Thermo Scientific Dionex UltiMate 3000 Series

6041RS ultra Amperometric Cell and Working Electrodes

For Electrochemical Detector ECD-3000RS

User Guide

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1 General Information

1.1 About this Guide

This user guide provides instructions for installation, set up, operation, shut down and maintenance of the 6041RS ultra Amperometric Analytical Cell and working electrodes for the ECD-3000RS Electrochemical Detector of the Thermo Scientific™ Dionex™ UltiMate™ 3000 series.

This guide is intended as a supplementary document to the *UltiMate 3000 ECD-3000RS Detector Operating Instructions*.

Refer to the *Operating Instructions* for the detector for general safety information on the device, and the conventions used throughout this guide regarding safety messages, notices and typography.

Keep this user guide with the *Operating Instructions* for the detector for quick reference.

The following conventions apply to throughout this user guide:

- The cell is referred to as *cell* or *amperometric cell* in this user guide. If other cell types are referenced, they are identified by name.
- The cell configuration may vary. Therefore, not all descriptions necessarily apply to your particular cell configuration.
- Illustrations in this user guide are provided for basic understanding. They can vary from the actual model of the cell or component. However, this does not influence the descriptions. No claims can be derived from the illustrations in this user guide.
- If not otherwise stated, the descriptions for the Viper™ capillary connections apply also to the nanoViper™ and possible other Viper capillary connections.

1.2 Safety

1.2.1 Safety Symbols and Signal Words

At various points throughout the user guide, messages of particular importance are indicated by certain symbols and signal words:

Warning: Indicates that failure to take note of the accompanying information may result in personal injury.

Important: Indicates that failure to take note of the accompanying information could cause wrong results or may result in damage to the instrument.

Tip: Indicates general information, as well as information intended to optimize the performance of the instrument.

1.2.2 Safety Precautions and Guidelines

Warning: Observe all safety precautions and guidelines as stated in the *Operating Instructions* for the detector.

Important: Electrochemical cells are sensitive to contamination and damage. To prevent damage to the cell and cell components, observe the following safety guidelines:

- Electrostatic discharge can cause performance degradation or a loss of functionality of the detector or electrochemical cell. To avoid this, take proper electrostatic discharge (ESD) protective measures.
- Always maintain flow when potential is applied. Never run the electrochemical cell dry while applying potential to the electrodes, as-this may damage the electrodes. Make sure that EC-compatible mobile phase flow is established before the cell is turned on and that flow remains turned on whenever potential is applied to avoid permanent damage to the cell.
- The electronic connector and the contacts of the cell identification chip on the rear side of the cell body are sensitive to contamination and damage.
  - ♦ Hold the cell only by the cell body. Do not touch the sensitive electronics.
  - ♦ Inspect the connector and ensure that there are no bent pins before installing the cell.
  - ♦ If liquid comes into contact with the identification chip, immediately remove it and wipe it dry to prevent any salt buildup or corrosion.

- The cell is sensitive to contamination. Wear protective gloves when handling the cell components and working electrodes. Before connecting the cell in the system flow path, flush the instruments in the flow path before the detector to waste, and flush the cell separately to waste, without a column connected.
- If the system flow path contains ferrous metals, such as stainless steel, this can disrupt operation of electrochemical cells and electrodes. Passivate the instruments and components before connecting the electrochemical cell in the flow path.

  For passivation instructions, refer to the *Operating Instructions*.
- Do not expose the electrochemical cells to mobile phases with high molar concentrations of nitric acid (> 5M HNO_3).
- The maximum operating pressure limit for the 6041RS ultra amperometric cell is 13.8 bar (200 psi, 1.38 MPa). Exceeding the pressure may cause leakage at the cell gasket.

  To avoid damage to the cell and restriction to flow, an analytical electrochemical cell must always be the last component in the system flow path.
- Make sure that you operate the cell within the specifications for backpressure and applied potential. Observe the specifications and the mobile phase guidelines for the electrochemical cells.

  For specifications, see chapter 6, page 57.
- Make yourself familiar with further safety guidelines for electrochemical cells in the *Operating Instructions* for the detector.

2 Cell Overview

2.1 Cell Description

The 6041RS ultra Amperometric Analytical Cell is an amperometric-style, thin-layer electrochemical cell.

For an operating principle of the detector with amperometric detection, refer to the *Operating Instructions* for the detector.

SmartChip Technology

The design of the electrochemical cells incorporates SmartChip™ technology for automatic recognition by the ECD-3000RS electrochemical detector.

The chip stores unique information about each cell type, including cell model and serial number. When the cell is connected to the potentiostat module, the identification chip technology:

- Transmits information directly to the connected chromatography data system for electronic tracking for method validation
- Automatically configures the detector with safe, established detection parameters, such as potential limits, to prevent unintended electrode damage

2.2 Cell Use

The cell has been specifically designed for use in liquid chromatography (LC) analyses using Direct Current (DC) Chronoamperometry or Pulsed Amperometric Detection (PAD), with the use of exchangeable working electrodes for adaptation for a variety applications requiring electrochemical detection.

The unique solid-state palladium reference electrode is part of the cell body and virtually maintenance free so that it never needs special filling solutions, cleaning, or replacement.

For details on the operational modes, refer to the *Operating Instructions* for the detector.

2.3 Cell Components

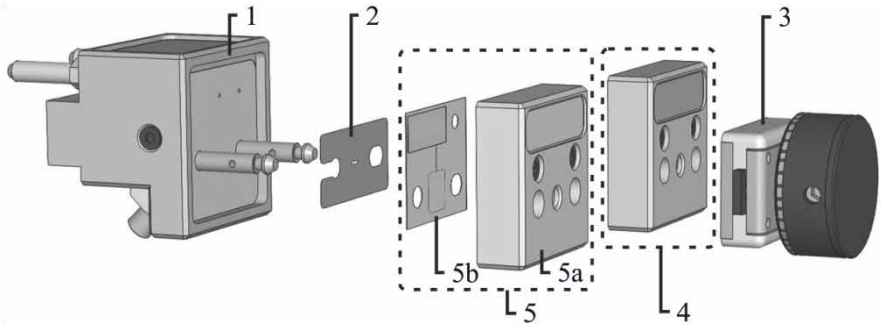


Fig. 1: Amperometric cell, exploded, with each working electrode type

No.	Description	
1	Cell body	
2	Gasket (→ page 7)	
3	Torque knob	
4-5	Working electrode (→ page 8), available as the following types:	
	4	Plate working electrode
	– or –	
	5 5a 5b	Thin-film working electrode (kit), consisting of Adapter for thin-film electrode Thin-film working electrode

2.3.1 Gaskets Overview

The gasket defines the cell volume and flow path of an amperometric cell. When assembling the cell, select the appropriate gasket size for your detection.

Two gasket sizes with respective volumes are available:

Gasket volume…	For detection type…	With working electrode…
50 nL	Routine detection	• Boron-doped diamond • Gold • Platinum (thin-film electrode)
25 nL	High-sensitivity detection	Glassy carbon (for monoamines)

The gaskets can be optically distinguished by the small hole that is present in one corner of the 25 nL gasket only.

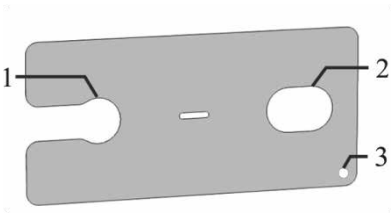


Fig. 2: Gasket (here: 25 nL gasket type)

Nr.	Description	Nr.	Description
1	Notch for alignment pin	2	Hole for alignment pin
3	*With the 25 nL gasket only* Small hole in the corner of the gasket for differentiation		

2.3.2 Working Electrodes Overview

The amperometric cell is shipped without working electrode. The working electrode must be ordered separately. Select an appropriate working electrode for your application.

Selecting an appropriate working electrode:

	Plate working electrode			Thin-film electrode
	Glassy Carbon (GC)	**Gold (Au)**	**Boron-doped diamond (BDD)**	**Platinum (Pt)**
Analytes	General use Aliphatic amines Aromatic alcohols Aromatic amines Catecholamines Catechols Conjugated-polyenes Disulfides Nitro-aromatics and aliphatics Phenols Quinones	Aliphatic alcohols Amino alcohols Aliphatic amines Amino sugars Aromatic nitros Disaccharides Mono-saccharides Oligo-saccharides	Thiols S-Nitroso Thiols Thioethers Disulfides Glutathione (GSH) Glutathione Disulfide (GSSG)	Alcohols Aldehydes Arsenite Formate Glycols Hydrogen peroxide Hypochlorite Hydrazine

Tip: The above table shows the working electrode material types that are typically used for the respective analyte class. The presence of an analyte class in this list does not imply that analytical methodes for its determination are available from Thermo Fisher Scientific.

3 Installation

3.1 Assembling the Cell

Assemble the amperometric cell with a gasket and a working electrode before you install and use the cell.

Parts required

- 6041RS ultra amperometric analytical cell
- Gasket (Select an appropriate gasket size, → page 7.)

  Tip: Use a new gasket whenever the cell is disassembled and reassembled.

- Working electrode
  Select an appropriate working electrode for the application to be performed (→ page 8), available as the following types:
  - ♦ Plate working electrode

  –or–

  - ♦ Thin-film electrode kit, consisting of thin-film electrode and adapter

Tools and additional items required

- Protective gloves (powder-free)
- Anti-static tweezers
- Lint-free cloths (2)
- HPLC-grade water

Preparations

1. Wear the protective gloves.
2. Unpack the cell.

3. Unpack the working electrode. For identification of the working electrode in the chromatography data system, such as Chromeleon™, proceed as follows:

   - *Plate working electrode:* Write down the serial number from the label on the bottom side of the electrode (*no. 1* in the image below).
   - *Thin-film electrodes:* Write down the lot number from the label on the thin-film electrode (*no. 2* in the image below).

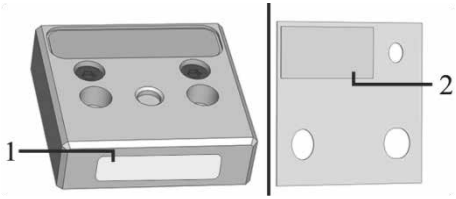


Fig. 3: Labels on the working electrode types

4. *If the cell is new or was stored*

   Remove the storage plugs and shipping spacer from the amperometric cell:

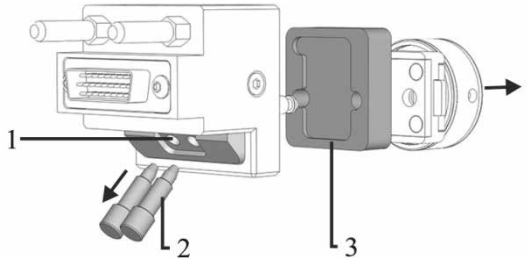
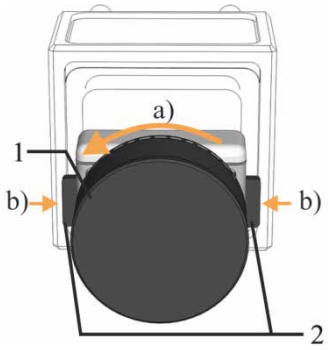


Fig. 4: Cell with storage plugs and shipping spacer (view from rear)

   - From the flow inlet and outlet of the cell body (*no. 1 in Fig. 4*), remove the storage plugs (*no. 2 in Fig. 4*).

- Remove the shipping spacer (*no. 3 in Fig. 4* above). To do so, remove the torque knob:



No.	Description
1	Torque knob
2	Side tabs

Fig. 5: Unlocking the torque knob

a) Turn the torque knob counterclockwise to loosen it.

b) Press the two side tabs on the knob and carefully pull the knob from the alignment pins on the cell body.

Tip: Keep the storage plugs of the cell, for example in the cell packaging, to have them easily available when storing or transporting the cell.

With amperometric cells, also keep the shipping spacer for storing or transporting the cell.

5. Clean the contacting surfaces of cell and working electrode:

a) Wet a lint-free cloth with a few drops of HPLC-grade water.

b) Wipe the surfaces of the working electrode and the inside surface of the cell body lightly with the lint-free, wetted cloth to remove any material that may be present.

c) With a second, dry lint-free cloth, wipe dry the working electrode and insidy cell body surfaces.

⚠ **Important:** To avoid damage to the components, do not immerse the plate working electrode, thin-film adapter or the cell body in water or any other liquid or mobile phase.

Follow these steps

1. Inspect and position the gasket (→ Fig. 6):

   a) To unpack a gasket from the gasket sheet set, grasp the gasket and pull to tear it from its break-away points.

   b) With the tweezers, grasp an edge of the gasket and inspect it. The gasket must be free of tears, wrinkles, dust and debris. A clean gasket will provide a good seal and ensure optimum cell performance.

   c) Place the gasket (*no. 1*) over the alignment pins (*no. 2*) of the cell body with the tweezers, matching the notch and hole of the gasket. Notch and hole in the gasket may be positioned in either direction.
   Make sure that the gasket is placed as follows:
   - the gasket lies flat against the cell body.
   - no wrinkles are visible on the gasket.

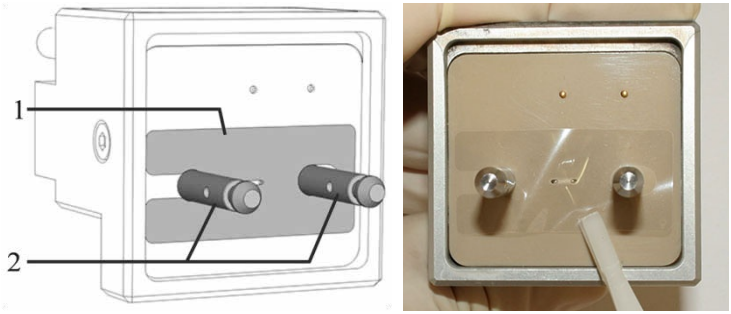


Fig. 6: Gasket installed on the cell body (example)

2. Install the working electrode, observing the correct alignment of the components. This step depends on the type:

   - **Plate working electrode** (→ Fig. 7)

     a) Place the working electrode on the cell body, aligning with the alignment pins. Mind the following:

        - The gold contact pads on the working electrode must match the two gold contact pins on the cell body.
        - The correct orientation of the working electrode is with the label being above the level of the alignment pins and facing away from the electrode.

     b) Check that the electrode rests on the gasket properly.

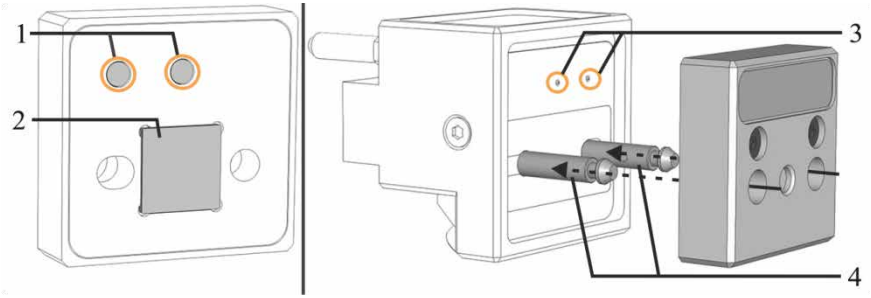


Fig. 7: Installing the plate working electrode

Nr.	Description	Nr.	Description
1	Contact pads (working electrode)	3	Contact pins (cell body)
2	Active electrode surface (plate electrode)	4	Alignment pins (cell body)

- **Thin-film working electrode** (→ Fig. 8)

  a) With the tweezers, place the thin-film electrode on the cell body, aligning with the alignment pins. Mind the following:

  - Do not touch the active electrode surface on the thin-film electrode (*no. 2* below).
  - The correct orientation of the thin-film electrode is with the label being above the level of the alignment pins and facing away from the electrode.
  - The electrode must rest on the gasket.

  b) Position the adapter on the thin-film electrode, aligning with the alignment pins. Mind the following:

  - The correct orientation is with the label facing away.
  - The gold contact pad on the adapter must match the right gold contact pin on the cell body.

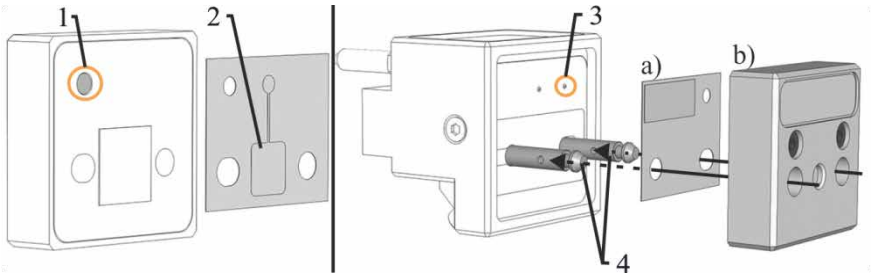


Fig. 8: Installing the thin-film electrode and adapter

Nr.	Description	Nr.	Description
1	Contact pad (adapter)	3	Right contact pin (cell body)
2	Active electrode surface (thin-film electrode)	4	Alignment pins (cell body)

3. Install the torque knob:

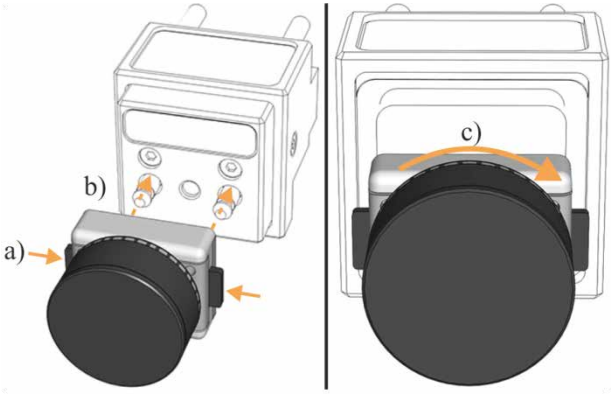


Fig. 9: Locking the torque knob

a) Take the torque knob by the side tabs to open the locks.

b) Position the knob on the alignment pins of the cell body. Release the side tabs to lock the alignment pins in the slots of the torque knob.

c) Turn torque knob clockwise until it clicks several times. The clicking sound confirms that the knob is properly seated.

   The knob now seals tightly against the gasket.

4. The cell is ready for installation to a potentiostat module on the detector. See section 3.2, page 16.

3.2 Cell Installation and Flow Connections

The procedure for replacing or reinstalling the cell corresponds to the installation steps upon first-time installation.

⚠ **Important:** The maximum operating pressure limit for the 6041RS ultra amperometric cell is 13.8 bar (200 psi, 1.38 MPa). Exceeding the pressure may cause leakage at the cell gasket.

To avoid damage to the cell and restriction to flow, an analytical electrochemical cell must always be the last component in the system flow path.

3.2.1 Guidelines for Installation

When installing the amperometric cell, observe the following guidelines:

- The amperometric cell does not have a directional flow for the flow connections. You can choose which port you want to use as inlet port and which as outlet port. Choose the ports in a way that best optimizes the fluidics of the system.
- No tools are required to remove and install an electrochemical cell when using Viper capillaries.
- In-line filters that are provided with the ECD-3000RS detector can be installed in the system flow path to protect the sensitive electrochmical cell from particulate contamination.
- To avoid that the capillaries are pinched when the door is closed, route the capillaries to the outside through the slots in the detector enclosure.

- Capillary connections between the analytical column outlet and analytical electrochemical cell should be as short as possible to avoid peak broadening effects due to excessive volume.
- When installing a new cell to the detector (for example, upon replacement), observe the following guidelines:
  - ♦ Always update the cell ID and working electrode information in the chromatography data system, such as Chromeleon.
  - ♦ Construct a hydrodynamic voltammogram prior to use of each new electrochemical cell (or working electrode material) to determine its optimum potential for the desired application.
    For further information on the hydrodynamic voltammogram, see section 4.3.2, page 28.
- For more information on the system flow path, refer to the *Operating Instructions* for the detector.

3.2.2 Installing the Cell and Flow Connections

Parts required

- Amperometric cell, with gasket and working electrode
- Potentiostat module (installed in the detector)
- Inlet capillary
- Cell waste line (such as from cell waste line kit), consisting of:
  - ♦ Capillary, PEEK, I.D. 0.015", gray
  - ♦ 2 tubing fittings, PEEK, 1/16"
- Analytical mobile phase

Preparations

1. Install the potentiostat module to the bay to which you want to install the cell. Refer to the *Installation Instructions* for the potentiostat module.

2. *If not yet done:* With only the potentiostat module installed (no cell attached), turn on the detector and wait until the self-test is completed.

   ⚠ **Important:** The detector must perform the self-test *before* you install an electrochemical cell. If the detector performs a self-test only after you have installed the cell, the self-test may fail. In this case, uninstall the cell and re-perform a self-test.

3. Perform a relay test with the potentiostat module, using the SimulatorRS cell. Refer to the *Operating Instructions* for the detector.

4. Prepare the waste line: Slide one tubing fitting over one end of the waste capillary.

5. Set up the flow connections in the system flow path before the detector.

6. Flush the system modules in the flow path before the detector to waste using an appropriate mobile phase for at least 1 hour at a flow rate of 1 mL/min to remove any potential contaminants.

Follow these steps

1. Set up the flow connections to the cell.

   Tip: The amperometric cell does not have a directional flow for the flow connections. You can choose which port you want to use as inlet port and which as outlet port. Choose the ports in a way that best optimizes the fluidics of the system.

   a) Connect the capillary to the inlet of the cell.

   b) Connect cell waste line to the outlet of the cell: Screw the fitting end into the outlet port of the cell. Route the waste line to waste.

2. Install the cell to the potentiostat module:

   a) Align the guiding pins of the cell with the alignment holes on the potentiostat module.

   b) Push the cell connector completely into the potentiostat module connector.

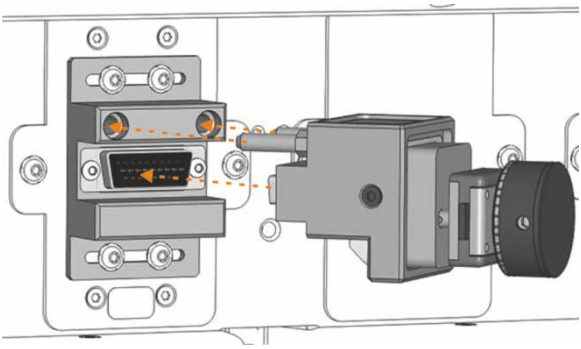


Fig. 10: Installing the cell to the potentiostat module

3. Flush the cell. Leave the potential turned off during flushing.

   a) Connect the pump outlet directly to the cell inlet.

   ⚠ **Important:** To avoid contamination, make sure that no analytical column is connected in the flow path when flushing a cell.

   b) Check that the cell waste line routes to waste.

   c) Set the pump flow rate as required for the intended application. Turn the pump flow on.

   ⚠ **Important:** Do not apply flow rates above 1.0 mL/min with the cell to avoid a leak at the gasket. This may damage the gasket or the working electrode.

   d) Check the cell for leaks and the leak sensor setting.

   e) Flush the cell to waste with analytical mobile phase at the flow rate required for analysis for at least 20 minutes to remove impurities and help conditioning the cell. Observe all *Mobile Phase Guidelines* in the *Operating Instructions* for the detector.

   Tip: Mobile phase quality significantly affects detection limits and detector performance. A careful consideration in the selection of the components of the mobile phase will be extremely useful in minimizing baseline noise and optimizing the performance during analysis.

4. Set up the flow connections in the system and to the cell. Refer to the *Operating Instructions* for the detector.

5. Configure the cell (→ page 21).

3.2.3 Configuring the Cell

To use the cell with a chromatography data system, such as Chromeleon, configure the cell.

This section describes the cell configuration using the Chromeleon Chromatography Data System. For other chromatography data systems, refer to the documentation of the data system.

1. Open the Chromeleon **Server Configuration** program.
2. On the configuration pages for the detector on the **Detector** page, click **Read Smart Cells**. The cell information for this bay is updated. For more information, refer to the *Operating Instructions* for the detector.
3. Click **View Cell Data** to open the **Cell Properties** dialog.
4. Select the cell bay to which you installed the cell in the **Cell Properties** dialog.
5. Enter the cell data:
   - Enter the serial number (of the working electrode) or lot number (of the thin-film electrode).
   - From the **Material** list, select the working electrode material.
6. Click **Update** and confirm the settings.
7. Save the detector configuration and close the Chromeleon **Server Configuration** program.
8. Equilibrate the cell. See next section.

3.3 Equilibrating the Cell

Before you start any analysis, allow the cell to stabilize, for the background current to stabilize. The baseline should be reasonably stable. The amount of time necessary to stabilize the cell depends on the application.

Several factors determine how long the cell needs to equilibrate, such as the nature and purity of the mobile phase, potential applied to the cell and especially the level of sensitivity needed for the analysis. The equilibration can take as little as few minutes for non-sensitive analyses to periods of hours for very sensitive analyses.

Preparations

Assemble, install and configure the chromatography data system for the cell. Follow the instructions in section 3.1, page 9 and section 3.2, page 16.

Follow these steps

1. Set the flow rate for the analyses and start the pump flow.

   ⚠ **Important:** Do not apply flow rates above 1.0 mL/min with the cell to avoid a leak at the gasket. This may damage the gasket or the working electrode.

2. Set the potential(s) to the value(s) required for the application in the chromatography data system.

3. Start the data acquisition.

4. *If you use the Chromeleon software*
   On the panel tabset, select **More Options** to open the More Options dialog. Select **Start Equilibration** for the cell that you want to equilibrate.

   Tip: When the equilibration of the cell has been successful, the boxes that displayed **Measuring** during the equilibration will show values.

5. Monitor the current for the cell that is equilibrated.

   Initially, the current from the working electrode will be high. Over time, this current decays exponentially. The time required for equilibration depends on the desired sensitivity.

   The following equilibration periods are intended only as guidelines and are subject to change, based on the application:

   - **DC Mode:** Allow the amperometric cell to equilibrate the cell for at least 4 hours after the initial assembly before routine analysis.
   - **Pulse Mode:** Allow the amperometric cell to equilibrate for at least 1 hour after the initial assembly with flow of mobile phase and the application of the Pulse waveform.

6. The equilibration has been successful once the baseline signal of the cell is stable and the noise has diminished.

Tip: When using a new cell amperometric cell or working electrode, always perform an HDV to optimize the potential for optimum cell performance.

Tip: *Upon first-time use and after storage of the Boron-doped diamond or glassy carbon working electrode*
After equilibration of the cell, perform an electrochemical treatment to activate the electrode material. See section 5.3.1, page 36.

4 Operation

4.1 General Information about Control

As part of the ECD-3000RS detector, the amperometric cell is operated using chromatography data systems, such as the Chromeleon Chromatography Management System.

For information on the chromatography data system, refer to the data system documentation and its Help.

4.2 Guidelines for Operation

Observe the following guidelines for operation of the cell:

- The 6041RS ultra Amperometric Analytical Cell can be used for DC Mode or Pulse Mode operation.
- *Upon first-time use of the Boron-doped diamond or glassy carbon working electrode*

  Perform an electrochemical treatment to activate the electrode material. See section 5.3.1, page 36.
- Monitor background currents. Changes in the background current may be indicative of a possible problem.
- Do not apply potentials to the cell if no electrolyte is present in the mobile phase and during organic cleaning or aqueous washing procedures.
- Remove the electrochemical cell from the detector when connecting a new column. Allow the column to flush for several hours to remove particles from the column before re-attaching the cell.

- Be sure to turn off the (potential to the) cell and remove it from the detector when chemically cleaning it or any other component of the system.
- If a problem occurs in the system, first check other components of the system before making the conclusion that the problem is a result of the cell.
- If a cell leaks, remove the cell from the detector immediately.

  With amperometric cells, replace the gasket(→ section 5.6.1, page 55) and/or the working electrode (→ section 5.6.2, page 56). If the cell is still leaking, remove and replace the cell (→ section 5.5, page 52).
- When problems with the cell or a loss in cell performance occur, check the *Operating Problems* section. Refer to the *Operating Instructions* for the detector for remedial action.
- Always use a buffered mobile phase.
  - ♦ The concentration of buffers should be kept between 50 and 100 mM to minimize the background current and baseline drift while maintaining constant pH value.
  - ♦ When changing from a buffer to a different operating mobile phase, be sure the solvents are miscible and will not induce precipitation of the buffers.
  - ♦ Do not allow buffers to remain in the cell without flow for extended periods. Cells should not be allowed to dry containing a mobile phase with buffers. For storage they should be flushed with at least 20% methanol.
- If a sample analysis is critical, it may help to have a replacement cell available before starting the analysis.

4.3 Optimizing Analytical Potential

The appropriate potential for an analysis is the potential that provides the largest signal for the oxidation (or reduction) of an analyte while minimizing the signal from interferences (for example, electroactive compounds that co-elute with the analyte or the mobile phase itself).

4.3.1 Guidelines for an Optimum Potential

Consider the following factors for an optimum potential:

- The best applied potential is typically obtained by generating a hydrodynamic voltammogram (HDV) curve and choosing a potential at which the signal just begins to plateau. The result is a maximum signal response by selecting the lowest applied potential possible.
- Typically the chromatographic conditions need to be finalized before the final detector settings are determined. It should be noted that factors which affect the separation (e.g. the ionic strength and the organic modifies) can alter the electrochemical characteristics of the analyte.
- The mobile phase and buffer solutions should not contain components that are oxidized or reduced at the analytical potential. Maintain a potential difference of 50 mV between the compound of interest and components in the mobile phase, if possible.

4.3.2 Hydrodynamic Voltammogram

A hydrodynamic voltammogram (HDV), often referred to as a current-voltage (CV) curve, is a plot of the current (signal or response) produced when an electrochemically active compound undergoes electrolysis at the working electrode as a function of the applied potential.

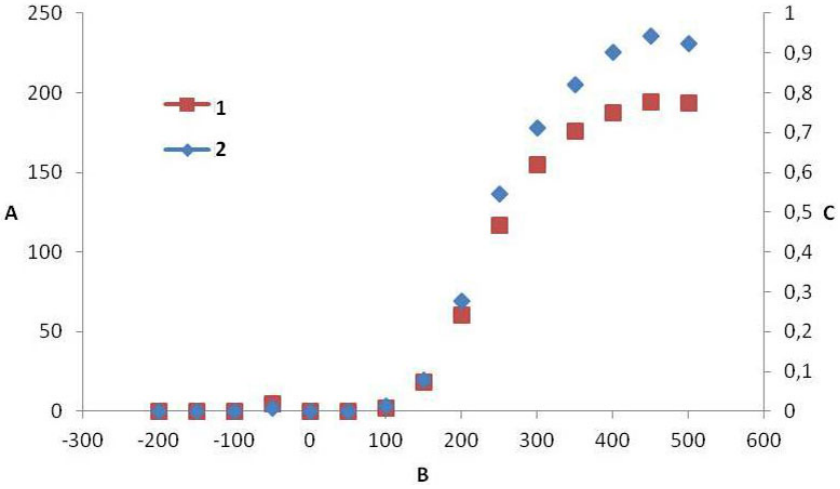


Fig. 11: Example of an HDV for 3.4 dihydroxybenzylamine detected with a 6041RS ultra amperometric cell

Letter	Description
A	Peak height of DHBA, nA
B	Applied potential, mV
C	Peak area of DHBA, nC

No.	Description
1	Peak height
2	Peak area

The information contained in an HDV is used in selecting the optimal applied potential to the working electrode for the detection of an analyte under a given set of chromatographic conditions.

A primary goal of an HDV is to determine the lowest practical applied potential for detection of your analyte of interest.

When a system is initially set up, a new electrochemical cell is installed, or a new analytical method is set up, run a hydrodynamic voltammogram to determine the optimal applied potential. A well characterized HDV curve provides the best applied potential in order to maximize the signal, and minimize the baseline.

As shown in the example in the image above, the optimal potential would be set just short of the curve plateau. Some adjustments may be required depending on the matrix of the sample. Do not set the applied potential too high otherwise other co-eluting compounds with similar redox potentials will also react.

Generate an HDV by injecting the compound of interest at a constant concentration and plotting peak response vs. applied potential. As an example, apply the potential in 100 mV incremental steps, allowing sufficient time for equilibration between the injections.

4.4 Optimizing Cell Performance

4.4.1 Baseline Optimization

To obtain a stable and quiet baseline, observe the following rules:

- When you perform data acquisition or use the system for analyes, do not recycle the mobile phase.
- Verify that the end of the waste tubing is submerged in the waste container. Do not let the waste line drip. Dripping can cause disurbances in the baseline.
- Protect cell, column and other flow path components from sudden thermal changes and electrical interferences.
- Use clean and properly prepared mobile phase. Monitor the data periodically to ensure that the mobile phase and system are not contaminated.

4.4.2 Optimization Key Factors

The performance of the cell can be optimized by careful consideration of the following key factors.

Optimization aspect	What to consider
Air bubbles	The amperometric cell has been specifically designed to overcome problems with air bubbles. If air bubbles are trapped in the cell pathways nevertheless, attach a filter or tubing with narrow bore to the waste line to increase the backpressure slightly. The increased pressure may dissolve or prevent air bubbles from occurring in the cell. However, do not exceed 13.8 bar (200 psi, 1.38 MPa), as pressures higher than this may cause the amperometric cell to leak.

Optimization aspect	What to consider
Air bubbles *(continued)*	Air bubbles trapped in the cell is a potential source of noise. Usually, this noise manifests itself as *spikes*. To further prevent air bubbles from forming in the cell, it is recommended that the mobile phase be degassed off-line prior to installation on the system.
Grounding	Make sure that all of the system modules and components are well grounded to a central grounding location to avoid "ground loops" which may form and can lead to increased baseline noise and other baseline artifacts. An electrician may need to be consulted to check on the condition of the electrical grounds. Grounding various components of the system (for example pump, columns, autosampler etc.) may result in reduced baseline noise.
Leaks	Improper sealing of the cell and gasket can take two forms: • Gross improper sealing can result in a visible leak where mobile phase exits the cell in the region of the working electrode. This can lead to very high background currents and possibly shorting of the cell. • Less severe improper sealing will not result in a loss of mobile phase from the cell, but may cause increased background current and increased noise. Install a new gasket when in doubt.
Mobile phase	When changing mobile phase, always flush the cell with the new mobile phase to ensure a stable reference potential. If using mobile phases that are prone to microbial growth (low organic content), the cell should be flushed periodically to waste to remove any possible contamination.

Optimization aspect	What to consider
Potential	Due to the nature of analytes of interest, and small variations in working electrode perfromance, the optimum detection potential should be determined experimentally. This can best be achieved by constructing a hydrodynammic voltammogram (HDV) curve for the analyte of insterest. After a potential has been applied to the cell, the current will reach a peak, then rapidly decay at first and then slowly decay before finally settling to a value that changes little with time. The rapid current decay is predominantly due to the charging current, whereas the slower decaying current is associated with the equilibration of the cell.
Pump flow	• Do not allow the flow to the amperometric cell to be interrupted when a potential is turned on. This may foul the working electrode or possibly lead to permanent damage of the cell. • Also, do not allow the cell to become dry while potentials are applied to it. Always turn off the potential to the cell (cells on/off functionality in the chromatography data system) when working on the cell. • Always make sure that there is sufficient mobile phase volume to last for the intended analysis period or to last overnight, etc. • The use of low flow rates or recycling of the mobile phase may be used during these times.

5 Maintenance and Service

5.1 General Notes and Safety Precautions

The following sections describe the routine maintenance and service and repair procedures that the user may perform. All other maintenance and service procedures must be performed only by Thermo Fisher Scientific service personnel.

Warning: The fluid components of the device may be filled with solvents that are harmful to health. Wear appropriate personal protective equipment. Rinse the fluid components with an appropriate solvent to remove harmful substances.

For information about the proper handling of a particular substance and for advice on specific hazards, refer to the material safety data sheet for the substance you are using. Observe the guidelines of Good Laboratory Practice (GLP).

Before starting maintenance or service procedures, observe the following safety precautions:

- For all service and repair procedures, observe all precautionary statements provided in the *Operating Instructions* for the detector.
- Use only the original spare parts and accessories authorized for the device by Thermo Fisher Scientific.

5.2 Routine and Preventive Maintenance

Perform the maintenance procedures listed in the table below at regular intervals to ensure optimum performance and maximum uptime of the cell. The exact maintenance schedule for the cell will depend on a number of factors.

Frequency	What you should do...
Daily	When buffer solutions are used, flush the system thoroughly after use. Use a solvent that does not contain buffers or salts.
	Platinum thin-film electrodes only Electrochemically treat the electrode daily before sample analysis. See section 5.3.1, page 36.
Regularly	Replace the gaskets of the amperometric cell regularly. See section 5.6.1, page 55.
	Replace the graphite and PEEK filter elements of the in-line filters at least on a quarterly basis. For replacement instructions, refer to the *Operating Instructions* for the detector.

5.3 Restoring Cell Performance

Restoring the performance of the amperometric cell may be required if you observe one or more of the following symptoms:

- Gradual loss in cell performance
- Tailing peaks
- Increase in background current and/or increase in baseline noise
- A cell does not produce the expected response or is no longer useable

Tip: If a sample analysis is critical, it may help to have a replacement cell available before starting the analysis.

The apparent loss of response in the cell can be a result of many factors, such as changes in the HPLC components, degradation of standards and auto-oxidation of the sample on the column.

If the effect is isolated to the cell, the loss of response can be a result of:

- Contamination of the electrode(s)
- Shift in the hydrodynamic voltammogram (HDV)

  Tip: In many cases, the first two effects occur simultaneously.

- Age of the cell or working electrode
- Physical damage to the working electrode
- Deposit of eluent contaminents or sample compounds in the cell

  Occasionally, eluent or sample compounds may deposit in the cell or on the electrodes. As a result, they increase the level of the baseline noise and adversely affect the response. In many cases, cleaning the cell may improve the performance of the cell.

Procedures for the amperometric cell

Perform the following procedures in the given order. If a procedure could not recover the cell response, try with the next procedure:

1. Electrochemically Treating the Working Electrode (→ section 5.3.1, page 36)
2. Cleaning the Cell and Working Electrode (→ section 5.3.2, page 39)
3. *Glassy carbon and gold working electrodes only*

   Polishing GC or Au Working Electrodes (→ section 5.3.3, page 42)

If none of the above procedures could restore the cell performance, replace the amperometric cell and install a new working electrode.

5.3.1 Electrochemically Treating the Working Electrode

To restore the performance in case of a loss in cell performance, the electrochemical treatment can be performed for:

- Boron-doped diamond working electrodes
- Glassy carbon working electrodes
- Platinum thin-film electrodes

Tip: With the gold working electrode being used only with a Pulse potentiostat module, electrochemical treatment is automatically done during Pulse Mode operation.

To electrochemically treat and thus clean the working electrode and sharpen the hydrodynamic voltammogram (HDV):

1. Turn off (the potential to) the cell.

2. Stop the pump flow to the cell.
3. Make sure that the cell is installed to the appropriate potentiostat module in the detector.
4. Replace the mobile phase with fresh mobile phase. The mobile phase should be of low organic solvent composition (less than 15%) flowing at about 1.0 mL/min. Do not recycle the mobile phase during the treatment.
5. Start the pump flow and turn on the potential to the cell. Use the following settings for the respective working electrode type:

Working electrode	When	Treatment
Boron-doped diamond	First-time use If electrode response drops	Apply a potential of +1900 mV to the electrode(s) for up to 10 minutes with mobile phase flowing at a flow rate of 0.5-1.0 mL/min. Do not exceed the maximum pressure limit of the cell.
Glassy carbon	First-time use	Apply a potential of +900 mV to the electrode(s) for up to 1 minute with the mobile phase that is intended for use with the analysis at a flow rate between 0.5-1.0 mL/min. Do not exceed the maximum pressure limit of the cell.
	If electrode response drops	1. Apply potentials in the range of -350 and -450 mV for up to 10 minutes using fresh mobile phase that is intended for use with the analysis at a flow rate between 0.5-1.0 mL/min. 2. Apply a potential of +1000 mV for additional 10-15 minutes.

Working electrode	When	Treatment
Platinum thin-film electrode	Daily before sample analysis	1. Apply a potential of -300 mV for 5 minutes with the mobile phase flowing at the flow rate intended for analysis. 2. Apply a potential of +300 mV and allow the electrode to equilibrate for 45 minutes before using more sensitive current range settings (1-10 nA).
Gold	The waveform of the Pulse Mode acts to continually refresh (and treat) the gold electrode surface so that additional electrochemical treatment is not necessary.	

6. After the treatment, return the detector to the initial operating conditions.

   a) Reset the potential to the potential for the analysis.

   b) Establish a stable baseline and test the response. Perform an equilibration with the cell (→ *Equilibrating the Cell* section earlier in this guide).

   If there is no observed improvement to the response, perform an additional pre-treatment step by applying a negative potential. The resulting high magnitude current (either positive or negative) can remove unwanted materials on the electrode.

Tip: Under some conditions, this procedure may provide only minimal improvement in response, or may deteriorate the cell performance even more.

If you could not restore the response with the above procedure and/or are still observing a diminshed response, clean the amperometric cell (→ section 5.3.2, page 39) or replace the working electrode (→ section 5.6.2, page 56).

5.3.2 Cleaning the Cell and Working Electrode

In some cases, exposure of the cell to acidic or base chemicals or an alternating aqueous/organic mobile phase reduces the build-up of lipophilic materials.

Tip: Cleaning the cells can have an additional benefit: The cleaning procedure may recover the response from contaminated and/or fouled electrodes.

Tools and additional items required

- Protective gloves (powder-free)
- Anti-static tweezers
- Lint-free cloths (2)
- HPLC-grade water

Follow these steps

1. Turn off (the potential to) the cell.
2. Stop the pump flow to the cell.
3. Remove the analytical column from the flow path.
4. Remove and disassemble the cell. See section 5.5, page 52.
5. Inspect the working electrode and rinse with HPLC-grade water to remove any material that may be present on the electrode.

   Important: To avoid damage to the components, do not immerse the plate working electrode, thin-film adapter or the cell body in water or any other liquid or mobile phase.

6. Inspect the cell body and clean the interior surface with a lint-free microcloth. You can wet the microcloth with HPLC-grade water in order to clean the surface.

7. Dry the working electrode surface and inside cell body with a lint-free cloth.

8. Replace the mobile phase with fresh 100% HPLC-grade water.

9. Connect a capillary directly from pump outlet to cell inlet.

10. Start the pump flow and flush the cell body with 100% HPLC-grade water at a flow rate of 1.0 mL/min for 2 minutes. Note the following:

    - Flushing the cell body removes any residual mobile phase and back-flushes any debris from the cell body flow path.
    - Water should begin to flow from the small orifice on the surface of the cell body. Wipe the surface periodically with a lint-free cloth to remove excess fluid and any debris around the orifice.

    ⚠ **Important:** If the pump pressure rises rapidly during this process, stop the flow and continue with step 16.

11. Stop the pump flow. Disconnect the capillary from the cell inlet.

12. Connect the capillary from pump outlet to cell outlet.

13. Start the mobile phase flow and flush the cell body with 100% HPLC-grade water at a flow rate of 1.0 mL/min for 2 minutes.

    Water should begin to flow from the small orifice on the surface of the cell body. Wipe the surface periodically with a lint-free cloth to remove excess fluid and any debris around the orifice.

    ⚠ **Important:** If the pump pressure rises rapidly during this process, stop the flow and continue with step 16.

14. When the pressure has returned to normal, re-assemble, re-install and reconnect the cell (→ chapter 3, page 9).

15. Turn on (the potential to) the cell at the working potentials of the application and test response while monitoring backpressure.

16. The next step depends

    - If the system pressure is not approaching unsafe limits and if the cell exhibits otherwise normal performance characteristics, the cell may be used with the higher backpressure.
    - If the backpressure of the cell remains unusually high and if it is adversely affecting the assay
      - *Glassy carbon or gold working electrodes only*
        Polish the working electrode (→ section 5.3.2, page 39).
      - Assemble and install the cell with a new cell body (→ chapter 3, page 9). The working electrode may continue to be used with the new amperometric cell.

5.3.3 Polishing GC or Au Working Electrodes

Glassy carbon or gold working electrodes only

If cleaning the cell and an electrochemical treatment could not recover the cell response or improve the cell performance, polish the glassy carbon or gold working electrode.

The polishing procedure physically renews the surface of the working electrode to recover the cell response and restore prior performance.

Warning: To avoid personal injury to skin and eyes, wear appropriate protective clothing and goggles when polishing the GC or Au working electrode.

Important: Do not polish a Boron-doped diamond plate working electrode or Platinum thin-film electrode. These electrodes can only be cleaned or electrochemically treated in attempts to restore their performance.

Important: To prevent scratches and other damage that may cause leaks, treat all internal parts of the cell carefully during the entire polishing procedure.

Parts required

Polishing kit for glassy carbon and gold working electrodes

Tip: To avoid the possibility of cross-contamination, do not use the same polishing disc for polishing different types of working electrodes.

Use a separate disc for each working electrode type and label each disc clearly for the type of working electrode that be used on it.

Tools and additional items required

- Protective gloves (powder-free) and protective eyewear
- Anti-static tweezers
- Lint-free cloth
- HPLC-grade water

Preparations

1. Turn off (the potential to) the cell.
2. Stop the pump flow to the cell.
3. Wear the protective gloves and eyewear.
4. Remove and disassemble the cell. See section 5.5, page 52.

Follow these steps

1. Rinse the working electrode with HPLC-grade water to remove any mobile phase that is adhering to the working electrode surface.
2. Prepare the polishing compound on the polishing disc:
   a) Wet the polishing disk with HPLC-grade water.
   b) Shake the bottle with the Alumina before each use. Add several Alumina drops from the bottle to form a circle with approximately 19 mm diameter to the center of the polishing disk.

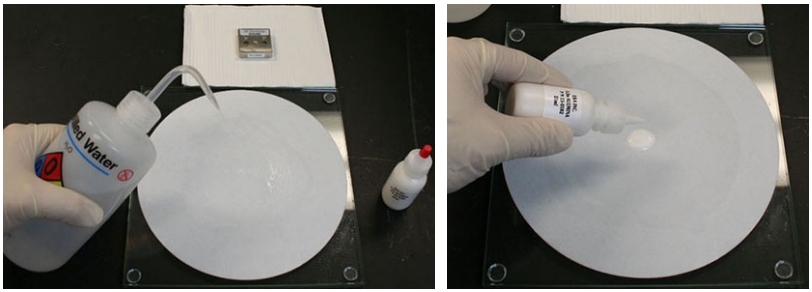


Fig. 12: Preparing the polishing compound
(left: dropping HPLC-grade water; right: dropping Alumina)

3. Place the working electrode on the polishing disc so that the working electrode material lies flat on the disc and the polishing compound.

4. Polish the working electrode: Move it around on the polishing compound in a figure-eight pattern in intervals of 10-20 seconds. Check its progress after each interval. Note the following:

   - Severe scratches may not be removed after 2 minutes of total polishing time.
   - Use only a moderate amount of pressure. Otherwise, the working electrode may wear too quickly or unevenly.
   - The working electrode is polished sufficiently when any dark color on the electrode is removed and a smooth, shiny surface appears.

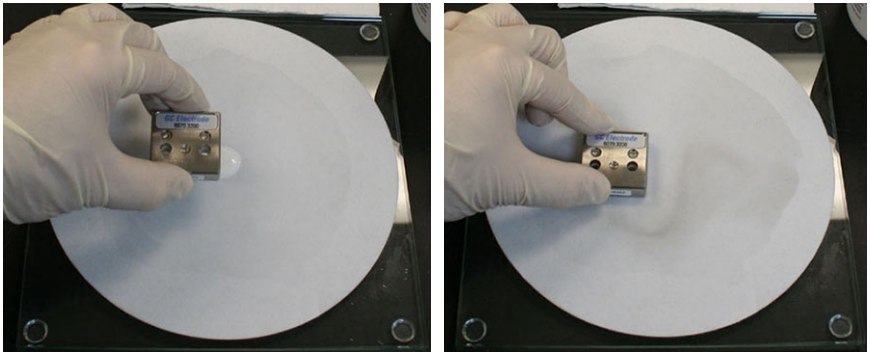


Fig. 13: Polishing (here: glassy carbon working electrode)

Tip: The polishing disc is reusable. You do not need to rinse it after each polishing procedure. After you used it for the first time, add only the needed amount of polishing compound and HPLC-grade water to re-wet the disc.

5. After the working electrode has been polished sufficiently, rinse the working electrode with HPLC-grade water until all traces of the polishing compound have been removed.

6. Dry the components:

   a) Dry the working electrode with a clean, lint-free cloth. Be careful not to leave any fingerprints or debris on the polished electrode surface.

   b) Carefully dry the cell body with a tissue. The cell body must be completely dry before reassembly.

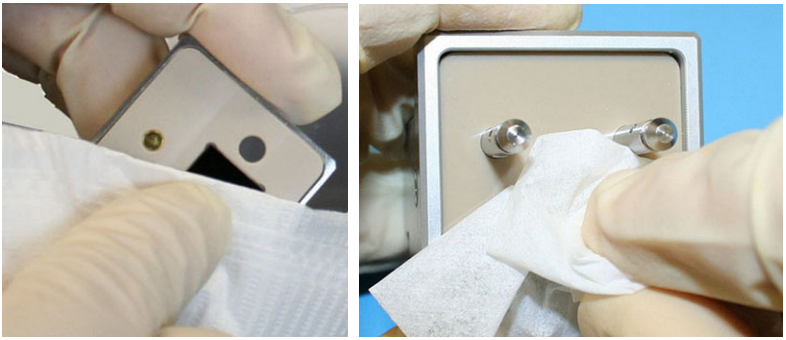


Fig. 14: Drying the components
(left: drying working electrode; right: drying cell body)

7. Assemble with a new gasket and the working electrode and install the cell. See chapter 3, page 9.

5.4 Shutdown and Storage

5.4.1 Guidelines for Cell Shutdown and Storage

Observe the following precautions before interrupting operation of electrochemical cells:

- Turn off (the potential to) the cell before stopping the pump flow.
- Rinse out any solvents from the cell(s) before removing the cell from the detector.
- For longer periods, always store unused electrochemical cells in their original dust-free packaging.
- Even during periods of detector inactivity, keep the amperometric cell assembled with working electrode and gasket being in place.
- When interrupting cell operation, observe the following differentiation for the duration of storage:
  - ♦ *If the cell is to be stored for 1 week or less*
    Follow the steps for short-term storage. See section 5.4.2, page 48.
  - ♦ *If the cell is to be stored for more than 1 week*
    Follow the steps for long-term storage. See section 5.4.3, page 49.

5.4.2 Short-Term Storage (1 week or less)

Tools and additional items required

- Protective gloves (powder-free)
- HPLC-grade water, organic solvent (without buffer salts)
- Storage plugs and original cell packaging

Follow these steps

1. Wear the protective gloves.
2. Turn off (the potential to) the cell in the chromatography data system, such as Chromeleon.
3. Flush the cell with a mixture of HPLC-grade water and organic solvent that does not contain buffer salt additives for 5 minutes at a flow rate of 1.0 mL/min. Use the same percentage as the previously used mobile phase to remove all traces of buffer salts from the cell.
4. Flush the cell with organic solvent similar to the previously used mobile phase for 5 minutes at a flow rate of 1.0 mL/min to remove water and prevent microbial growth.
5. Stop the pump flow to the cell.
6. Without pump flow, proceed as required:

   ♦ Leave the cell installed on the detector, without flow.

   –or–

   ♦ Remove the cell from the detector:

   a) Disconnect the capillaries from the cell inlet and outlet.
   b) Carefully disconnect the cell connector from the connector of the potentiostat module.

c) Install the storage plugs on the cell inlet and outlet. Use the plugs that were installed when the cell was shipped. Using different plugs and tightening them may damage the cell inlet and outlet.

d) Store the cell in its original packaging.

e) Keep the amperometric cell assembled with working electrode and gasket being in place.

To restart operation with the cell, reinstall and configure the cell (→ section 3.2, page 16).

5.4.3 Long-Term Storage (more than 1 week)

Tools and additional items required

- Protective gloves (powder-free)
- HPLC-grade water, HPLC-grade methanol
- Storage plugs and original cell packaging
- Shipping spacer and original working electrode packaging

Follow these steps

1. Wear the protective gloves.
2. Turn off (the potential to) the cell in the chromatography data system, such as Chromeleon.
3. Flush the cell with a mixture of 20% HPLC-grade methanol and 80% HPLC-grade water that does not contain buffer salt additives for 5 minutes at a flow rate of 1.0 mL/min. Flush long enough to remove any trace of the application mobile phase from the cell.

4. Flush the cell with 100% HPLC-grade methanol for 5 minutes at a flow rate of 1.0 mL/min to remove water and prevent microbial growth.
5. Stop the pump flow to the cell.
6. Remove and disassemble the cell. See section 5.5, page 52.
7. Dry the surfaces of the cell and the working electrode with a lint-free cloth.
8. Store the working electrode in its original packaging.
9. Place the shipping spacer over the alignment pins of the cell.
10. Install the torque knob:

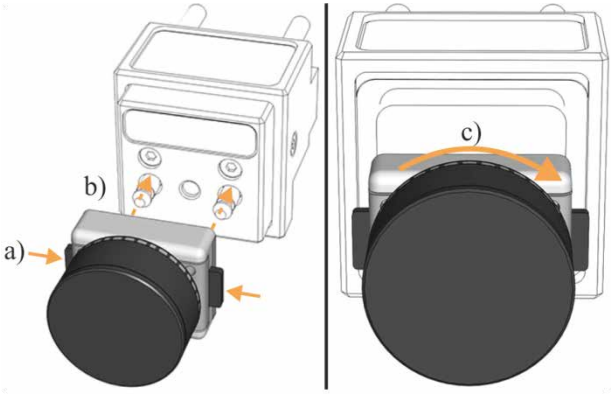


Fig. 15: Locking the torque knob

a) Take the torque knob by the side tabs to open the locks.
b) Position the knob on the alignment pins of the cell body. Release the side tabs to lock the alignment pins in the slots of the torque knob.
c) Turn torque knob clockwise until it clicks several times. The clicking sound confirms that the knob is properly seated.

11. Install the storage plugs on the cell inlet and outlet. Use the plugs that were installed when the cell was shipped. Using different plugs and tightening them may damage the cell inlet and outlet.

12. Store the cell in its original packaging.

5.5 Removing and Disassembling the Cell

When

- For replacement of cell components
- For long-term storage of the cell

Tools and additional items required

- Protective gloves (powder-free)
- Anti-static tweezers

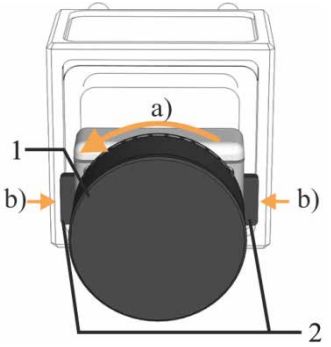
Preparations

1. Wear the protective gloves.
2. Turn off (the potential to) the cell.
3. Stop the pump flow to the cell.

Follow these steps

1. Disconnect the capillaries from the cell inlet and outlet.
2. Carefully disconnect the cell connector from the connector of the potentiostat module.

3. Remove the torque knob:



No.	Description
1	Torque knob
2	Side tabs

Fig. 16: Unlocking the torque knob

   a) Turn the torque knob counterclockwise to loosen it.
   b) Press the two side tabs on the knob and carefully pull the knob from the alignment pins on the cell body.

4. Remove the working electrode:

   - *If a plate working electrode is installed*
     Lift the plate working electrode over the alignment pins.
   - *If a thin-film electrode is installed*
     Lift the adapter over the alignment pins. With the tweezers, carefully remove the thin-film electrode.

5. With the tweezers, carefully remove the gasket from the cell body, taking care not to scratch the surface of the cell body. Dispose of the used gasket. Do not reuse gaskets.

6. The next steps depend:

   - *If cell and working electrode are to be stored*
     Continue with the steps for long-term storage on page 50.
   - *If a cell component or the cell is to be replaced*
     - For the cell gasket, see section 5.6, page 55.
     - For the working electrode, see section 5.6.2, page 56.
     - For the amperometric cell, assemble and install a new cell. See chapter 3, page 9.

5.6 Replacing Cell Components

5.6.1 Replacing the Cell Gasket

Parts required

Gasket
Select an appropriate gasket size (→ page 7).

Tools and additional items required

- Protective gloves (powder-free)
- Anti-static tweezers

Preparations

1. Wear the protective gloves.
2. Remove and disassemble the cell. See section 5.5, page 52.
3. Unpack the gasket.

   Tip: Use a new gasket whenever the cell is disassembled and reassembled.

Follow these steps

Assemble with a new gasket and the working electrode and install the cell. See chapter 3, page 9.

5.6.2 Replacing the Working Electrode

Parts required

Working electrode
Select an appropriate working electrode for the application to be performed (→ page 8).

Tools and additional items required

- Protective gloves (powder-free)
- Anti-static tweezers
- Lint-free cloths (2)
- HPLC-grade water

Preparations

1. Wear the protective gloves.
2. Remove and disassemble the cell. See section 5.5, page 52.

Follow these steps

Clean the contacting surfaces of cell and working electrode. Assemble with a new gasket and the working electrode and install the cell. Follow the instructions in chapter 3, page 9.

6 Technical Information

Specification	6041RS ultra Amperometric Analytical Cell
Cell design:	Thin-layer, micro-volume, single-channel cell
Working electrode:	Interchangeable: • Glassy carbon (GC) • Boron-doped diamond (BDD) • Gold (Au) • Platinum (Pt)
Potential range:	±3300 mV (vs. Palladium) – optimum range determined by working electrode material used
Flow rate:	Up to 1.0 mL/min (optimum flow rate determined by application/mobile phase composition)
Operating pressure:	13.8 bar (200 psi, 1.38 MPa) maximum (at the inlet)
Internal volume:	Cell only (inlet to outlet): 1.60 µL Depending on gasket: plus 25 nL or 50 nL
Flow connections:	Inlet/Outlet: 10-32 thread female port (compatible for nanoViper fingertight fitting)
Parametric control:	Automatic parameter configuration through chromatography data system (such as Chromeleon) via SmartChip cell recognition. The SmartChip identifies and reports sensor type and defines data collection.
Wetted parts:	PEEK, palladium, BoPET, polyethylene naphthalate *Plus: working electrode material (see previous table entry)*
Environmental conditions:	Operating temperature: 10-45 °C (50-113 °F) Air humidity: 18 to 80% relative humidity, non-condensing
Solvent compatibility:	Compatible with typical reverse- and normal-phase compositions

Specification	**6041RS ultra Amperometric Analytical Cell**
Dimensions (h × w × d):	41 × 45 × 86 mm (1.6 × 1.8 × 3.4 in.)
Weight:	Approx. 162 g (5.7 oz)

Technical information: June 2016.
All technical specifications are subject to change without notice.

7 Consumables and Spare Parts

Accessories, spare parts, and consumables for the module are always maintained at the latest technical standard. Therefore, part numbers are subject to alteration. However, updated parts will always be compatible with the parts they replace. The part number always refers to the packing unit. For more information, contact the Thermo Fisher Scientific sales organization for Dionex HPLC Products.

Description	Part no.
6041RS ultra Amperometric Analytical Cell, for analytical purposes Including • Thin-layer amperometric cell for single-channel detection • Gaskets • Anti-static tweezers *Note:* The 6041RS amperometric cell is shipped without working electrode. Select the required working electrode for the cell.	6070.3000
Adapter for thin-film electrode (without electrode)	6070.3005
Cell waste line kit, including • Capillary (PEEK, 0.015" x 1/16" I.D. x O.D., L 1.5 m, gray) • 2 fitting screws (PEEK, 1/16”)	6070.4900
Gasket, volume: 25 nL, BoPET, 5 gaskets	6070.2528
Gasket, volume: 50 nL, BoPET, 5 gaskets	6070.2529
Polishing kit for GC and Au working electrodes, including • 1 polishing disc on glass plate • 1 bottle alumina suspension, 25 mL	6070.3110
Thin-film working electrode kit, platinum (Pt), including • Thin-film working electrode, platinum (Pt) • Adapter for thin-film electrode	6070.3510

Description	Part no.
Thin-film working electrode, platinum (Pt) (without adapter)	6070.3500
Working electrode (plate type), boron-doped diamond (BDD)	6070.3100
Working electrode (plate type), glassy carbon (GC), high efficiency	6070.3200
Working electrode (plate type), gold (Au)	6070.3300