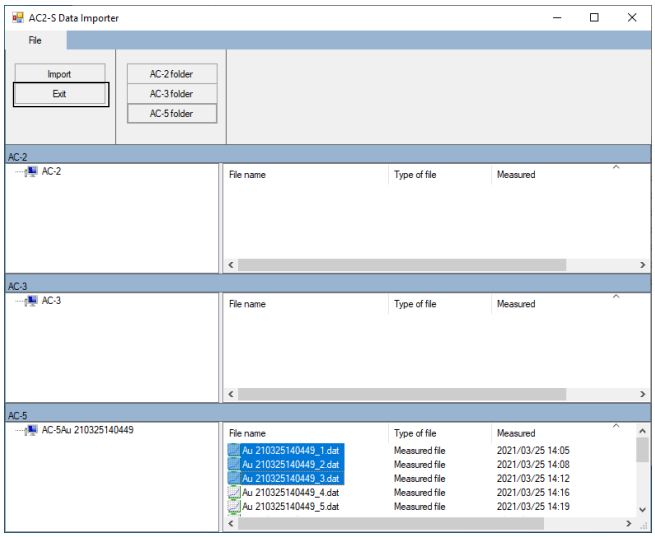


7 Launch the AC-2S data analysis application and confirm that the AC-2 or AC-3 data converted to AC-2S format has been saved.



8-5 Quitting the AC-2S conversion application

1 Click the [Exit] button.



This closes the AC-2S data conversion application.

9

Ending Main Unit Operation

9-1 Turning off the power

Turn off the power to the product.
Exit the AC-2S measurement application if it is running. (Refer to '6-9 Quitting measurement'.)

CAUTION

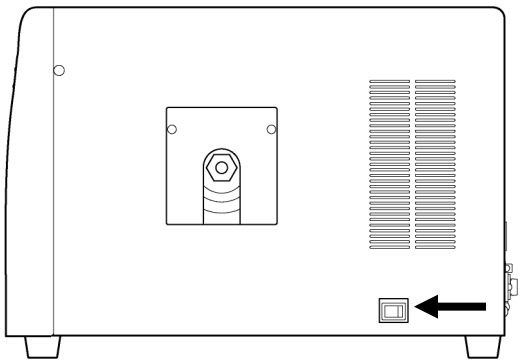
- Be sure to close the AC-2S measurement application before turning off the power to the product. Turning off the power to the product while the AC-2S measurement application is running may cause problems with the application.

NOTE

▶ You can open the AC-2S analysis application to view previously measured data even when the product power switch is turned off.

<AC-2S>

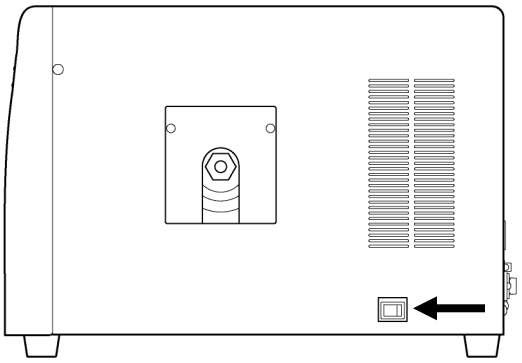
1 Turn off the power switch on the right side of the AC-2S LC unit.



2 Shut off the dry compressed air supply.

<AC-2S Pro α/AC-2S Pro β>

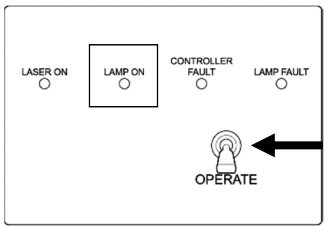
1 Turn off the power switch on the right side of the AC-2S LC unit.



2 Shut off the dry compressed air supply.

3 Turn on the plasma light source (LDLS).

Insert the power cable of the plasma light source unit into the power outlet. After confirming that the unit's fan is running, raise the OPERATE switch in the controller section. Check to confirm that the LAMP ON LED has gone out.



10

Maintenance

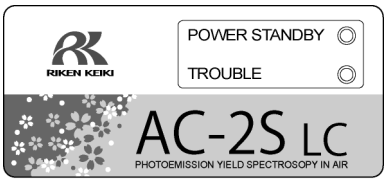
10-1 Daily inspection

Maintain and inspect the product periodically to ensure product performance and improve the reliability of the measurement data.

10-1-1 Display lamp inspection

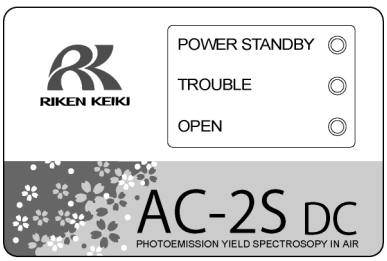
Check to confirm that the LED lamps on the product light up correctly.

<AC-2S LC (light source unit)>



Inspection item	Inspection details
POWER/STANDBY LED	Measurement in progress: Lights up (green) Standby (warming up): Blinks (green)
TROUBLE LED	Normal: Off Error: Lights up (red) During operational checks and immediately after turning on power: Blinks (red)

<AC-2S DC (measuring unit)>



Inspection item	Inspection details
POWER/STANDBY LED	Measurement in progress: Lights up (green) Standby (warming up): Blinks (green)
TROUBLE LED	Normal: Off Error: Lights up (red) During operational checks and immediately after turning on power: Blinks (red)
OPEN LED	Normal: Off Sample inlet open: Lights up (orange)

10-1-2 Sample chamber interior inspection

Before turning on the power, open the sample inlet and check to confirm that the interior is not dirty.
Remove dirt as follows:

- Use a vacuum cleaner or similar to remove any powder.
- Wipe the stage with isopropyl alcohol to remove adhering dirt.

NOTE

▶ If you use solvents or other such liquids to clean the interior, leave the sample inlet open for several hours. Check to confirm that the sample chamber is free of solvent vapor before using the product.

WARNING

- To open the sample inlet, press gently with your finger on the part marked “PUSH”.
  Any of the following actions may damage the sample inlet:
  - Pressing on the sample inlet anywhere other than the part marked “PUSH”
  - Pressing on the sample inlet with the palm of your hand
  - Subjecting the sample inlet to a load of 400 N or more (The sample inlet can be opened and closed with a force of 5 - 6 N.)
  - Forcing open the sample inlet when it does not open

CAUTION

- Do not leave charged fine power or volatile solvents inside the sample chamber.
  Performing measurements while charged fine power or volatile solvents remain inside the sample chamber may damage the detector and reduce its service life.
- Isopropyl alcohol is a combustible liquid.
  Handle with care. Keep the risk of fire in mind.

10-2 Consumable part replacement intervals

Contact Riken Keiki to replace consumable parts.
This product uses the following consumable parts:

No.	Name	Recommended check interval	Recommended replacement interval	Quantity (piece/unit)
1	Detector	1 year	1 year	1
2	Optical fiber	1 year	1 year	1
3	Activated carbon filter	1 year	5 years	1
4	D2 lamp (for AC-2S)	1 year	1 year	1

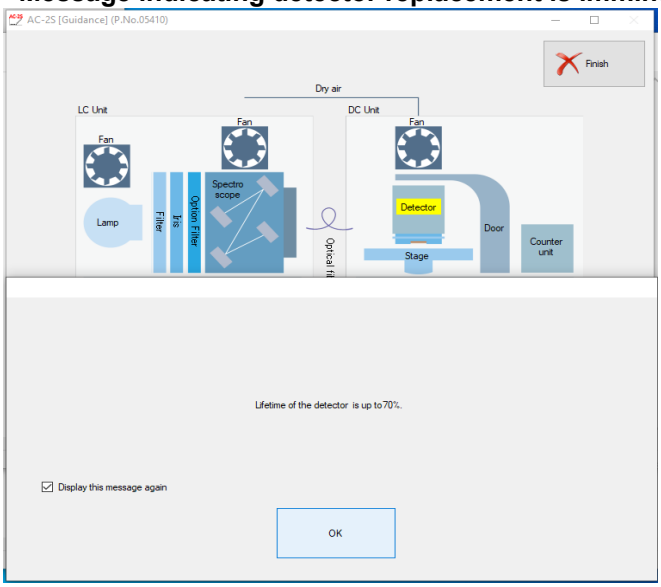
NOTE

- The above replacement intervals are guidelines only. Replacement intervals may vary depending on actual operating conditions. These intervals do not constitute warranty periods. Replacement intervals may vary depending on the results of regular maintenance.

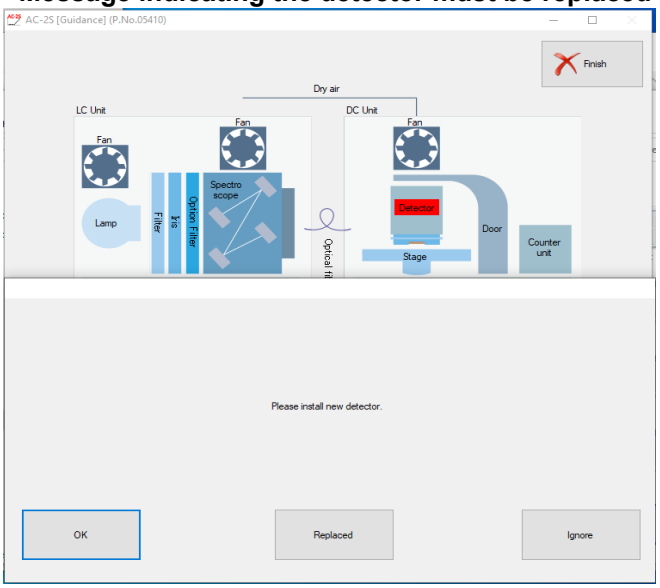
10-2-1 Detector (LE-6118)

A message appears when the detector is due for replacement.
Contact our sales department promptly if any of the following messages appears:

<Message indicating detector replacement is imminent>



<Message indicating the detector must be replaced>



NOTE

- Even if the above messages do not appear, replace the detector if you observe signs of detector deterioration, such as reduced detection rate, increased noise, or measurement scatter.
- The replacement interval will depend on how frequently the product is used.
- The detector will no longer be capable of measurements if the anode degrades to a certain point.
- Replaced detectors can be refreshed by an overhaul. Please contact our sales department for more information on detector overhauls.

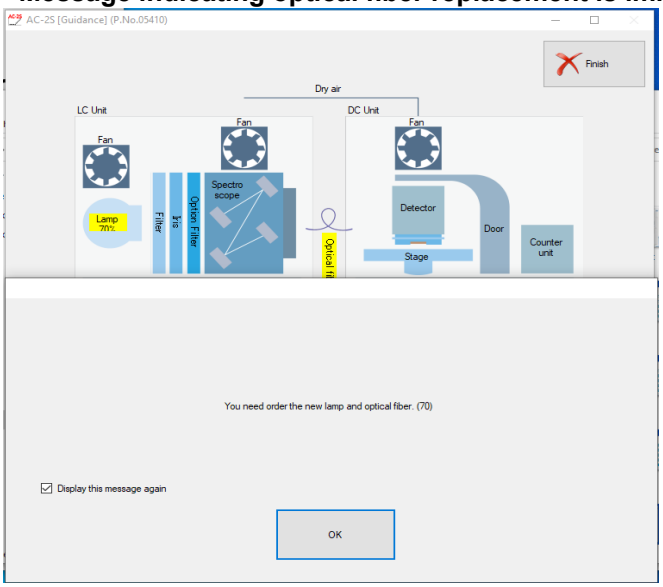
CAUTION

- The LE-6118 detector is intended for use with the AC-2S Series. It cannot be used with the AC-2. Likewise, the LE-6110 detector used with the AC-2 cannot be used with the AC-2S Series.

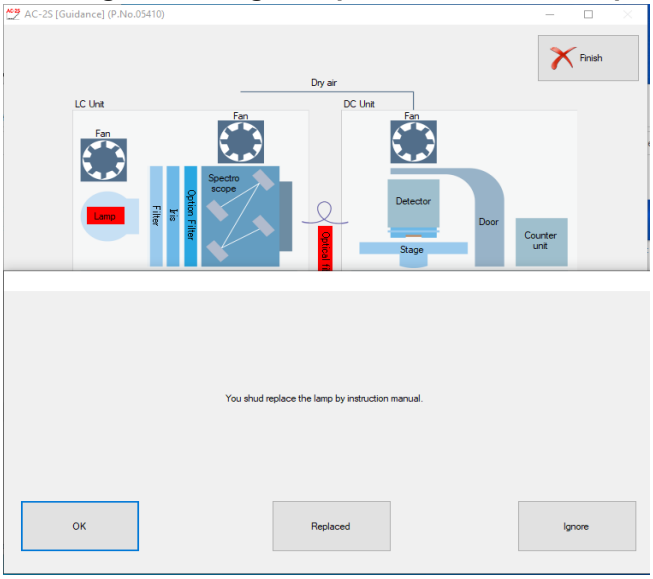
10-2-2 Optical fiber

A message appears when the maximum light intensity of the optical fiber drops.
Replace the optical fiber if this message appears or if the UV intensity used for measurement cannot be achieved. The replacement interval will vary depending on how frequently the product is used and on the UV intensity used.
Contact Riken Keiki promptly if any of the following messages appears:

<Message indicating optical fiber replacement is imminent>



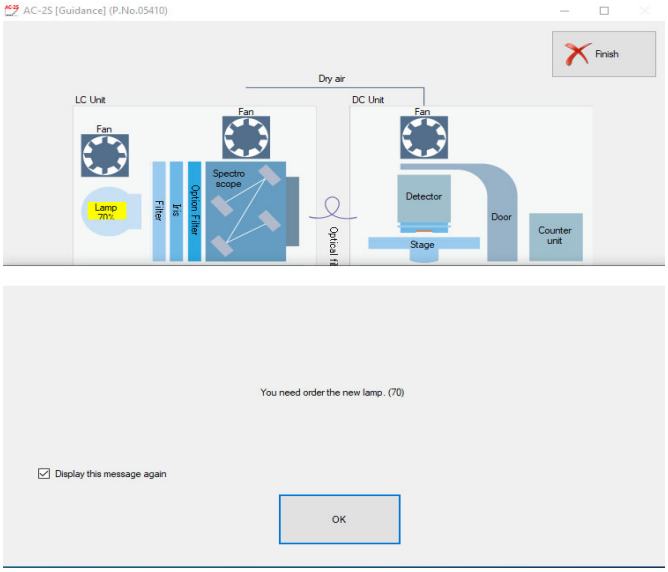
<Message indicating the optical fiber must be replaced>



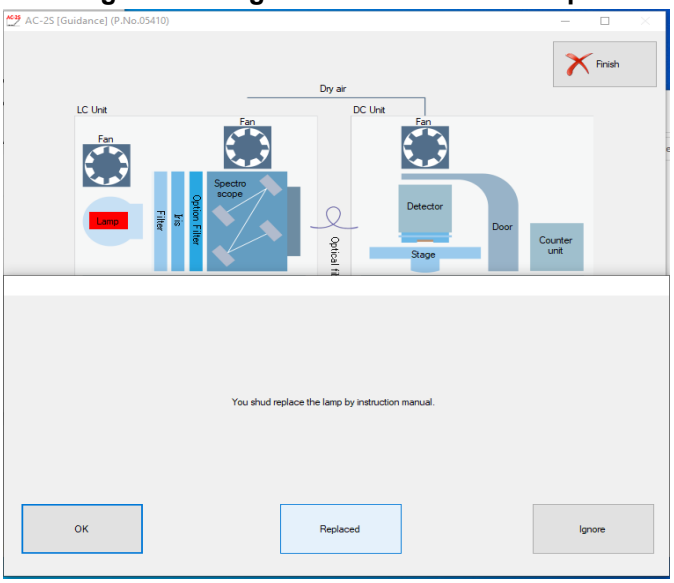
10-2-3 Deuterium (D_2) lamp **AC-2S**

A message appears when the UV lamp is due for replacement.
The UV lamp has a service life of approximately 1,500 hours.

<Message indicating lamp replacement is imminent>



<Message indicating the detector must be replaced>



10-2-4 Activated carbon filter

The activated carbon filter adsorbs and decomposes ozone generated by the UV light. Replace the filter if its ozone decomposition performance drops. The filter has a service life of approximately 5 years.
Contact our sales department to replace the activated carbon filter.

11

Storage, Relocation, and Disposal

11-1 Procedures for storage or when not used for extended periods

Store the product after referring to ‘4-1 Installation precautions’.
Store spare detectors in their dedicated packing case.

11-2 Procedures for relocation or reuse

Before moving the product, refer to ‘4-1 Installation precautions’, ‘4-2 Cable connection’, and ‘4-3 Pipe installation’ for guidance on conditions at the new installation site.

CAUTION

- Contact our sales department for readjustment.

11-3 Product disposal

Contact our sales department for product disposal.

12

Troubleshooting

12-1 Fault diagnosis

The product features a self-diagnostic function that checks individual functions at startup and when running.
Normal measurements cannot be performed if a fault occurs. Determine the cause and take the appropriate corrective action.
The TROUBLE LED on the product lights up (red) to indicate that a fault has occurred. An error message is also displayed on the control PC.

CAUTION

- The TROUBLE LED may not always light up and an error message may not always be displayed if the main unit or controller performs erratically for unforeseen reasons.
  In situations like this, turn off the power switch on the product and unplug from the mains socket.

12-2 Corrective action

If a fault occurs, stop the operation. Refer to the following information to clear the cause of the fault. Once the cause of the fault has been cleared, restart the product.
This troubleshooting section does not address causes of all problems that may occur with the product. It provides brief explanations to assist in determining the causes of common problems.
If symptoms not addressed here occur or if problems persist even after taking corrective action, contact our sales department.

NOTE

- In the event of faults due to unknown causes or if different causes occur continuously, make a note of the control PC screen display and symptoms and contact our sales department.
- If the fault appears likely to cause injury or damage to property, contact our sales department immediately. Do not attempt to replicate the fault.
- Be sure to save any measured data related to the problem. This data is often useful in determining the cause of a problem.

Symptom/display	Cause	Corrective action
The power cannot be turned on.	The power supply cable is not plugged into the mains socket.	Turn off the product power switch, then plug the power supply cable into the mains power supply socket.
	The main socket is not supplying power.	
	The power supply fuse has blown.	Check the reason for the fuse blowing. Replace the fuse if no problems are identified.
The power turns on, but the product does not start up correctly.	The sample inlet is open.	Close the sample inlet completely. The product starts up automatically.
The AC-2S measurement application starts up, but communication is not possible.	The interface cables (USB or RS-232C) are not properly connected.	Reconnect the interface cables (USB and RS-232C).
	Momentary electromagnetic interference resulted in a communication error.	Turn the main unit and AC-2S measurement application off and back on again.
The TROUBLE LED blinks (red) for a few minutes immediately after the power is turned on.	This indicates that operation is being checked after the product starts up.	This is not a fault provided that the TROUBLE LED goes out after blinking (red) for a few minutes.
The TROUBLE LED lights up (red).	The dry compressed air pressure is low.	Check the dry compressed air pressure, then restart the product.
	The UV lamp does not light up.	Restart the product. If this fails to resolve the problem, replace the UV lamp.
	The fan is not running.	Restart the product.
The anode voltage cannot be set.	The detector is defective.	Replace the detector. Contact our sales department.

13

Product Specifications

13-1 Product specifications

Item		Specification		
Model		AC-2S	AC-2S Pro α	AC-2S Pro β
Measurement principle		Photoemission yield spectroscopy in air (PYSA) (Detector: Low energy electron count method)		
Measurement energy scanning range		3.4 - 6.2 eV (364 - 200 nm)	2.0 - 6.2 eV (620 - 200 nm)	3.4 - 6.2 eV (364 - 200 nm)
Repeatability (standard deviation)		Work function 0.02 eV (sample: gold sheet)		
Measurement time		Standard time required for work function measurement: Approx. 5 minutes[*1]		
Maximum count		4,000 cps		
UV lamp		Deuterium (D_2) lamp	Laser-driven light source (LDLS)	
Minimum light intensity		1.0 nW or less (at 5.9 eV)	5.0 nW or less (at 5.9 eV)	1.0 nW or less (at 5.9 eV)
Maximum light intensity		500 nW or more (at 5.9 eV)	2,500 nW or more (at 5.9 eV)	200 nW or more (at 5.9 eV)
UV light Spot size		4 mm × 4 mm square or smaller		0.4 mm × 0.4 mm square or smaller
Spectrometer		Grating-type monochromator		
Sample size		50 mm × 50 mm (max.), maximum thickness 10 mm		
Sample stage size		115 mm × 122 mm	120 mm × 122 mm (heated sample stage)	
Multi-point measurement function		Up to 4 points (auto measurement)		
Operating temperature/ humidity range		15 °C - 35 °C (no sudden changes), up to 60 % RH (no condensation)		
Dry compressed air supply conditions		0.1 - 0.2 MPa, 0.5 L/min (measurement), 2.0 L/min (purging)		
Power supply				
	Main unit	100 V - 240 V AC ±10% 50/60 Hz, 5 A (max.)		
	LDLS	—	AC adapter: 100 V - 240 V AC, 50/60 Hz, 2.5 A Main unit: 12 V DC, 120 W	
	Temperature controller	—	100 V AC (±10 %), 50/60 Hz, 1 A (max.)	
Power consumption				
	Main unit	Approx. 120 VA / 210 VA (100 V AC / 240 V AC)	Approx. 80 VA / 150 VA (100 V AC / 240 V AC)	
	LDLS	—	Approx. 60 VA / 110 VA (100 V AC / 240 V AC)	
	Temperature controller	—	Approx. 20 VA (100 V AC)	
External dimensions				
	AC-2S LC (light source unit)	Approx. 480 mm (W) × 317 mm (H) × 450 mm (D)	Approx. 623 mm (W) × 317 mm (H) × 450 mm (D)	
	AC-2S DC (measuring unit)	Approx. 465 mm (W) × 360 mm (H) × 450 mm (D)	Approx. 465 mm (W) × 360 mm (H) × 450 mm (D)	Approx. 500 mm (W) × 360 mm (H) × 450 mm (D)
	Temperature controller	—	Approx. 200 mm (W) × 163 mm (H) × 280 mm (D)	

Weight			
	AC-2S LC (light source unit)	Approx. 25 kg	Approx. 30 kg
	AC-2S DC (measuring unit)	Approx. 31 kg	Approx. 31 kg
Operating environment conditions		·Operation location: Indoor ·2000 meters above sea level or lower ·TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGOLY II ·POLLUTION DEGREE 2	

*1 For measurement energy scanning range: 4.2 - 6.2 eV, step: 0.1 eV, count time: 5 s per step

13-2 Display/control unit specifications

Item	Specification
Display	Size: 17 inches or more Resolution: 1,024 × 768 or more
Control PC	Desktop PC Processor: 1 GHz or higher 32-bit (X86) processor Memory: 1 GB of RAM Hard disk: 16 GB of free space Direct X 9 graphics processor with Windows Display Driver Model (WDDM) 1.0 or later driver USB ports: Two or more CD-ROM or DVD-ROM drive Mouse
OS	Windows 10

13-3 Software (measurement/analysis) function specifications

Function	Details
Supported OS	Windows10
Work function measurement	Determines work function or ionization potential by measuring photoelectron spectrum.
Automatic UV intensity adjustment function	Automatically adjusts the incident UV intensity based on the user-specified required UV intensity.
Auto system startup function	Automatically sets system initialization and detector anode voltage.
Cut and paste function	Allows use of measured data in other applications via cut and paste operations. (May not be supported by some applications.)
Repeated measurement function	Performs repeated measurement.
Mean calculation function	Calculates the mean for multiple data items.
Differential calculation function	Calculates the differential value and supports density of states measurement.
Film thickness measurement function (AC-2S Pro α and AC-2S Pro β)	Creates calibration curves and calculates film thickness from the count rate.

13-4 Software (data conversion) function specifications

Function	Details
Supported OS	Windows10
Data conversion functions	Converts data from existing models (AC-2/AC-3/AC-5) to AC-2S format.

14

Appendix

14-1 Detection principle

14-1-1 Photoelectron detection principle

The AC-2S employs an open counter capable of counting photoelectrons in atmospheric conditions.
(Refer to '<Open counter configuration diagram>'.)
The sample is placed directly under the detector and has an electric potential of 0 V.
The detector consists of two overlapping layers of metal mesh (suppressor grid and quenching grid) and a metal wire (anode). Initially, Voltages of 80 and 100 V, 2,600 V, respectively are applied to these

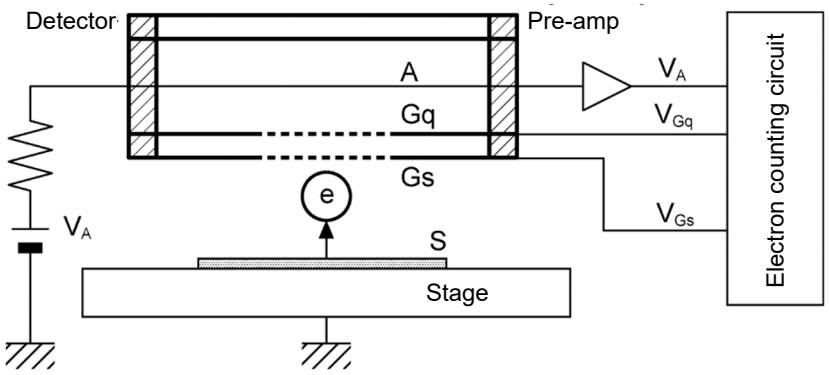
Electrons emitted from the sample surface due to UV irradiation repeatedly collide with air molecules and drift toward the suppressor grid.
The electrons emitted in this process adhere to oxygen molecules, which act as carriers entering the detector and approaching the anode.

The electrons carried close to the anode are accelerated by the strong electric field and separated from the oxygen molecules.
The electrons further accelerated close to the anode ionize air molecules through collisions, further increasing the number of electrons. This phenomenon is known as an electron avalanche.
The electrons generated by the electron avalanche collect at the anode, producing electrical pulses in the external circuit. These pulses are captured by an electrical circuit, enabling the electrons to be counted.

The electron avalanche caused by the influx of electrons into the detector also generates a large number of positive ions.
These positive ions have greater mass and move toward the test sample surface more slowly than electrons, but destabilize the electron avalanche caused by subsequent electrons and collide with the sample.
The electrical circuit changes the potential of the quenching grid and suppressor grid to 400 V and -30 V, respectively, for a period of just 2 ms at the same time a signal pulse is captured and counted. This reduces the potential difference between the quenching grid and the anode and halts the electron avalanche.
During this period, the positive ions are neutralized and quenched by both grids.
The suppressor grid keeps positive ions from colliding with the sample and keeps electrons from entering the detector until the positive ions have been quenched. These processes generate a dead time* in the detector. The dead time for this product is the time between one electron being counted and renewed capacity to count another electron. The number of electrons that cannot be counted during this dead time is obtained by extrapolation and duly applied to correct the measurement.

* Dead time
The dead time refers to the time after the detection of a particular event until the next event can be detected.
Radiation detection equipment is typically subject to intervals, called dead time, during which radiation cannot be detected. Measurements must be corrected, based on actual conditions, to account for this.

<Open counter configuration diagram>



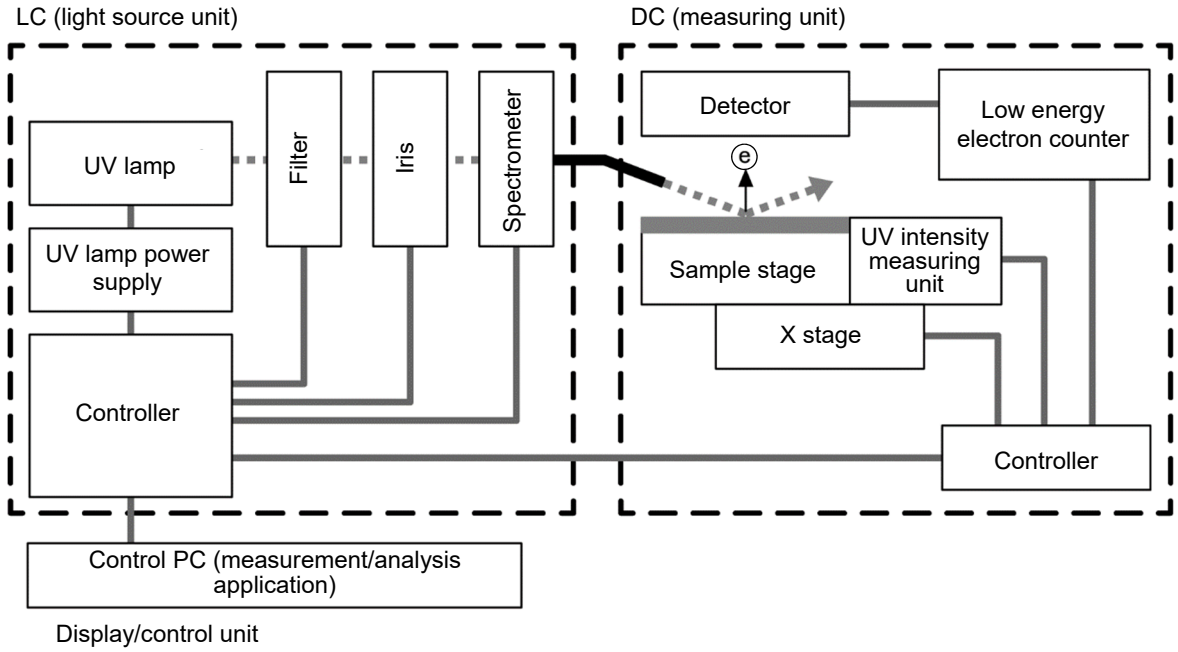
Gs: Suppressor grid Gq: Quenching grid A: Anode

S: Sample e : Electron

14-1-2 Photoelectric work function measurement

As shown in the following figure, the AC-2S consists of a UV lamp, UV intensity controller (filter, iris), spectrometer, detector, controller, X stage, and control PC.

<AS-2S configuration diagram>

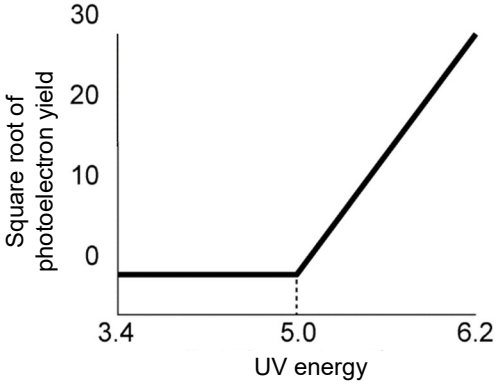


Light of wavelengths between 200 and 300 nm emitted by the UV lamp is monochromatized by the spectrometer into the required wavelength, which is directed to the sample surface.
Each photon possesses energy E, which can be calculated as a value between 3.4 and 6.2 eV using the following equation:
$E = hc / \lambda$ (h: Planck constant, c: speed of light, λ: wavelength)

If we sweep upward from the lower of this incident UV energy, electron emissions due to the photoelectric effect starts at a certain energy.
This energy is called the photoelectric work function. The photoelectric work function is considered as the work function for metal samples and as the ionization potential for semiconductor samples.

As shown in the following graph, if we plot the incident UV energy on the horizontal axis against the square root (exponent 0.5) of the photoelectron yield actually measured on the vertical axis, we obtain a straight line for metal samples.
The photoelectric work function can be determined from the intersection of the extrapolated straight line obtained by the least squares method with the ground level. The slope of the extrapolated straight line forms an index for parameters such as surface contamination and oxide film thickness.

<Relationship between UV energy and electrons>



14-2 Terminology

Term	Definition
Slope	Slope of the graph of incident UV energy plotted against photoelectron yield This forms an indicator of photoemission.
Photoemission threshold	Energy threshold at which photoemission starts
Work function	Energy required to release one electron from the surface of a solid
Ionization potential	Minimum energy required to ionize a molecule This is the maximum valance band energy for a semiconductor.
Density of states	This is the number of states between energy E and E + dE.
Incident UV energy	Energy per photon of incident UV This is obtained from the wavelength of the incident UV using the following equation: Energy [eV] = 1,240 / incident wavelength [nm]
Incident UV intensity	Total energy of incident UV per unit time This is obtained from the output current of a photodiode using the following equation: UV intensity [nW] = Number of incident photos per unit time × energy [eV] ÷ 0.625
UV intensity correction	Correction of differences in incident UV intensity for each energy when measuring work function and ionization potential The correction applies the following equation, based on the assumption that photoemission is proportional to incident UV intensity. Corrected count = Actual count ÷ incident photon count × 5.90 eV incident photon count

Revision History

Issue	Revision details	Issue date
0	First issue	2021/9/30
1	3-1-3 Optional accessories correction	2022/3/2
2	CE marking addition	2022/11/28

CE

EU-Declaration of Conformity

Document No.: 320CE22133

RIKEN KEIKI

We, RIKEN KEIKI Co., Ltd. 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan declare under our sole responsibility that the following product conforms to all the relevant provisions.

Product Name: Photoelectron Spectrometer
Model: AC-2S

Council Directives		Applicable Standards
2014/35/EU	LV Directive	EN 61010-1:2010/A1:2019
2014/30/EU	EMC Directive	EN IEC 61326-1:2021
2011/65/EU[1]	RoHS Directive	EN IEC 63000:2018

[1]Including substances added by Commission Delegated Directive (EU) 2015/863

Place: Tokyo, Japan

Date: Nov. 25, 2022

T. Takakura

Takakura Toshiyuki
General manager
Quality Control Center