

UPS System Operating Instructions Iowa 2005

1. Introduction

The UPS accessory allows the collection of ultra-violet photoelectron spectra from solids. It consists of a double differentially pumped UV light source, gas admission system and pumping lines, an additional trapped rotary pump and a UV Source Control Unit.

When He gas is used the lamp is capable of producing He(I) and He(II) resonance lines. Further lines can be produced if other gases are used, e.g. Ne.

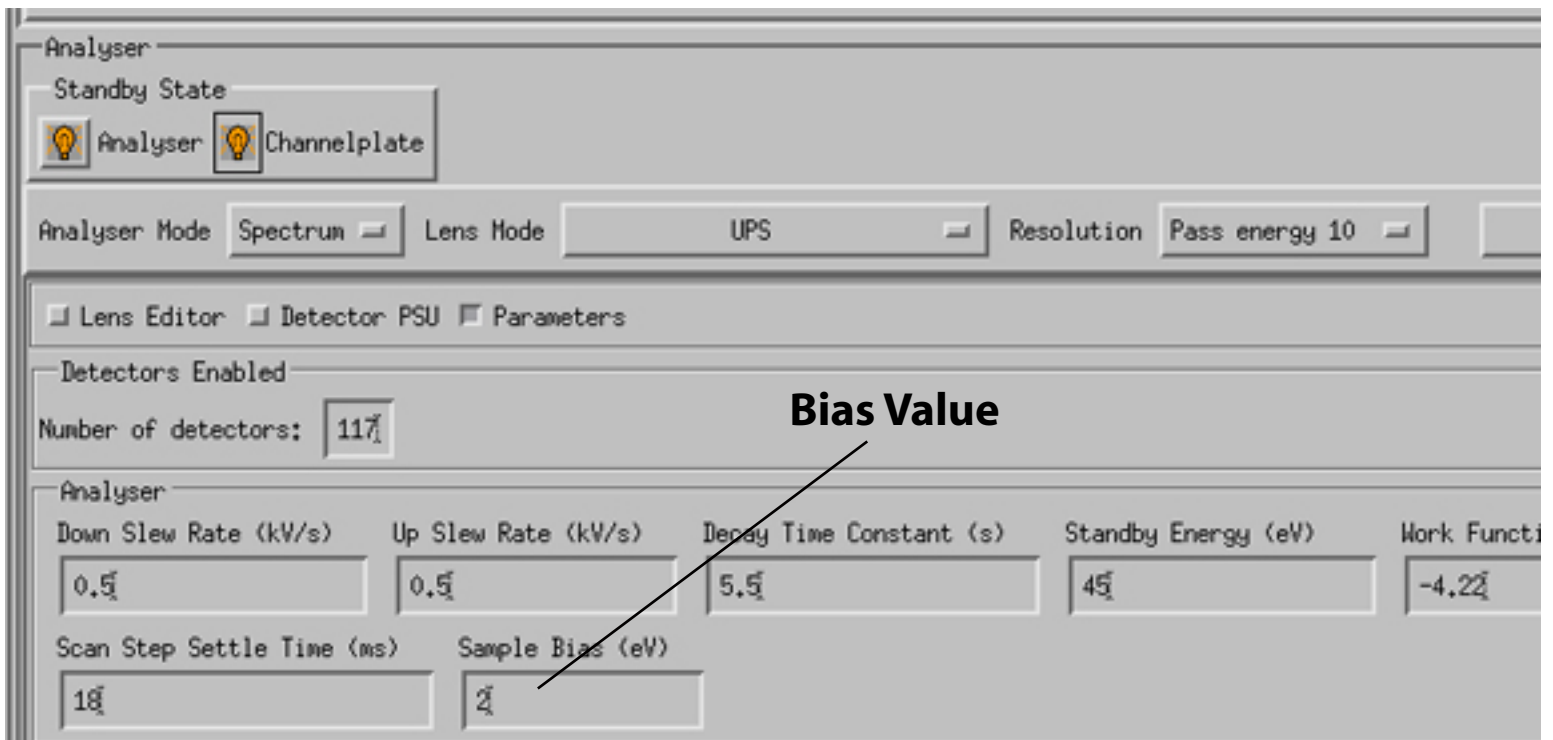
The UV source (also referred to as the UV lamp) is a differentially pumped high voltage chamber. A high voltage across electrodes within the source initiates a gas discharge within the source region. The pressure at which the source runs is typically many orders of magnitude greater than the required SAC pressure. The discharge chamber is separated from the SAC by a thin capillary tube. This has two functions: it produces a partially collimated beam of UV radiation directed at the sample; and it reduces the gas flow from the source region into the SAC. Note that, although the capillary reduces the gas flow between the chamber and the SAC, if the UV source is subject to high pressures the SAC will also be affected. ***It is possible to accidentally vent the SAC via the UV source!***

Two stages of differential pumping also separate the discharge region of the UV source from the SAC in order to maintain a low pressure in the analysis chamber. The first stage is rough pumping via the second trapped rotary pump. The second stage is fine pumping via the STC turbomolecular pump. The He gas is supplied to the UV source via stainless steel tubes. The gas must be high purity and the gas line clean. If gas of insufficient purity (due to a low He grade or dirty gas line) is used then problems with the source and

poor UV spectra will result. For this reason it is possible to rough and fine pump the gas lines and bake them to achieve a high cleanliness standard.

The power supply used for the UV source is UV Source Control Unit. This is operated manually.

A sample bias of -2 volts is applied to conducting samples via the sample current lead connection when the UPS lens mode is selected. This is useful when studying the onset of the secondary electron cascade where electrons have near zero kinetic energy. The value of the bias should be set by a Kratos engineer, it is registered in the parameters section, see below:



The bias value is set inside the magnet control unit, it can not be changed in the software.

2. Gas Line Purge and Bake-out

As mentioned in the introduction it is very important to achieve and maintain high source gas purity for the correct operation of the UPS accessory. For this reason it is possible to pump out and bake the gas supply lines. The following describes the actual procedure for purging the He gas line and baking the lines. It is assumed that a high purity laboratory grade (99.999%) gas bottle and regulator have been fitted to the gas supply lines and that the system has been leak checked.

2.1 Gas Line Purge

2.1.1 Ensure that the following valves are closed:

Valve V1 (He leak valve)

Valve V8 (Rough differential pumping)

Valve V7 (fine differential pumping)

Valve V3 (He line fine pumping)

Valve V4 (He line rough pumping)

Valve V5 (He gas inlet valve)

2.1.2 Open V4 (He line rough pumping) to pump out the He line.

2.1.3 Open V2 (upper He line valve) if it is not already open to evacuate the upper portion of the He line.

2.1.4 Wait at least 10 minutes.

The He gas line is now being pumped. You now have several options: introduce He gas into the line ready for an experiment (section 2.2); bake the He line (section 2.3); fine-

pump and the bake the He line (Section 2.4). The instructions below describe how to perform each of the possible actions in turn. In general if the UPS lamp has not been used for some time it will probably be necessary to bake-out the He line before proceeding.

2.2 Preparing the He Line for Use

The following instructions describe how to make the He line ready for an experiment. It assumes that the He line is currently been rough pumped. However, the instructions are also valid if the line is been fine pumped.

2.2.1 Close V3 (He line fine pumping) if the He line is been fine pumped.

2.2.2 Close V4 (He line rough pumping) to stop rough pumping the He line.

2.2.3 Check that V1 (He leak valve) is closed.

2.2.4 Open V5 (He gas inlet valve) to fill the He line, check the STC and SAC pressure to ensure the procedure has been preformed correctly.

2.2.5 The He gas bottle may need to be opened to fill the He line. Once the line is full (checked by the regulator) the He bottle may be closed again to conserve the He reservoir. Keep a frequent check on the pressure in the regulator to ensure the He gas in the gas line is not exhausted (if this happens quickly then it is probable that a leak exists in the He gas line).

2.3 Gas Line Bake-out

This section describes how to bake-out the He line. It assumes that sections 2.1.1 to 2.1.4 have been followed and the He line is currently being rough pumped.

2.3.1 Follow the Gas Line Purge procedure up to step 2.1.4 above.

2.3.2 Bake-out the He lines using the bake-out heater tape. This tape has a separate 3 pin UK style plug. It is recommended that the line is pumped and baked overnight.

2.3.3 Following the bake-out turn off the heating tape.

2.3.4 Close V4 to stop pumping the He line.

Follow the procedure described in section 2.2 to fill the gas line full of He ready for use.

2.4 Fine Pumping and Baking of the He Gas Line

This section describes how to fine pump and bake the He gas line. This is the best way to ensure that both the UPS lamp and the He gas line are completely clean ready for use. This procedure is more affective if an entire instrument bake is performed, however, it can be used just to pump and bake the He line.

2.4.1 Follow the gas purge (section 2.1) up to step 2.1.3.

2.4.2 Check that the pressure in STC is less than 1×10^{-5} torr.

2.4.3 Open V7 (UV lamp fine pumping valve) while watching the SAC pressure. Ensure that the SAC pressure does not rise above 1×10^{-7} torr.

2.4.4 Open V8 (UV lamp rough pumping valve) while watching the SAC pressure. Ensure that the SAC pressure does not rise above 1×10^{-7} torr.

2.4.5 Close V4 (He line rough pumping valve).

2.4.6 Open V3 (He line fine pumping valve) while watching the SAC pressure and the pressure in the STC. Ensure that the SAC pressure does not rise above 1×10^{-7} torr and the pressure in the STC does not rise above 1×10^{-5} torr.

The He line can now be baked-out using the heating tape as described in section 2.3 above. However, if an entire instrument bake is to be performed follow the instructions below:

2.4.7 Slowly open V1 (He leak valve) while watching the SAC pressure. Ensure that the SAC pressure does not rise above 1×10^{-7} torr.

2.4.8 The He line and the instrument may now be baked using the bake-out heater tape and the instrument bake-out procedure. **N.B. ensure that you follow the instrument bake-out procedure carefully. If delicate components (e.g Camera and Photomultiplier etc) are not removed then extensive damage to the instrument can result.**

Following the He line bake-out (whether or not the whole instrument was baked) follow the instructions below:

2.4.9 Following the bake-out close V1 (He leak valve) if it was opened.

2.4.10 Close V3 (He line fine pumping valve).

Follow the procedure described in section 2.2 to fill the gas line full of He ready for use. **If the UPS system is not to be used immediately close V8 and V7 to isolate the SAC from the introduction chamber.**

3. Normal Operation

This section describes the normal operation of the UV source. It assumes that high purity He gas has been supplied to V1 (He leak valve) and a clean sample is positioned for analysis. Due to the low mean free path of low energy electrons in solids, UV spectra are very sensitive to sample contamination, therefore metallic samples must be cleaned by ion bombardment prior to analysis.

3.1 Lighting the UV source and obtaining UV spectra

3.1.1. Check that the pressure in the STC is less than 1×10^{-5} .

3.1.2. Open V7 (UV lamp fine pumping) while monitoring the SAC pressure, ensure that it does not exceed 1×10^{-7} torr. **If the introduction chamber is vented with V7 open then the SAC will be vented to atmospheric pressure. V7 must be closed before sample introduction!**

3.1.3. Open V8 (Rough differential pumping) while monitoring the SAC pressure, ensure that it does not exceed 1×10^{-7} torr.

3.1.4. Set the 10 turn potentiometer on the UV Source Control Unit to 5.37 (which gives 30 mA emission when the source is lit).

3.1.5. Turn the UV Source Control Unit on.

3.1.6. Open V1 (He leak valve) slowly until the UV source lights. Do not exceed a pressure of 1×10^{-6} torr in the SAC.

Typical He(I) running pressures:

SAC 4×10^{-7} torr

STC 2×10^{-5} torr

3.1.7. The emission current can now be adjusted using the 10 turn potentiometer on the UV Source Control Unit if desired.

3.1.8. To record a He(I) spectra set the lens mode to UPS.

3.1.9. A typical range of kinetic energies should be between about 6 eV and 24 eV. Use a pass energy of 5 or 10 eV, a step size of 0.05 or 0.025 eV and a dwell time of 100 ms. Use the 110 micron aperture to start so that the detector is not overloaded. Try to keep the counts below 2×10^6 CPS.

3.1.10. For insulators turn the charge neutraliser on (NB with the neutraliser on there will be a large, narrow spike at about 3 eV KE. Avoid recording this spike as a high count rates may damage the detector. The count rate must always be kept below 2 x counts per second.).

Note that the instrument supplies a 2 volt negative bias to the sample stage via the sample current cable) when UPS mode is selected. This bias is automatically accounted for when the kinetic energy scale is plotted. However, for insulating samples the bias will not be effective. The software has no way of taking this into account so the energy scale will be incorrectly adjusted. In practice this does not present a real difficulty as the neutraliser will shift peaks in the opposite direction and peaks will need to be charged compensated as usual.

3.2 Switching Off Source for Short Periods

3.2.1 To switch off for a short time switch the UV Source Power Supply off.

3.2.2 Close V1 (He leak valve).

3.2.3 Close V8 (Rough differential pumping) and V7 (fine differential pumping).

NB, if the STC is vented with V7 open then the SAC will also be vented!!!

The system may be left in this condition if you intend to use the UPS accessory within the next couple of weeks or so. If you wish to shut down the unit for a longer period of time then continue with the next step.

3.2.4 Close V?? (He gas inlet valve).

From this point, before restarting the UPS system, follow the procedure for purging the gas line.

4. Notes on He(II)

He(II) spectra can be more difficult to obtain because it is harder to operate the UV discharge source under He(II) conditions. When the source is running in He(I) mode the discharge has a 'peachy' colour. To obtain good He(II) spectra then first set the source up for He(I). The source must be completely out-gassed and the He gas must be pure to obtain the best He(I) and He(II) performance. It is necessary to run the source for a number of hours before attempting He(II) spectroscopy. This is especially important if the UPS accessory has not been used for some time. The time required should decrease if the source has been used recently. For this reason it is suggested that UPS experiments be run concurrently over several days instead of in a more random fashion.

The reference energy should be set for He(II) and the scanned energy range should be from approximately 20 to 44 eV (kinetic energy). The step size should be 0.05 eV or 0.025 eV and the pass energies used should be 5 or 10 eV. Use more detectors when acquiring He(II) spectra. Observe the scanned spectra whilst gradually closing the leak valve. As the pressure in the source decreases the colour of the discharge will change from peachy to lilac. As the pressure is decreased further a blue mist will be formed in the discharge tube. This is the He(II) operating region. This region is very close to the extinction point of the source so more care and patience is required. If the source does turn off then the pressure must be increased back to the He(I) operating region and the process started again. As the source becomes cleaner with prolonged use it should become easier to achieve and maintain good He(II) operating conditions.