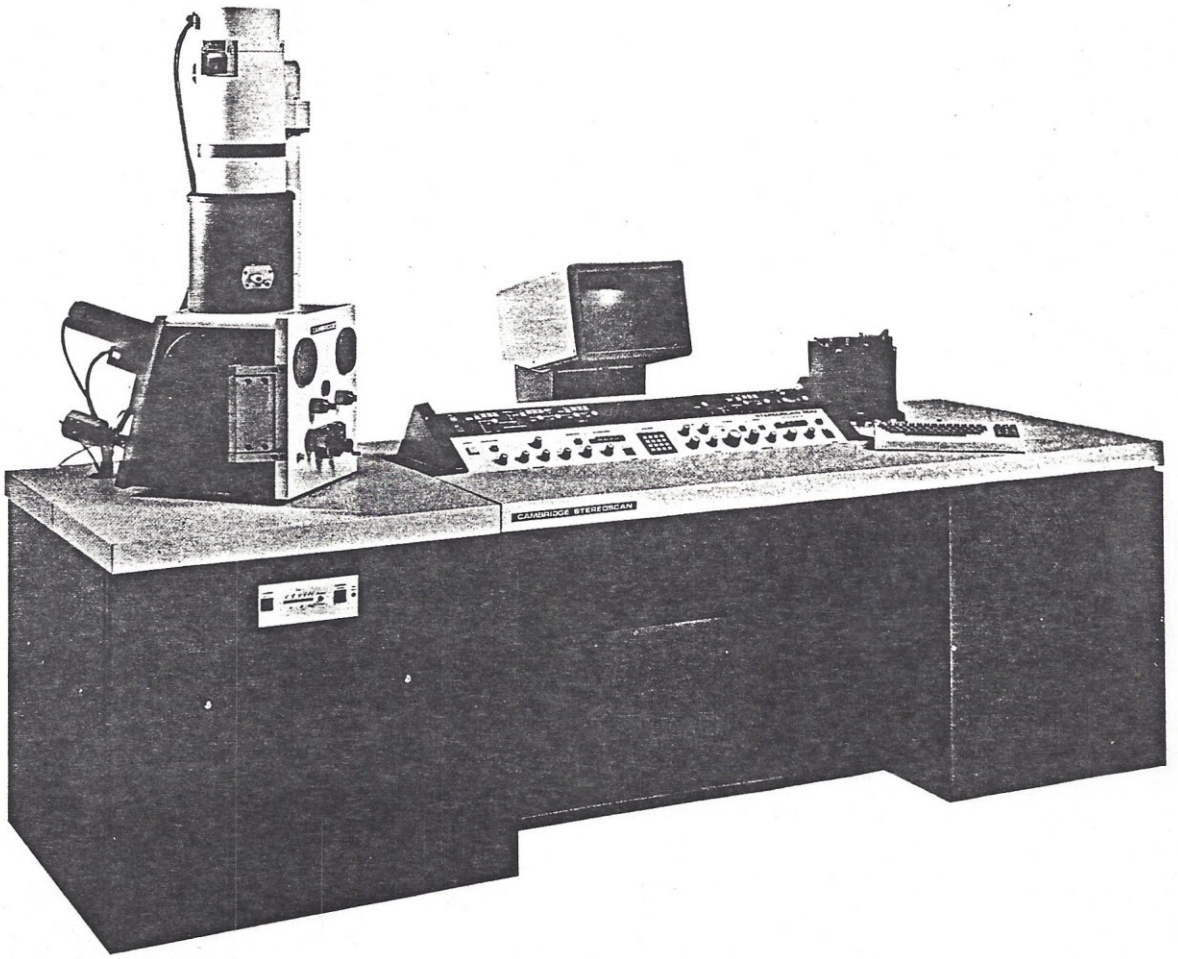
CAMBRIDGE INSTRUMENTS



STEREOSCAN 200 STUDENT GUIDE

CAMBRIDGE INSTRUMENTS VIDEO TRAINING SYSTEM

STEREOSCAN 200

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INTRODUCTION – COURSE AIMS

Welcome to Cambridge Instruments Video Training System.

You have purchased the most up-to-date video based instrument training method for scanning electron microscopes available.

The purpose of this course is to provide you, the student, with the necessary information and knowledge to operate your instrument both routinely, at high resolution and maintain it on a daily basis.

The equipment you will need to obtain full benefit of this modular video training system is, of course, a video player of the same operating standard as the cassettes you have purchased. Also a TV set or video monitor connected to the player. Please try to arrange your video system so that you can easily see it, hear it and operate it's controls as well as being easily able to operate your microscope. Have at hand for reference your Instrument Operating Manual already supplied with your microscope because from time your tutor will refer to it.

HOW TO USE THIS COURSE

It is expected that: 1) you have arranged your video system as advised; 2) you are familiar with its operation and facilities: stop; start and rewind; 3) you have read and are familiar with your microscope's operating manual and that it is available for easy reference and 4) you read the transcript contained in this manual.

You are now ready to begin. Place cassette number 1 into your player. Follow the instructions in your player's operating manual and begin.

You will see and hear your tutor describe what he is going to teach you in this particular module and he will then tell you what to do. Stop the cassette at these times and do what he has told you. If at first you do not obtain the effect he has described rewind the cassette, listen and watch again and have another attempt. Continue in this way until you have completed the cassette.

When you have completed the first cassette go on to the next one – No 2 to No 3 and so on. The complete volume numbered 1-8 is a carefully designed and integrated system. Successful completion of one cassette will take you on to the next one and will impart the necessary knowledge for you to operate competently one of the most modern scanning electron microscopes available today.

WHO SHOULD USE THIS COURSE

All persons who intend to operate this scanning electron microscope, whether supervised or not, who meet your establishment's requirement to operate sophisticated electronic analytical instrumentation and who have a good understanding of spoken English.

COURSE TRANSCRIPT INTRODUCTION

This transcript is printed here only to help and assist you and in no way should it be considered as a substitute for the video cassettes. The text as printed here from page 4 to 30 is as spoken by your tutor on the video presentation. It is not an example of written technical English. Read it; certainly be very familiar with it; use it to help your understanding of what effect you, with your tutor can achieve. Please read carefully Module 7 Parts 1 and 2 with particular reference to Cassette 8 and Module 8. All microscopes manufactured during late 1984 have a modified filament assembly requiring a different method of reassembly, after removal and cleaning.

S200 OPERATOR TRAINING VIDEO MODULE NO 1 SWITCHING ON THE MICROSCOPE AND GETTING A WORKING VACUUM

INTRODUCTION

Welcome to the Stereoscan 200 Operator Training Course. In this training module we are going to start at the very beginning. Initially we are going to find out how to switch on the instrument and how to obtain a working vacuum.

The Stereoscan 200 we are using is **not** fitted with the optional Ion Pump and associated isolation valves. If however, your system **is** fitted with an Ion Pump and valves don't worry; the instructions given in the Operator's Manual will add to what you will learn in this training module.

While you are watching this training video, you might like to follow the corresponding operating routine shown in the flow diagrams. If this is the case, stop the tape in a few moments and then turn to Chapter 1 in the Operator's Manual.

Remember, if at the end of the video you do not fully understand what you have just seen and heard, play the tape through again – perhaps several times – until you feel confident that you do.

LECTURE

The FIRST STEP is to turn on the external power to the Stereoscan. Having done so the red "OFF" push switch located at the top left hand side of the console should then be illuminated.

NEXT, check that "CHAMBER VACUUM" is **not** selected. This can be determined quite easily by examining the push switch which is located on the vacuum switching panel underneath the specimen chamber.

The switch should be in the released state and therefore protruding from the panel slightly.

NOW press the green "ON" push switch. Having done so this should now be illuminated and power will be distributed to the microsope's electronic systems.

THE NEXT STEP is to get ready to open the specimen stage door in order to load the specimen. To do this first release the clamp and then gently turn the stage Z control anticlockwise by approximately two turns to lower the Z mechanism. Do not do this if the Z control is already fully anticlockwise. This procedure reduces the risk of the specimen touching the microscope's final lens and therefore helps avoid serious damage.

OPEN the stage door carefully, checking all the time that no part of the stage mechanism, specimen holder or specimen touches any of the precision components within the specimen chamber or the walls of the chamber. If necessary take preventative action to avoid damage by manipulating the stage X and Y controls as appropriate.

Remember always to wear gloves when handling specimens or any part of the microscope that will normally be under vacuum. This will help to avoid contamination which, in extreme cases, can seriously degrade the overall performance of the system. Specimen changing methods are demonstrated later in routine number four so we will not expand this point at this time.

NOW check that a suitable specimen is properly installed. Bear in mind that later in Video Module number two, we are going to obtain a picture using an acceleration potential of twenty-five kilovolts. This means that we should at this point choose a stable conductive specimen.

Carefully close the specimen stage door, checking that there is no risk of anything being damaged. Fasten the clamp and immediately press the "CHAMBER VACUUM" push switch to pump out the system.

Both the rotary pump and the turbomolecular pump should now start simultaneously and begin the automatic vacuum pump down sequence.

A vacuum monitor is provided which enables you to obtain an approximate reading of the vacuum level. When the vacuum system is functioning correctly, the monitor will indicate a steady improvement in vacuum level but as the system approaches it's ultimate vacuum, the improvement will be very slow.

Usually a working vacuum level is reached in about two to three minutes. If the specimen has a tendency to outgas or if the microscope is used in a humid atmosphere without dry nitrogen back filling, for example, it could take up to five minutes or so.

In order to protect both the operator and the instrument, a system of safety interlocks ensures that it is impossible to obtain a picture until a suitable vacuum level has been reached. This vacuum level is called "vacuum ready".

The "CHAMBER VACUUM" push switch will light up when the "vacuum ready" state is reached.

SYNOPSIS

You have now seen how to switch on the instrument and how to obtain a working vacuum.

Having arrived at this point we are now ready to move on to routine number 2 which will deal with how to obtain a picture. Should you wish at this stage to shut down the instrument, the full shut-down procedure is demonstrated in Video Module No 5, which you may refer to straight away.

Finally, here are a few points that you should remember:

- Read the Operator's Manual, study the corresponding operating routine shown in the flow diagrams.
- Treat the specimen stage with care; it is a piece of precision mechanical equipment.
- Remember always to wear gloves.

and finally

- Play this tape through again if you don't feel confident that you understand its contents.

S200 OPERATOR TRAINING VIDEO MODULE NO 2 OBTAINING A PICTURE

INTRODUCTION

In this training module we are going to see how to obtain an image of the specimen on the Stereoscan 200 display screen. This will involve completing a 'pre-flight check' on the operating controls and basic setting-up of the electron gun controls which will then lead us on to obtaining an image of the specimen.

The Stereoscan 200 we are using is **not** fitted with the optional LaB_6 emitter. If your system **is** fitted with an LaB_6 emitter don't worry, the instructions given in the Operator's manual will add to what you will learn in this training module.

Whilst you are watching this programme you may like to follow the corresponding operating routine shown in the flow diagrams. If this is the case you should stop the tape in a few moments and then turn to Chapter 1 of the Operator's Manual.

Remember, if at the end of the video you do not fully understand what you have just seen and heard, play the tape through again – perhaps several times – until you feel confident that you do.

LECTURE

The FIRST STEP is to check if the vacuum is ready. Remember that the CHAMBER VACUUM push switch will light up when the "vacuum ready" state is reached.

Remember also that it is impossible to proceed and ultimately obtain an image until this condition is reached. These points are explained in module number one.

It is normal practice to complete a 'pre-flight check' on the controls during vacuum pump down.

Details of how the various controls should be set initially are given in the manual at the top of the relevant flow diagram.

THE NEXT STEP is to lift the protective flap and press the OPERATE push switch which should then illuminate. This turns on the power supplies to the electronics, activates the operator's controls and starts up the cooling fans.

After about 30 seconds of warm-up a snowy image known as a raster or scan will appear on the display screen.

NOW TURN ON the electron beam by pressing the BEAM push switch. This switches on both the acceleration voltage power supply and the filament current power supply simultaneously.

NEXT carefully set the FILAMENT control to its centre marker. The FAIL indicator above the beam switch should now be off. If it remains **on** the filament has failed and must be replaced. (Should you at this stage in our programme suspect that the filament has failed, view video module no 7, part 1 and watch the first part of the column maintenance procedure which will show you how to change the filament.) The TRIP indicator above the beam switch should be off.

Sometimes the TRIP indicator will come on persistently. Normally there will be a simple reason for this – for example, perhaps you are turning the FILAMENT current control too quickly or maybe the electron gun components require cleaning.

If the TRIP comes on turn the FILAMENT control fully anticlockwise, and reset the beam by pressing the BEAM push switch once and then again. If the condition persists it could be that the low kV anode is fitted by mistake or that the filament height is incorrect.

CONTINUE BY switching to EMISSION IMAGE – a bright filament emission image will now be visible on the microscope screen.

If necessary reduce the AUTO LEVEL control to enable you to see detail in the emission image.

Adjustment of the FILAMENT control over a small range will enable you to achieve precisely the desired level. There are two distinct levels of filament current that can be used. These are known as the **first** peak and the **second** peak. The first peak looks like this and corresponds to a fairly low filament current. This level could be used for low magnification microscopy and will give very long filament life since the temperature of the filament is relatively low.

Increasing the filament current gives you the second peak which looks like this and corresponds to a high filament current. This level is used for high resolution microscopy and for quantitive X-ray microanalysis. Sometimes this level or setting is known as 'saturation'. It provides maximum emission and best stability but since the temperature of the filament is very high the life is somewhat reduced.

Let us go through this important point again. By adjusting the FILAMENT control saturation is achieved when the emission image **just** becomes solid. Be careful not to increase the FILAMENT control beyond this point once it has been reached. You will not improve the system performance, all you will do is dramatically reduce the filament lifetime.

Next reduce the RESOLUTION control to 3. Now, if necessary, reduce the AUTO LEVEL control to produce a circular image with no flare. Using the Y and X **SHIFT** GUN ALIGNMENT controls, position the brightest part of the filament emission image in the centre of the microscope screen.

Now increase the RESOLUTION control to 7. If necessary, again adjust the AUTO LEVEL control to produce an image like this. The filament emission image should be positioned centrally but this time use the Y and X **TILT** GUN ALIGNMENT controls.

You should at this point check that the FILAMENT control setting is optimised; that is, set to either the first peak or the second peak depending on your requirements.

Finally switch off EMISSION IMAGE: this completes the basic setting up of the electron gun controls.

The next step is to decrease the RESOLUTION control to 4 and spin the MAGNIFICATION CHANGE control anticlockwise to set minimum magnification.

Now use the FOCUS COARSE and MEDIUM controls to obtain a sharp image.

Then, using the specimen stage controls to select a suitable area, commence the examination. Should the specimen touch alarm sound at any time, immediately reverse the stage control you are turning to avoid damage to the specimen or the instrument.

Now increase the magnification, adjusting the FOCUS controls as necessary. Generally speaking we use COARSE FOCUS at very low magnifications. We use MEDIUM and FINE FOCUS at higher magnifications. As we increase the magnification we have to increase the RESOLUTION control setting. Although this gives us good image sharpness it increases image noise – the picture goes 'snowy'. As a rough guide, a resolution setting of about 6 will be required for a magnification of around thirty-thousand times. At one-hundred thousand times you will have to increase the resolution to at least 9, for example.

To counteract the effect of excessive image noise we use slower scanning speeds; VIS 2 instead of TV for instance.

Some operators will be reluctant to increase the resolution setting because it increases image noise and seems unnatural. Some of you will also be reluctant to use scan speeds slower than TV because this too seems an unnatural way to view the image. This reluctance at first is understandable, but you must persevere and overcome this. Only by doing so will you be able to exploit to the full, the capabilities of the S200 system.

Final aperture alignment and astigmatism correction, associated with high magnifications, will be dealt with in video Module 6. These and other advanced operating techniques are covered in chapters 2 and 5 of the Operator's Manual. These chapters are essential reading.

SYNOPSIS

You have now seen how to obtain an image on the Stereoscan 200 display screen which has involved both completing a systematic 'pre-flight check' on the operating controls and basic setting-up of the electron gun controls. These two key steps were the essential pre-requisites for obtaining an image of the specimen.

Here are a few points that you should remember:

- Read the Operator's Manual, study the corresponding operating routine shown in the flow diagrams.
- Practice the 'pre-flight checks' until they become second nature.
- Always set the FILAMENT and GUN ALIGNMENT controls with care and precision. A well adjusted electron gun will help to ensure that the microscope system performs at its best and that reasonable filament life is achieved.
- Operation at high magnification on difficult samples often requires skill and experience – even with a high performance 'state-of-the-art' scanning electron microscope like the Stereoscan 200.

Recognising this, Cambridge Instruments run Instructor based training courses where advanced operating skills are taught in a fully structured manner.

Please ask your local representative if you would like more information.

S200 OPERATOR TRAINING VIDEO MODULE NO 3 TAKING A MICROGRAPH

INTRODUCTION

In this training module we are going to see how to take a micrograph using the camera which is attached to the high resolution record unit.

The Stereoscan 200 we are using is fitted with a Polaroid 545 Land film holder and the type of film we are using is Polapan Land 52. On your system you may have a different type of camera and film. Should this be the case then the instructions given in the Operator's Manual will add to what you will learn in this programme. Whilst you are watching this programme, you may like to follow the corresponding operating routine shown in the flow diagrams. If this is the case stop the tape in a few moments and then turn to Chapter 1 of the Operator's Manual. Remember if at the end of the video you do not fully understand what you have just seen and heard, play the tape through again – perhaps several times – until you feel confident that you understand the procedure.

LECTURE

The FIRST STEP is to ensure that you have a good quality image on the visual display screen. You will need to put into practice what you have learned in video module No. 2 which dealt with how to obtain an image.

One good tip is to optimise the image sharpness at one or two coarse magnification steps higher than the magnification you actually require for the micrograph.

If the magnification is, say, greater than ten-thousand times you will have to pay attention to aperture alignment and astigmatism correction. This is covered in video module 6, and chapters 2 & 5 of the Operator's Manual.

The NEXT STEP is to check that the record facility parameters are correct according to the Operator's Manual. FIRST set the 'F' stop then insert the lens, the spacers, and tighten the locking ring. NEXT place the camera into position and fasten the clamps. NOW set the ASA rating – full details of this can be found in Chapter 2, Section 8 of the Operator's Manual.

FOLLOWING this select one of the two PHOTO speeds. FAST, which is 50 seconds, is the photo speed most generally used for taking routine micrographs of noise free images like this. SLOW, which is 200 seconds, is used in cases where the image noise or 'snow' is excessive – even when viewed at visual scan speed 3. In this video we are dealing with a relatively noise free image so we will use the FAST photo speed – incidentally the photograph is in no way affected by the visual scanning mode.

NOW check that the photo number and the specimen number, found on the right hand side of the data zone, are as required. This data is entered via the DATA ENTRY key pad. Extra information can be added to the micrograph by means of the TEXT keyboard if required. Chapter 2 of the Operator's Manual explains how to do this.

We will assume that this is the first micrograph of a photo session. FIRST select GRAPH; now you should see in graphical form the distribution of video signal along a particular scan line in the image. The actual scan line from which the graph is derived is determined by the setting of the Y POS control.

If at any time you want to find out which scan line you are using, all you have to do is switch to NORMAL. A small bright square can be moved up and down the screen by turning the Y POS control. This square indicates the actual scan line from which the graph is derived.

With the square select a scan line, which is an average representation of the field of view. Switch to GRAPH to examine the video signal distribution along this line.

Utilising the upper and lower indicators on the screen, emphasised here in white, adjust the AUTO LEVEL control so that the mean of the graph lies midway between these levels.

This sets the average video signal to approximately 50%, since the lower markers on the display screen represent 0% video signal and the upper represent 100% video signal.

NEXT add or subtract contrast as required by means of the CONTRAST control. Do this until peaks in the graph are nearly level with the upper markers on the display and troughs in the graph are nearly level with the lower markers. By doing this we are effectively setting the photographic exposure for the micrograph.

It is a good idea at this point to make mental notes about the positions of both AUTO LEVEL and CONTRAST controls because these settings will probably be satisfactory for other fields of view if the distribution of video signal is similar.

NOW switch off GRAPH by switching to NORMAL.

The small bright square is moved by means of the Y POS control to the data zone at the top of the screen where it will disappear automatically otherwise it will be seen on the micrograph.

The microscope is now in ready to take a micrograph. Load the camera with a sheet of instant film – or open the camera shutter, depending on which type of camera is in use.

Press PHOTO START; this will initiate the photo scan. When the photo scan has finished, the visual display screen will return to displaying a full image at normal visual scan speeds.

NOW process the sheet of film or if appropriate, close the camera shutter and wind on the film. If you are using instant film check that the exposure is satisfactory. If it is, you can then look for another suitable area on the specimen to photograph. During the initial period of familiarisation, it is good practice to keep a record of the conditions you used to produce the micrographs. This will help to ensure that each micrograph you take is correctly exposed by providing you with useful feedback. If the exposure is not satisfactory first examine the data zone on the micrograph which should show white alphanumerics on a black background. If this *is* the case then the unsatisfactory exposure was probably caused by incorrect setting of AUTO LEVEL and CONTRAST whilst in the GRAPH mode. if the data zone is not exposed correctly then check the camera aperture, type of film and record tube ASA setting. If these are correct, it is possible that the record tube BRIGHTNESS and CONTRAST controls require re-calibration. The procedure for doing this is given in Chapter 2, section 8 of the Operator's Manual, but hopefully you should end up with a result like this.

SYNOPSIS

You have now seen how to take a micrograph on the Stereoscan 200. One of the major steps in the procedure involved adjustment of the AUTO LEVEL and CONTRAST controls whilst in the GRAPH mode. We do this to set up the photographic exposure for the micrograph. At first you will probably have some difficulty in getting a satisfactory exposure. Don't worry because it does take quite a lot of practice – especially with 'instant' film. Usually negative films have considerably more exposure lattitude and most exposure errors can be corrected during processing.

Here are a few points that you should remember:

- Read the Operator's Manual; study the corresponding operating routine shown in the flow diagrams.
- Always optimise the image quality at one or two coarse magnification steps higher than the magnification you actually require for the micrograph.
- Be prepared to practice in order to learn the art of getting the micrograph exposure correct. Do this by carefully adjusting the AUTO LEVEL and CONTRAST controls in the GRAPH mode and by close examination of the resulting micrographs.

FINALLY

- Play this tape through again if you don't feel confident in this procedure.

S200 OPERATOR TRAINING VIDEO MODULE NO 4 CHANGING THE SPECIMEN

INTRODUCTION

In this training module we are going to see how to change the specimen on the Stereoscan 200.

The instrument we are using is **not** fitted with the optional Ion Pump and associated isolation valves. If however your system **is** fitted with an Ion Pump and valves don't worry, the instructions given in the Operator's Manual will add to what you will learn in this training module.

Whilst you are watching this programme you may like to follow the corresponding operating routine shown in the flow diagrams. If this is the case, stop the tape in a few moments and then turn to Chapter 1 of the Operator's Manual.

Remember, if at the end of the video you do not fully understand what you have just seen and heard, play the tape through again – perhaps several times – until you feel confident that you do.

LECTURE

The routines we are about to see can be used at any time provided that the power is switched on. The power on routine is demonstrated in video module number 1. To recap briefly the green "ON" push switch should be illuminated indicating that power is distributed to the microscope's various electronic functions.

The FIRST STEP is to turn the FILAMENT control fully anticlockwise to minimum and switch the BEAM to "OFF".

The NEXT STEP is to get ready to open the specimen stage door in order to change the specimen. As the Stereoscan 200 is normally used with dry nitrogen backfilling, it is always advisable to release the stage door clamp prior to venting the chamber. This avoids harmful pressurisation of the specimen chamber which could possibly lead to damage of an accessory such as an X-ray detector.

NOW GENTLY turn the stage Z control anticlockwise by approximately two turns to lower the Z mechanism. Of course it is not necessary to do this if the Z control is already fully anticlockwise when the number on the dial will be between 000 and 998 approximately.

This procedure reduces the risk of the specimen touching the microscope's final lens and therefore helps avoid serious damage.

NEXT press the CHAMBER VACUUM push switch. The system will reach atmospheric pressure after about 40 seconds. NOW open the stage door carefully, adjusting the X and Y controls if necessary, checking all the time that no part of the stage mechanism, specimen holder or specimen, touches any of the precision components inside the chamber walls themselves.

Remember always to wear gloves when handling specimens or any part of the microscope that will normally be under vacuum. This will help to avoid contamination which, in extreme cases, can seriously degrade the overall performance of the system.

Now that the door is open, we will take a close look at the specimen stage. This particular stage is currently fitted with a specimen holder which can accommodate up to 8 small specimen stubs. Let us briefly examine the five axes of movement.

The X control moves the specimen holder in left or right directions. The Y control moves it backwards or forwards. The Z control moves the specimen holder up or down. The TILT control changes the angle that the specimen holder makes with the scanning electron beam. The ROTATE control rotates the specimen holder and when the stage is configured this way, it enables us to select individual specimens for examination.

Now we will examine some of the other important aspects of this type of specimen stage. It is supplied with a kit containing tools, a Z spacer plate and a variety of specimen holders. Your choice of specimen holder will depend on the shape and size of the specimen you wish to examine. Sometimes it will be necessary to change the Z spacer plates. For example, if you want to examine a very large specimen you may find that there is insufficient room – even with the Z movement at its lowest position. Also, if you attempt to tilt a very large specimen you may find that it will touch the microscope's final lens and cause damage. In these examples the solution is to remove the thick Z spacer plate. Conversely if you want to examine a very small specimen under high resolution conditions you may have to fit either the thick, or the thick and thin spacers to ensure that a short working distance is achieved. At least one Z spacer plate must *always* be fitted to support the Z mechanism. More information on clearances, working distances and Z spacer plates will be found in the Stage Technical Data Sheet.

To remove the *thick* spacer plate (for instance), START by removing the specimen holder and then raise Z fully. NOW remove the two screws which clamp the mechanism to the spacer plates and rest the mechanism on the chassis. NEXT remove the two screws which attach the Z spacers to the stage chassis. NOW remove the thick spacer and, using the shorter screws, attach the thin spacer to the chassis again. FINALLY re-clamp the mechanism with the two screws.

Specimens are typically mounted on stubs by means of conductive adhesive which must be allowed to dry fully before putting into the specimen chamber. Loading this type of specimen holder is quite a simple matter.

Pick up the mounted specimen using the special tool. Insert the stub carefully in the specimen holder and secure it using the tool provided.

Before closing the stage door make sure that the vacuum 'O' ring seal is correctly located in its groove. NOW check the cleanliness of the seal and the sealing face of the chamber. Sometimes dust or small fibres may be present which are frequently the cause of vacuum leaks. Clean if necessary by means of a standard dusting aerosol. On no account must the aerosol be directed towards any of the precision components inside the specimen chamber.

Carefully close the specimen stage door checking all the time that there is no risk of anything being damaged. Fasten the clamp and immediately press the CHAMBER VACUUM push switch to pump out the system.

Usually a working vacuum level is reached in about two to three minutes but if the specimen has a tendency to outgas or the microscope is operated in adverse conditions then it could take up to five minutes or so.

The CHAMBER VACUUM push switch will light up when the 'vacuum ready' state is reached.

The FINAL STEP is to obtain a picture. Do this by ensuring that the microscope is switched to OPERATE and after the 30 second warm-up period, when the snowy image should appear, switch on the BEAM. If you need help, video Module No 2 deals with how to get a picture.

Remember, if you are operating the stage controls and the specimen touch alarm sounds, you should immediately but gently reverse the movement of the stage control you are using to avoid damage to the specimen or the instrument.

SYNOPSIS

You have just seen how to change a specimen on the Stereoscan 200. Here are a few points that you should remember:

Read the Operator's Manual and study the corresponding operating routine shown in the flow diagrams.

Always wear gloves when handling specimens or any part of the microscope that will normally be under vacuum.

When opening and closing the specimen stage door, check all the time that there is no risk of anything being damaged.

If the alarm sounds the specimen or specimen holder has touched something – You must respond to this warning immediately.

It is worth spending time considering what you want to achieve from the specimen examination before deciding what holder and Z plate to use. This will save time in the long run.

Finally play this tape through again if you don't feel confident in the procedure.

S200 OPERATOR TRAINING VIDEO MODULE NO 5 SWITCHING OFF

INTRODUCTION

In this programme we are going to find out how to switch off the Stereoscan 200. There are three levels of switching off; these are Partial, Intermediate and Total. Partial switch off simply means switching off the electron beam.

Intermediate switch-off involves switching from OPERATE to STANDBY but Total switch-off means *complete close-down* of the instrument by switching off the main power.

These three levels of switching-off will now be demonstrated and explained. An important point to bear in mind is that in practice it is unusual to carry out a Total switch-off procedure because on the basic instrument this will bring the entire system up to atmospheric pressure. In adverse operating conditions this could lead to column oxidation, which could in severe cases seriously degrade the microscope's performance.

Whenever the system is vented, the risk of oxidation should be minimised by back filling with a dry inert gas such as nitrogen.

If the instrument has to be left routinely in the completely switched off state for long periods, say for up to two or three days, it should be fitted with the chamber isolation valve, which is available as an option. This will prevent the entire system from being vented and should therefore provide protection from oxidation for as long as the vacuum lasts.

The Stereoscan 200 we are using is fitted neither with the optional isolation valve just mentioned nor with the optional Ion Pump and associated isolation valves. If however, your system *is* fitted with these options don't worry, the instructions given in the Operator's Manual will add to what you will learn in this programme.

While you are watching this training video, you may like to follow the corresponding operating routine shown in the flow diagrams. If this is the case, stop the tape in a few moments and then turn to Chapter 1 of the Operator's Manual.

Remember, if at the end of the programme you do not fully understand what you have just seen and heard, play the tape through again.

LECTURE

As starting points for each of the three routines explained in this module, we will assume that the microscope is in a fully operational state each time.

To begin, let us look at the Partial switch-off routine. You would use this if you wanted to switch the microscope off for a short period of, say, one or two hours.

First, switch to HOLD by pressing the push switch; this will disable the AUTO SIGNAL LEVEL system. Then check that the visual display brightness is not too high. If it is too bright, ensure that the tube does not get burnt by taking the necessary action promptly.

Next turn the FILAMENT control fully anticlockwise to minimum and then switch off the electron beam by pressing the BEAM push switch. This completes the Partial switch-off routine.

Having completed the Partial switch-off routine let us now look at the Intermediate switch-off routine. This is the routine you would use to switch the microscope off for a medium period of time; for instance, at the end of the day or when you do not want to use the microscope for several days.

First switch to HOLD by pressing the push switch; this will disable the AUTO SIGNAL LEVEL system. Then check that the visual display brightness is not too high. If it is too bright, ensure that the tube does not get burnt by taking the necessary action promptly.

Next turn the FILAMENT control fully anticlockwise to minimum and then switch off the electron beam by pressing the BEAM push switch.

Finally lift the protective flap and press the OPERATE push switch to bring the electronics system to a STANDBY state. Whilst in this state, the microscope must remain connected to the electrical supply and switched on; otherwise it will be vented fully or partially, depending on its configuration.

This completes the Intermediate switch off routine.

To end this training module we shall now examine the Total switch-off routine. It is strongly recommended that the Stereoscan 200 is left under vacuum wherever possible to avoid column oxidation, even during extended periods when the microscope is not in use, or during major servicing of the vacuum system. You should therefore only use this routine if it is absolutely necessary.

First switch to HOLD by pressing the push switch; this will disable the AUTO SIGNAL LEVEL system. Then check that the visual display brightness is not too high.

If it is too bright, ensure that the tube does not get burnt by taking the necessary action promptly.

Next turn the FILAMENT control fully anticlockwise to minimum and then switch off the electron beam by pressing the BEAM push switch.

Now lift the protective flap and press the OPERATE push switch to bring the electronics system to a STANDBY state.

Next, turn on the dry nitrogen gas for the backfilling system and check that the pressure is correct.

Next, switch off the main power by pressing the red "OFF" switch located at the top left hand side of the console. Having done so the green "ON" switch underneath it should no longer be illuminated and you should hear the vacuum pumps stop.

At the same time, release the stage door clamp to avoid excessive pressurisation of the specimen chamber, because some accessories, for example X-ray detectors, can be damaged by excess pressure. If the optional Baffle Valve is not fitted, the entire system will be vented and back filled.

After the system has vented fully, turn off the dry nitrogen backfilling supply to minimise gas consumption.

Now fasten the stage door clamp. Finally disconnect the mains electricity supply. This completes the total switch-off routine. The Stereoscan 200 is now in a totally closed-down state but should not be left like this for any longer than absolutely necessary.

You have now seen how to switch-off the Stereoscan 200. Normally you will use either the Partial switch-off or the Intermediate switch-off routines. As explained, it is inadvisable to use the Total switch-off routine unless absolutely necessary.

Here are a few points to remember:-
As always read the Operator's Manual and study the corresponding operating routine shown in the flow diagrams.

Always ensure that the FILAMENT current control is at minimum by checking that it is fully anticlockwise before switching the BEAM on or off. This is particularly important if the optional LaB_6 emitter is fitted because this is more sensitive to thermal shock.

Partial switch-off is for short periods of up to two hours and is used mainly to prolong emitter life.

Intermediate switch-off is used when the operator wants to bring the microscope to a standby state at the end of a period of operation or when the system will be idle for several days. At standby the vacuum system is still fully operational so the microscope can be available for use within seconds.

You have now completed module 5, which should bring you to a reasonable level of competence in the day to day operation of your stereoscan 200.

We suggest that before going on to module no. 6, which contains advanced operating routines, that you make sure that you are fully conversant with modules 1-5. Only by doing so will you derive full benefit from the advanced programme.

S200 OPERATOR TRAINING VIDEO MODULE NO 6 ADVANCED OPERATION THE TECHNIQUE OF HIGH RESOLUTION MICROSCOPY

INTRODUCTION

Training Module No 6 is an advanced programme, and will be presented by Mr Rod Griggs, who has a wealth of experience in teaching advanced operating techniques to Stereoscan users. Before I hand you over to him please remember that to gain full value from this module you should have read and understood the S200 Operator's Manual, and be familiar with the position and function of all the controls on the operating console.

In this training module on Advanced Operation, we are going to study the technique of high resolution microscopy.

The object of this video is to demonstrate a systematic approach to getting the best performance from the Stereoscan 200 when applying it to the examination of a Cambridge Instruments high resolution test specimen.

Before you proceed with the video, it is essential that you have read and understood Chapter 5 of the Operator's Manual first. This chapter deals with advanced operation and provides a great deal of very useful and important background information which supplements this video. If you have not read Chapter 5 yet you should stop the tape and do so.

The test specimen we are going to use consists of a carbon substrate coated with evaporated gold. Although somewhat vulnerable, this specimen is both stable and electrically conductive. Its characteristics are such that it will enable us to produce good quality micrographs at one hundred thousand times magnification and demonstrate very high resolution. This type of specimen is available from Cambridge Instruments UK, and is used in our factory to monitor instrument performance. It must be emphasised at this point that very high resolution cannot be achieved on all types of specimen. This is especially true of specimens which have insufficient surface topography and do not, therefore, produce sufficient image contrast.

Even is the specimen is suitable, very high resolution cannot always be achieved on all features within the same field of view.

The key point to remember is that optimum resolution is only available from optimum specimens.

Having defined the test specimen and the objective of the examination, practical experience tells us that we should operate the microscope at a high acceleration voltage – probably 30KV which is the maximum on the Stereoscan 200.

The reason behind the choice of a high acceleration voltage will be explained, but before we go any further, let us pause for a moment and think briefly about a highly contrasting situation that many operators have to deal with routinely.

Some specimens are delicate and nonconductive – they are both beam sensitive and charge sensitive. Such specimens can be difficult to examine and almost invariably they require very low acceleration voltages – for example 2 or 3KV. Delicate specimens should be examined with a so called "low dosage" electron beam. This means a very low acceleration voltage and a very low probe current – that is, a much higher setting of the resolution control than you would normally use, and finally the fastest scanning speed possible – consistent with removing unwanted image noise. The best solution is to use a combination of the Lanthanum Hexaboride (LaB_6) emitter and the Cambridge Instruments Image Store. The store can produce very high quality noise free pictures from beam and charge sensitive specimens examined under 'low dosage' electron beam conditions.

Now let us return to the subject of examining our stable and electrically conductive test specimen under high resolution conditions using an acceleration voltage of 30KV.

As with the other training videos, play the tape again if you do not understand what you have seen and heard. This comment is especially applicable to this training video because it covers a subject for which it is difficult to produce comprehensive and useful flow diagrams. The reason for this is that advanced operating is all about applying the power and sophistication of the Stereoscan 200 to a **specific specimen** by developing an operating regime which will, within the limitations of the SEM technique, **satisfy the requirements of your investigation.**

Having said this, I am sure you will discover that in practice a very large proportion of the operating regime demonstrated in this video is highly applicable to the vast majority of routine high resolution microscopy.

One final word of warning. Do not attempt to try out anything in this advanced operator training video until you are fully familiar with the basic training package. This means that you should have studied the Operator's Manual, and understood and practised the basic operating routines in modules 1 to 5 **before** you progress to this module.

If you have not completed this vital foundation work you will not benefit from this video.

LECTURE

The **first** of twelve key steps in a systematic approach to getting a good quality high resolution micrograph of the test specimen, is to ensure that the electron gun is clean and correctly adjusted. Switch the operators console to standby, bring the entire microscope up to atmospheric pressure and then open the electron gun. It is advisable to use dry nitrogen backfilling during this operation.

Remember always wear suitable gloves when handling any part of the microscope that will normally be under vacuum. We are using the type which do not generate fibres so the risk of column contamination by particulate matter is minimised.

Remove the filament assembly and then the anode. Then, by means of a microscope, check that both parts are clean and that the filament assembly is correctly adjusted. Incidentally the Stereoscan 200 we are using here is fitted with a tungsten filament and **not** the optional LaB_6 system. Check for contamination on the anode and on the gridcap because this could lead to persistent beam tripping – as explained in module number 2. Check that the filament is central and that its height adjustment is correct. More information on this will be found in module number 7 which deals with routine maintenance.

Since we are going to operate at an acceleration voltage of 30KV, we must ensure that the anode is configured for high KV operation. This is done by taking out the anode spacing ring which, when in use, fits immediately below the anode. Now remove any dust and replace the components carefully; first the anode, and then the filament assembly. Check the gun 'O' ring vacuum seal and gently close the gun, keeping your fingers well clear for safety reasons.

Still wearing gloves, the **second** step is to open the door carefully and configure the specimen stage for high resolution microscopy. For best results, our high resolution test specimen should be examined at a tilt angle of 45° maximum and at a working distance of 3 to 7mm. To enable us to achieve this short working distance, we should already have put into practice what we learnt in module No 4 regarding the use of Z spacer plates.

The **third** step is to ensure that the specimen has been stored correctly. Our high resolution test specimen is kept in a desiccator in an attempt to slow down the gradual degradation which is inevitable with the majority of specimens. We will now carefully insert the specimen into the holder on the stage using the correct tool, thus avoiding surface damage.

Make sure that everything is clamped up tightly to safeguard against the possibility of vibration problems. Check that the specimen earthing cables are correctly connected and are in good condition.

Close the door gently while checking that there is no danger whatsoever of damaging any other equipment within the specimen chamber as a result of using the very short working distance. Fasten the clamp and pump out the entire system.

Experience has shown that as the vacuum improves so does the microscope's resolution. For this reason we will wait until the vacuum is better than 10^{-5} Torr before we switch on the electron beam and obtain a picture

While we are waiting for a really good vacuum, let us discuss briefly why we will be using an acceleration voltage of 30KV and a working distance of around 5mm.

In practice, best resolution is usually obtained from stable and electrically conductive specimens at around 25 or 30KV and this can be easily verified experimentally.

Even though the SEM **system** resolution would be better at say 40 KV, the **specimen** resolution may not be expected to increase. It is for this reason 30 KV has been chosen for the upper limit of acceleration voltage on the Stereoscan 200.

There are several reasons for choosing 30KV for this high resolution test specimen: First, the electron gun brightness is greater at a high acceleration voltage. This means that the electron beam contains more electrons for a given beam diameter.

As a result, the signal to noise ratio of the specimen picture is improved – it is less snowy and more crisp at high acceleration voltages. As a matter of interest, the so called gun brightness increases almost linearly with increase in acceleration voltage. The LaB_6 emitter has a distinct advantage over the tungsten in that its brightness is very high even at low acceleration voltages.

Second, the combined adverse effect of two electron lens limitations known as chromatic aberration and diffraction aberration is less severe at high acceleration voltages. At low acceleration voltages chromatic aberration dominates and causes a significant increase in the electron beam diameter. This, combined with reduced gun brightness decreases the system resolution dramatically.

So, it would appear that a high acceleration voltage will always give the best resolution – but it must not be too high otherwise **loss** of resolution or image quality will occur for the following reasons:

At high voltages the electron beam penetrates the specimen surface to a greater depth and this can produce several **adverse** effects, for instance, loss of information relating to fine structures, making thin surface films artificially transparent and general reduction of image contrast.

High acceleration voltages also increase the risk of specimen charging and beam damage which both result in severe loss of image quality and resolution. As a general rule, a high acceleration voltage **will** give the best resolution. You must be prepared to experiment in order to establish the optimum voltage for the specimen under examination.

This voltage should be the best all round acceptable compromise between the various factors I have just spoken about.

Now let's discuss why we will be using a **short** working distance for our high resolution test specimen.

The main reason is simply that the focusing lens performance is so much better at short working distances. This is because of yet another electron lens limitation known as spherical aberration. This too has an adverse effect by causing enlargement of the electron beam diameter and a consequent reduction in system resolution. This aberration is particularly dependent on working distance. The loss of system resolution as a function of increase in working distance is quite alarming.

Having said this, don't make the mistake of positioning the specimen **so** close to the focusing lens that: (a) the magnetic field from the lens affects the emission from the specimen and, (b) the proximity of the lens shields the electron collector system. Either of these two errors will reduce the collection of available signal from the specimen and will, therefore, increase the image noise.

There are dangers when operating at a short working distance which you must be aware of. There is a significant risk that the specimen might touch and seriously damage the microscope's focusing lens. If this happens the specimen touch alarm should sound **but only if the specimen is electrically conductive.** PLEASE BE AWARE OF THIS. It's a good idea to retract or remove the backscattered electron detector if one is fitted because such detectors are quite vulnerable.

Returning briefly to the point about electron lens limitations, the aberrations we have been discussing exist in all electron optical systems, but you can be assured that through computer optimised design and up to date manufacturing technique, the lenses in your Stereoscan 200 are of the best design, material and construction that existing technology will allow.

Unfortunately time will not allow us to discuss further the characteristics of electron optical systems. If you would like more information please study the references given in Chapter 5 of the Operator's Manual.

Having discussed the choice of acceleration voltage and working distance let us now check the vacuum level – it looks ideal for high resolution work.

Now that we have a good vacuum let us continue with the **fourth** step.

Perform your 'pre-flight' check as usual but pay particular attention to the following points:

a. Select 30 KV acceleration voltage.
b. OPTIBEAM normal. Because we will be using a combination of **high** acceleration voltage and a **short** working distance, this is the correct setting for OPTIBEAM by definition.
c. Set the RESOLUTION FINE control fully clockwise.
d. Select 5mm working distance on the COARSE FOCUS control.
e. The electron collector voltage should be ON. The switch should be in its position closest to the specimen chamber backplate. By doing this you will ensure that all the available secondary electron emission is picked up from the specimen and is used to form the image.

Having done this switch the microscope to OPERATE.

The **fifth** step is to obtain a correctly adjusted electron beam.

First turn on the electron beam and in the emission image mode adjust the filament current finely to a level equivalent to the second peak of emission. If you remember, the second peak, sometimes called saturation, is used for high resolution microscopy because it provides maximum emission and best stability. Align the electron gun using the normal routine, adjusting the shift controls first and then the tilt controls. If you are not exactly sure how to do this refer back to video module number 2. Now switch off the emission image. Later we will return and, using a more precise technique, we will optimise both the filament current and the gun alignment.

Next set the resolution to 4 and the magnification to minimum.

The **sixth** step is to set the required working distance. First set the working distance readout, shown at the top of the screen in the data zone, to 5mm. This is done by means of the medium focus control. By so doing we are making the focusing lens focus at the specific working distance of 5mm. Next, using the specimen stage Z control gently raise or lower the specimen to meet focus. Focus is met when the picture on the screen is sharp. When focus is achieved in this manner, we can be sure that the specimen is at 5mm working distance. This is a useful technique to remember.

The **seventh** step is to select the correct final aperture size. Having defined both the acceleration voltage and the working distance, and having selected OPTIBEAM normal, we must make sure that we are using a 20 microns diameter final aperture. The Y micrometer is used to select any one of 4 final apertures. An individual aperture is located at approximately every 8mm on the Y micrometer scale.

When the microscope leaves our factory the aperture changer is normally loaded with 20 microns apertures at 0, 8 and 24mm nominally and with a 50 microns aperture at 16mm nominally. Select a 20 microns aperture which you know to be clean and in good condition. Do this by turning the Y micrometer to the reading on the scale at which you know the required 20 microns aperture will be selected **and** in the correct position.

Now increase the magnification to about 5 thousand times; try to maintain good image sharpness by adjustment of the focus controls and by increasing the RESOLUTION control to a medium setting of at least 7.

As you adjust focus, it is highly probable that you will see the picture swing instead of gently going in and out of focus. The swinging can occur in any direction; it is a symptom of aperture misalignment and must be eliminated if we want to get the best resolution from the microscope. To align the aperture, first ensure that the RESOLUTION setting is at least 7 and choose a field of view containing a prominent feature. Position the feature centrally on the screen using the IMAGE SHIFT controls, and try to focus it as best you can. Now switch on the focus wobble facility (only useable in TV mode) and adjust the change control until the feature has a total swing of about 50mm on the screen.

Now analyse the direction of swing. In this case it is predominantly in the Y direction on the screen. This means that the Y micrometer on the aperture changer is out of adjustment. Carefully adjust the Y micrometer until the Y component of the swing is eliminated. Now we are left with a small amount of X swing, so a small adjustment to the X micrometer is needed. Repeat this process until all the swing is eliminated and the picture simply goes gently in and out of focus under the action of the focus wobbler. Switch off the focus wobbler. Now the final aperture should be fairly accurately aligned but we will have to check it again later at a higher setting of the RESOLUTION control.

The **eighth** step is to optimise the filament current and the gun alignment. This will be done at a higher setting of the RESOLUTION control and by means of a more precise technique. First increase the RESOLUTION control to a high setting of at least 9. Next switch to HOLD by pressing the button in.

Whilst observing the signal meter, very carefully adjust the filament current control over a small range, stop adjusting when the signal on the meter is as high as you can possibly get it. The best method of doing this is to use the same technique you might use when tuning in a radio. Be careful not to pass more current through the filament than is absolutely necessary otherwise its life will be dramatically reduced. Release the HOLD button, switch to emission image and check briefly that you are still in the fully saturated condition by observing the filament emission.

Switch the emission image off and then switch to HOLD by pressing the button in again. Whilst observing the signal meter, very carefully adjust the gun alignment TILT controls over a small range. Stop adjusting them when the signal on the meter is as high as you can possibly get it. Release the HOLD button.

Although the electron gun emission is now optimised, the gun alignment TILT controls must be rechecked later.

The **ninth** step is to optimise the RESOLUTION control setting. Our objective is to take a high resolution micrograph at one hundred thousand times magnification that demonstrates very high resolution. Increase the magnification 1 coarse step, re-focus using fine focus. Increase by another 2 coarse steps, again re-focus using fine focus. By now you will have probably arrived at the point where you cannot seem to focus probably, however hard you try. Each time this happens you should increase the setting of the RESOLUTION control, re-focus using the fine focus control.

Now re-align the final aperture as before using the focus wobble facility. With each increase of the RESOLUTION control setting the picture gets correspondingly more noisy or 'snowy'. Switch to scanning mode "VIS 1" or "VIS 2" because this will help to reduce the picture noise and will therefore enable you to see the specimen structure more clearly during fine focusing. Do not sit too close to the screen, sit well back and you will see more of the specimen structure and less of the noise. Keep increasing the magnification until you are at one hundred thousand times. Increase the RESOLUTION control setting and re-focus so that you can resolve the very fine structures in the picture. By this time the RESOLUTION control will probably be at eleven or even twelve. You can now use the RESOLUTION FINE control to perfect the setting of resolution. Re-focus as necessary using FINE focus.

As a guide, set the resolution controls high enough to enable you to see and resolve the structure of interest, but not too high so that the picture becomes unacceptably noisy. Judging what is acceptably or unacceptably noisy is quite difficult, but you will soon learn through experience. Don't be afraid of noise. It is quite surprising how noise-free the micrograph of what appeared to be an excessively noisy picture can be. This is because during set-up we view the picture at relatively fast visual scan speeds, but during the micrograph exposure very **slow** photo scan speeds are used. The slower the scan speed the less the noise.

For the **tenth** step switch back to TV and use the focus wobble facility to check the aperture alignment as before. Then press the HOLD button and whilst observing the signal meter, very carefully optimise the gun alignment TILT controls by adjusting them over a small range, trying to get the signal on the meter as high as possible. Now release the HOLD button.

Final aperture alignment had to be done at this point because accurate alignment **must always** precede astigmatism correction which is the next step in the procedure.

The **eleventh** step is to correct any astigmatism that may be present in the picture.

First, by means of the IMAGE SHIFT controls, find a region of the specimen which has both good contrast and clear structure in all directions. Position this region centrally on the screen and focus it.

Next select scanning mode SMALL because this facility intensifies the picture and makes it less noisy. It is, therefore, a most valuable aid. You may have to decrease the visual brightness temporarily to obtain the full benefit of small scan. Focus the picture again.

Now make sure that the STIGMATOR controls are zeroed by setting them to half full range as shown.

Next focus the picture the best you possibly can. If astigmatism is present, it is recognisable by a characteristic bi-directional stretching of the picture as the fine focus control is adjusted about the point at which best focus has been found. As the fine focus control is very gently rotated in one direction (from the point of best focus) so the picture stretches in a particular plane. As the fine focus control is very gently rotated in the opposite direction (back through the point of best focus) so the picture stretches in another plane, exactly at right angles to the first plane. This is the definitive symptom of astigmatism. Although the orientation of the characteristic bi-directional picture stretching is random, the planes of stretch themselves are ALWAYS at right angles to each other in a given astigmatic picture.

Having detected some astigmatism in this picture we must now correct it using the following routine. First focus the picture the best you can; then adjust the left hand stigmator control until the picture becomes sharper; then adjust the right hand stigmator until the picture becomes even sharper; then return to the fine focus again until the picture improves still further. It is usual to go around this loop of focus; left hand stigmator; right hand stigmator; focus several times until the astigmation is corrected fully. To get the best results you must follow strictly the sequence of adjustments in this routine.

Do not confuse picture swinging with picture stretching. Picture swinging is caused by final aperture misalignment, but picture stretching is caused by astigmatism.

Now select a new field of view using the IMAGE SHIFT controls. This is necessary because after a period of time, some beam damage may have taken place even though the specimen is fairly robust.

Next focus the picture using the fine focus control and then switch to VIS 1. Adjust the visual brightness as required.

Do not touch any of the electron optical controls because they are now in an optimised state and must not be disturbed.

The **twelfth** step is to take [illegible]
First switch to photo speed SLOW by releasing the FAST switch. We are going to use the slow photo speed because the picture is rather noisy. This amount of noise is quite normal for a modern SEM operating under high resolution conditions and is nothing to worry about. Next switch to GRAPH and set up the AUTO LEVEL and CONTRAST controls using the procedures demonstrated in video module number 3. To recap briefly, the object at this point is to adjust the AUTO LEVEL control so that the mean of the graph lies midway between the two level indicators on the screen. Having done this, adjust the CONTRAST control until peaks are nearly level with the upper indicators, and troughs are nearly level with the lower indicators.

Now switch off GRAPH by switching back to normal. Get the camera ready – then press PHOTO START to initiate the photoscan. During the photo scan sit back in the operator's chair and relax, keeping yourself well away from any part of the microscope. This should prevent you from making physical contact with the system and causing vibration which, at these high magnifications, can be very noticeable on the micrograph.

Now that the photoscan has finished, let us examine the micrograph. It would appear from the result that all our hard work has been well worthwhile.

SYNOPSIS

You have now seen a systematic approach to getting the best performance from the Stereoscan 200 when it is applied to the examination of a Cambridge Instruments high resolution test specimen.

Here are some points you should consider:

1. Make sure that you have read and understood Chapter 5 of the Operator's Manual because it provides vital information which supplements this video.

2. Routine maintenance is very important if you want to get the best performance from the microscope. You should pay particular attention to: (a) all aspects of column cleaning, (b) accurate set-up of the electron gun components and, (c) regular checks on the electron collector system performance.

3. Take steps to ensure that your working environment is conducive to advanced operation. For both the operator and the instrument correct ambient conditions are essential. Suitable background lighting, suitable room temperature and humidity, lack of background noise and general disturbance for instance all help the operator to concentrate fully. For the instrument room temperature and humidity are also important points, so too are the absence of vibration and stray magnetic fields.

4. Amongst other things, this video has introduced you to three new operating procedures:

a. full optimisation of filament current and gun alignment by means of a more precise technique using the signal meter.

b. final aperture alignment using the focus wobble facility.

c. astigmatism correction.

In order to get the best performance from the microscope you must practice these new procedures.

5. An operating regime that gives the best performance on one specimen will not necessarily give the best performance on another specimen. You must be prepared to experiment on your own specimens to establish the best microscope conditions to use. You should spend time optimising all major parameters such as acceleration voltage, working distance, specimen tilt angle and the resolution control setting.

6. Incorrect or incomplete specimen preparation cannot usually be compensated for by clever operation of the Stereoscan 200. Careful consideration of the specimen preparation procedures and adequate care in their use are essential pre-requisites to success in the use of the microscope. Remember, optimum resolution is only obtainable from optimum specimens.

7. If you have to examine beam and charge sensitive specimens do so with a 'low dosage' electron beam and for best results use a combination of the LaB_6 emitter and the Image Store facility.

8. Refer to published text books, journals and conference proceedings. Join a microscopy society and an SEM users group because in this way you will be able to communicate with people doing similar work and learn about their techniques.

9. Operation under high resolution conditions or on difficult specimens requires patience, skill and experience – even with a high performance 'state-of-the-art' scanning electron microscope like the Stereoscan 200. Recognising this, Cambridge Instruments run instructor based training courses where advanced operating skills are taught in a fully structured manner. Please ask your local representative if you would like more information.

10. Play the tape through again if you don't feel confident that you understand. Remember this. 'Practice makes Perfect'. **HAPPY SCANNING!**

S200 OPERATOR TRAINING VIDEO MODULE NO 7 PART 1 BASIC ROUTINE MAINTENANCE

INTRODUCTION

In this training module we are going to examine the basic routine maintenance operations that the operator is expected to carry out to keep the instrument in good working order. Broadly speaking, the basic routine maintenance falls into two main areas; these are the vacuum system and the electron optical column.

Please be aware that there is advanced routine maintenance which is beyond the scope of this video but is covered fully by a separate course and partially in Chapter 3 of the Operator's Manual. You should discuss advanced maintenance with your Cambridge Instruments representative who will advise you about the service contracts offered by the company.

In this programme we will first examine the tools and equipment needed to carry out basic routine maintenance covered in this programme efficiently and effectively.

Secondly, we will discuss some of the key problems for both the operator and the instrument that can occur during maintenance work.

The third objective is to examine in detail each basic routine maintenance operation in turn to: a) review what has to be done, b) discuss how frequently it has to be done and, c) demonstrate how it is actually done.

It must be stressed that routine maintenance on the Stereoscan is very important for two main reasons:-

Firstly it ensures user satisfaction because the microscope works well.

Secondly, it reduces down-time because the overall reliability of the microscope is enhanced.

Chapter 3 of the Operator's Manual supplements this video and you should read it as soon as possible. Please find the Operator's Manual now and turn to page 79 which shows a diagram of the column. Keep this ready, you will need it a little later on. Also have ready a piece of paper, a pen and a highlighting pen. Remember as with the other videos, if you don't fully understand what you have just seen and heard, play the tape through again until you feel confident.

LECTURE

Our first objective is to examine the various tools and pieces of equipment which we will be needing. They will help us tackle the basic routine maintenance in an efficient and effective manner.

The first items that we have here on the table are a set of tools which are supplied as standard with the microscope. These consist of an assortment of screwdrivers, extraction tools and a polishing rod.

There are, however, a number of items which you will need to obtain in order to complete all the servicing routines which will be dealt with in this module. You will need a nylon lab. coat and a packet of polythene gloves. To carry out the cleaning and polishing routines you will need a square of 10mm plate glass with polished edges, a selection of wooden cocktail sticks and small balsa wood dowels, a tube each of 1 micron and 0.25 micron diamond paste and two pairs of fine tweezers, one of which should be plastic tipped. You will require plenty of filter papers and fibre free tissues for cleaning and polishing various individual items. All removable parts of the microscope will be cleaned in either methanol, propanol, or Arklone solvent, so we will need a drum of this, as well as a small rinsing bottle.

You must acquire a suitable ultrasonic cleaning tank. This one has a capacity of 2½ litres and is ideal.

An assortment of laboratory beakers will be needed as well as a pair of forceps.

To dry the components you will want a hot air blower. A small domestic hair dryer held in a retort stand is most suitable.

A binocular bench microscope of about 20 times magnification is essential for close inspection of components.

Incidentally don't forget to buy a few standard laboratory dusting aerosols.

Once the components have been cleaned they should be placed in a suitable dust free box, like this inexpensive food storage container.

A few Petri dishes are extremely useful for small and delicate components, whilst a trace of Fomblin grease is needed for lubricating the lower 'O' ring on the gun alignment coil only. Finally, of course, you will need the Instruction Manual which is supplied with each Stereoscan 200.

Having taken a close look at the tools and equipment needed, we will now move on to our second objective, which is to discuss some of the problems of maintenance to both the operator and the instrument.

The main hazard to the operator is caused by the cleaning materials we have to use. Although we will be using ICI "Arklone" which is a safety solvent, we must take adequate precautions to avoid breathing the vapour, so a well ventilated room is essential. Used solvent must be disposed of correctly. It must never be poured down the sink or any other normal drain. The solvent manufacturers data sheet must be read and understood by everybody that uses the solvent.

Please take note of the following points:

1. When loading and unloading the ultrasonic cleaning tank, ensure that it is switched off – physical contact with the high frequency vibrations is said to be harmful.

2. Open and close the electron gun slowly and carefully to avoid trapping and damaging your fingers.

3. A general point but an important one: the exhaust from the rotary pump contains oil vapour which could be hazardous if you breathe it. Make sure that the rotary pump exhaust is routed either to a purpose designed extraction system or to a compatible oil mist filter.

Now let's discuss a number of key points to remember when undertaking routine maintenance.

1. Column cleaning must be done in an atmosphere which is dry and as free of dust as practicably possible. The operator should not wear clothes which are dust generating such as woollen garments.

2. All freshly cleaned components must be kept covered to protect them from dust. Do not use commercial compressed air for dusting because it usually contains oil vapour which will cause severe contamination. Use a purpose made aerosol or suitably filtered nitrogen gas.

3. Keep the cleaning solvent well away from the highly absorbent surface of the electron gun ceramic.

4. Mu-metal shields are very delicate. If they are strained or dropped their effectiveness as magnetic screens is reduced. Do not clean them, only remove any dust using a dusting aerosol.

5. Great care must be taken when handling column components since they are machined to close tolerances and to fine surface finishes. In consequence they are very prone to damage.

6. Components with 'O' ring grooves and mating surfaces have to be ultrasonically cleaned very carefully to avoid damage. Place these components in the bath in such a way that there is no risk of anything whatsoever making contact with either the 'O' ring grooves or the mating surfaces.

7. Do not wet 'O' rings with solvent as this damages them. If necessary, you can wipe them carefully with a lint free tissue.

8. Keep anything magnetic well away from any part of the microscope in case accidental magnetising takes place with disastrous effects.

9. Wherever possible, keep the microscope under vacuum, this will help to maintain a good vacuum environment and keep the column cleaner.

I know this seems to be a substantial list, but please remember that most hazards can be completely avoided by reasonable care and common sense.

Armed with sufficient information on what tools and equipment we need and an awareness of the procedures for routine maintenance, we can now get straight on with the maintenance operation, starting with the vacuum system.

To begin with, we will examine the AIR ADMITTANCE DRIER ASSEMBLY which is mounted on the rear panel of the plinth. If this unit is allowed to become ineffective the pump-down time of the vacuum system will become longer than normal.

The colour of the desiccant should be checked routinely every day. It should be a bright cobalt blue for at least 75% of what can be seen. As the desiccant becomes saturated with water, the blue crystals turn a white-ish pink colour. Let us assume that 25% of the desiccant is no longer bright blue so that we can see how to service this unit.

First disconnect the input and output tubes and then unclip the drier by releasing the rubber rings.

Next unscrew and remove the knurled retaining ring followed by the end cap and the filter disc. Now pour out the desiccant but avoid breathing the dust. The desiccant can either be reactivated by drying it in an oven or it can be discarded. Next remove the remaining two filter discs, leaving the perforated metal support. The three filter discs which are identical should be washed in a liquid detergent followed by rinsing and thorough drying. To re-assemble the unit, replace the two filter discs making sure that their shiny sides face away from the crystals. Now fill the unit with 600-700 grams of crystal taking care not to breathe the dust. Next fit the last filter disc making sure that its shiny side faces the crystals this time. Refit the end cap and the knurled retaining ring. Then mount the unit on the clips using the rubber rings. Finally re-connect the input and output tubes. This completes the routine maintenance on the AIR ADMITTANCE DRIER ASSEMBLY.

Next, check the rotary pump oil level. In practice the oil level should not change much, even after an extended period of use. The oil level should be checked routinely every week by examining the sight glass. The minimum level corresponds to the bottom of the glass, the maximum level is a point 25mm below the top of the glass. If the oil needs topping up, close down the vacuum system, remove the filter cap and slowly pour in Edwards number 15 pump oil until the level in sight glass is correct.

Every six months drain all the oil from the pump via the drain plug and replace to the correct level with fresh oil. The Manual covers this operation fully.

Maintenance of the turbomolecular pump needs to be handled exactly as follows:

First, switch off the entire system and unplug from the mains supply.

Second, remove the left hand panel of the instrument, this will expose the turbo control unit.

Disconnect the two multiplugs on the vacuum control unit, unbolt the control unit from its four mountings and place the unit on the floor beside the instrument.

Next, undo both the vacuum connection and the electrical connection to the pump. Loosen and remove the pump retaining bolts taking care not to drop the pump.

Now with the pump in a convenient working position suspended over the two empty 100ml beakers, undo the two drainage bolts on the vacuum outlet side as shown here.

Rotate the pump, now remove the other two bolts at the top of the unit. Slowly drip exactly 20 ml of fresh oil into one hole then drip 20 ml into the other hole. Use only the correct specified oil which can be supplied by Cambridge Instruments. 20 ml of oil will now drip slowly from both drainage holes.

Leave the pump in this position for at least 30 minutes to make sure that all 20 ml of excess oil has drained fully.

Now replace the filler bolts, turn over the pump, wipe the body, and replace the drainage bolts.

You should re-install the pump in the reverse order of removal, ensuring that the 'O' ring and carrier are clean and correctly located.

When replacing the controller, take care that the two electrical connections are fully engaged and that no cables can foul the exposed fan.

This procedure should be undertaken every six months. The operator should not attempt to change the bearings on this type of pump. Should the bearings require replacement, the pump should be exchanged or returned for repair. This facility is available under the company's service contract scheme.

Now we will leave routine maintenance of the vacuum system and move on to column maintenance; but before we get down to the practical work, let me make a few important points.

The period between column maintenance and the extent of maintenance required will depend on factors such as frequency of use, the type of specimens examined and the environmental conditions under which the microscope is operated.

As a general rule, if the required performance can be achieved then you are best advised to leave well alone.

Only if the resolution deteriorates to an unacceptable level, or if the column has incurable astigmatism, or if there are picture disturbance symptoms (which you have confirmed to be column charging rather than specimen induced) should you carry out full column maintenance. Remember, don't do a full column service unless you have to! Assuming column maintenance has become necessary, you should bear in mind that it is a very time consuming activity. The first time you do a full column clean you should allow at least 5 hours. Don't rush, because that's when things go wrong.

Will you now please find page 79 of the Manual, the diagram of the column. Also please find the piece of paper, the pen and the highlighting pen.

First of all we are going to define on the column diagram using the highlighting pen which parts the operator is expected to service. Please get ready and highlight numbers 2 to 10 and number 15.

There are four levels of routine column maintenance and in increasing order of complexity they are: PARTIAL, INTERMEDIATE, FULL and ADVANCED. ADVANCED level can only be carried out by a Cambridge Instruments approved service engineer so we will not consider it further.

Now using the piece of paper, please get ready to write down which items are serviced at each level.

First, the PARTIAL level: items 2 and 3.

Second, the INTERMEDIATE level: items 2, 3 and 15.

Third, the FULL level: items 2, 3, 15, 4, 5, 6, 7, 8, 9 and 10.

If you want to stop the tape so that you can digest this information please do so now.

To continue: let us review when you would use the various levels of column maintenance.

First, the PARTIAL level. You would use this routinely each time the filament has failed or when you were experiencing excessive beam tripping. Second, the INTERMEDIATE level. You would use this routinely to restore the performance of the microscope when it has been confirmed that the source of excessive astigmatism is final aperture contamination. As a guide, this would be every four to twelve months depending on usage.

Third, the FULL level. You would use this if the INTERMEDIATE level failed to restore the performance to your satisfaction. Perhaps every six to eighteen months.

It should be mentioned now that after very heavy usage, even the FULL level may not restore the high resolution performance of the microscope. If this is the case you should call your local service centre because it may be necessary for them to carry out an ADVANCED level column service.

Now we will get down to the practical work and start with the PARTIAL level of basic routine maintenance.

During all the subsequent procedures the microscope electronics should be switched off using the operate switch. Please note incidentally, that from mid 1984 there was a gradual changeover to a modified filament holder. Filament changing routines for the modified holder are demonstrated in video supplement number 1.

First bring the chamber and the column up to atmospheric pressure – dry nitrogen backfilling is recommended. Wearing gloves that do not generate fibres, carefully open the gun and loosen the three filament assembly clamp screws. Remove the filament assembly by pulling it upwards. Now standing on a platform to gain extra height, lift out the anode which fits on the top of the gun alignment coils. Use a gentle rotating action because it is a very good fit and in consequence jams up easily. Next, close the gun and pump out the system to maintain a good vacuum environment.

Now we will dismantle the filament assembly. First loosen the two filament holder clamp screws and using the tool provided, remove the filament holder from the grid cap. Loosen the four filament alignment screws and remove the filament.

Dispose of the filament carefully. The fine tungsten wire can easily pierce your skin and cause a very unpleasant injury.

The grid cap and the anode are now ready for cleaning. The top surface of these components has a special finish which should not be polished with abrasives. Using a selection of wooden cocktail sticks, and carefully shaped balsa wood dowels, polish the holes, the taper and surrounding area with 1 micron grade diamond paste using the cocktail stick and a balsa wood dowel for the grid cap and similar piece of specially shaped balsa wood for the hole in the top of the anode.

Thoroughly rinse the components in Arklone and then ultrasonically clean them in Arklone. After about 5 minutes remove the components from the ultrasonic cleaner using suitable forceps. As each component is removed, dry it immediately, using the hot air blower. This is done to minimise the risk of water droplets forming on the surface of the components since the Arklone evaporates so rapidly that condensation can form. Inspect the components under the microscope. In particular checking that the three height setting screws in the grid cap are all protruding by an equal amount. If necessary adjust them.

This is necessary because sometimes the action of the ultrasonic vibrations disturbs their setting. If you wish, wrap the anode in thin polythene membrane, though this is not strictly necessary, and place it in a container for temporary storage. On no account use domestic cling film.

Next, select a new filament from the box of filaments supplied with the instrument. Place the new filament centrally in the filament holder and very gently tighten the four filament alignment screws. Make sure that the filament is fairly central but make absolutely certain that its connection pins are well aligned with the slot in the base of the filament holder. This is very important and will avoid the risk of short circuiting the pins.

Now invert the tool and insert the filament holder into the grid cap taking note of the correct orientation. Gently tighten the two filament holder clamp screws and remove the tool.

Next, invert the filament assembly and using the microscope, accurately centralise the filament by means of the four filament alignment screws which are now accessed through special holes in the grid cap. This is a difficult operation and takes practice. The object is to get the tip of the filament as central as possible in relation to the hole in the grid cap. Whilst doing this, occasionally rotate the grid cap because this improves the accuracy. When the filament is central, the four screws should be gently tightened. Do not overtighten the screws because there is a real danger that you might crack or fracture the ceramic base of the filament itself.

The filament height is set behind the front face of the grid cap. This too is a difficult adjustment and again takes practice. The use of a microscope and the special jig helps to minimise the difficulty.

First, temporarily loosen the two filament holder clamp screws. The three height setting screws are then adjusted evenly until the tip of the filament is aligned accurately with the periphery of the hole in the grid cap. Again rotate the grid cap during this operation because this improves the accuracy. When accurate alignment has been achieved, finally tighten the filament holder clamp screws. Finish off by checking that the filament is still central.

Then, wrap it in thin polythene membrane if you wish to and place it in the container.

Now bring the chamber and column up to atmospheric pressure again and open the gun. Unwrap the anode, dust it and inspect it under the microscope again.

Re-dust and fit the anode using a gentle rotating action to ensure that it is located correctly. The anode should sit level on the gun alignment coils and be free to rotate. Next re-dust and fit the filament assembly taking note that it has to be located correctly. Tighten the three filament assembly clamp screws. Check and dust the 'O' ring and face. Finally close the gun and again pump out the system.

Having serviced these items, the PARTIAL level of basic routine column maintenance is finished and we come to the end of part 1 of this module. In part 2 we will move on to the INTERMEDIATE level.

S200 OPERATOR TRAINING VIDEO MODULE NO 7 PART 2 BASIC ROUTINE MAINTENANCE

INTRODUCTION

In part 2 of Module 7 we can move on to the INTERMEDIATE level which covers all the items at PARTIAL level plus the final aperture changer which is item 15.

LECTURE

First, bring the chamber and column up to atmospheric pressure – dry nitrogen backfilling is recommended. Next remove the four screws clamping the aperture changer to the column. Now draw the aperture changer out smoothly whilst keeping it horizontal. Do not manipulate the micrometers because this will misalign the apertures and is quite unnecessary. Now invert the aperture changer and put a dish in position ready to catch the small parts as they are removed.

Using the correct size screw driver and a great deal of care remove the three screws retaining the aperture clamp plate.

You must exercise extreme caution when doing this; if the screw driver slips the clamp plate could be damaged beyond repair. Remove the screws and then lift the plate off using plastic tweezers to avoid damage. Invert the aperture changer with the dish still in position. Some of the final apertures will probably fall out. Those that do not fall out can be pushed out of the aperture carrier disc with great care under the microscope using the point of a cocktail stick. You must push the top surface of the aperture well away from the hole as the apertures are made of platinum which is soft and damages very easily.

Clean the holes in the clamp plate from both sides using 0.25 micron diamond paste and a cocktail stick. Also clean the flat surfaces using 0.25 micron diamond paste and a filter paper laid on the glass slab. Then thoroughly rinse the plate in solvent and ultrasonically clean it. The aperture carrier disc can be cleaned in the same way as the clamp plate using diamond paste followed by thorough rinsing in solvent.

Turning to the final apertures, the method for cleaning these is given in the Operator's Manual but this time we will be installing new apertures. With the aperture changer inverted, load the carrier disc with the new apertures using the plastic tweezers.

Please note that one side of the apertures is funnel shaped. When loading apertures into the inverted aperture changer, the funnel side of each aperture must be uppermost.

After removing the aperture clamp plate from the ultrasonic bath and drying it using the hot air blower, inspect the plate under the microscope and dust it.

Next fit the clamp plate using the three screws. Special screws are used for this because they have to be non-magnetic. Again be careful not to let the screwdriver slip otherwise it could skid across the surface of the clamp plate and damage the holes. Now, dust the aperture clamp plate, check the 'O' ring, dust the top side of the unit and insert it smoothly into the column whilst keeping it level. Tighten the 4 screws progressively and finally pump out the system. This completes the maintenance work at the INTERMEDIATE level.

Now we can move onto the FULL level of basic routine column maintenance. This level covers all the items at the INTERMEDIATE level plus items 4 to 10 inclusive. First bring the chamber and column up to atmospheric pressure, as always dry nitrogen back filling is recommended. Then, open the gun and remove the anode. First, we are going to remove item number 4, the gun alignment coils assembly. Start by removing the Mu-metal shield which is a simple push fit onto the periphery of the coils assembly. Next, undo fully the three screws clamping the coils assembly. Now using the tool provided, gently pull the assembly upwards keeping everything vertical. Gently pull until the assembly is obviously free but then stop because it is wired to the electronics console via a cable with a plug and socket which must not be stretched. The cable enters the column through a port hole situated just above the trim band. Locate the cable and feed it into the column whilst lifting the coils assembly. As soon as the plug and socket become visible disconnect them and then lift the gun alignment coils assembly completely out of the column. Put this in a container to protect it from dust.

Leave the cable inside the column ready for re-assembly. We will not dismantle and clean this assembly just yet. We will wait until we have removed the other items.

Next, we will remove items number 5 and 6 which make up the anticontaminator assembly. Using an extended hexagonal socket driver, undo fully the three screws clamping the assembly.

Now lift the assembly out completely using the tool provided. Put the assembly in a container to protect it from dust.

Finally we will remove the 'inner' tube (column liner) assembly which comprises items 7,8,9 and 10. Having removed the anticontaminator the top of the inner tube assembly becomes visible. This is not held in position by any screws. Lift the tube out completely with the tool provided. Use both hands in case the tube slips. Put the tube in the container to protect it from dust. Now close the gun to keep dust out of the column.

First we are going to work on the gun alignment coils.

First remove the two visible 'O' rings and put them safely in a dish. Then remove the top plate. Clean the hole in the top plate using 1 micon diamond paste and a piece of specially shaped balsa wood. Clean the flat surfaces using 1 micron diamond paste and a filter paper laid on the glass slab. Thoroughly rinse the plate in "Arklone" and then ultrasonically clean it in "Arklone" for about 5 minutes.

Now very carefully remove the 'O' ring at the top of the assembly. Be careful not to damage the exposed edge of the metal lining which protrudes from the top of the assembly.

Clean the bore of the gun alignment coil assembly using 1 micron diamond paste on a piece of fibre free tissue attached to the plastic cleaning rod. Thoroughly rinse the assembly in solvent and then ultrasonically clean it in solvent for about 5 minutes. Solvent will not damage the plastic encapsulation material used in the construction of the coils assembly. Remove the parts from the ultrasonic bath and dry them immediately using the hot air blower. Then inspect them under the microscope for cleanliness or damage.

Refit the top plate and the 3 'O' rings. The smaller 'O' ring should be lubricated with the smallest trace of "Fomblin" grease type RT15. The grease must be applied with a piece of fibre free tissue using only enough grease to just put a shine on the 'O' ring. **DON'T OVERDO IT!.** Now wrap it and place it in a container for temporary storage.

Now we will move on to the anticontaminator assembly. First remove the 'O' ring and put it safely in a dish. By removing the bottom two screws separate the inner part from the outer part. Next remove the inner top plate by removing its clamping screws. Clean the hole in the inner top plate using 1 micron diamond paste and a piece of specially shaped balsa wood.

Clean the flat surfaces using 1 micron diamond paste and a filter paper laid on the glass slab. Thoroughly rinse the plate in solvent and then ultrasonically clean it in solvent for about 5 minutes. Clean the bore of the inner part using 1 micron diamond paste on a piece of fibre free tissue attached to the plastic cleaning rod. Thoroughly rinse the inner part in solvent and then ultrasonically clean it in Arklone for about 5 minutes. The outer part is **not** cleaned with diamond paste. Simply rinse it and ultrasonically clean it in solvent. Now remove all the anticontaminator components from the ultrasonic bath and dry them immediately using the hot air blower. Then inspect them under the microscope for damage and cleanliness. Now reassemble the unit, not forgetting the 'O' ring. Wrap the finished assembly in the polythene membrane if you wish (but on no account use domestic "cling film") and place it in a container for temporary storage.

Now we come to the final part – the inner tube assembly.

To dismantle the assembly first remove the collar and then tip out the top spray aperture. Remove the nozzle which clamps the bottom spray aperture and tip out the aperture. Sometimes the spray apertures are reluctant to come out – be patient, do not use force, or any object which could scratch the bore of the inner tube or damage the apertures.

There are 2 methods for cleaning the spray aperture. One is given in the Operator's Manual, but we will use an alternative method. Clean the holes in the apertures with 1 micron diamond paste using cocktail sticks. Clean the flat surfaces using 1 micron diamond paste and a filter paper laid on the glass slab. Thoroughly rinse and ultrasonically clean the apertures in solvent for about 5 minutes. Clean the collar using 1 micron diamond paste on a piece of fibre free tissue attached to the plastic cleaning rod.

Clean the nozzle with 0.25 micron diamond paste applied to a rolled-up piece of fibre-free tissue. Thoroughly rinse the nozzle in solvent and then ultrasonically clean it for about 5 minutes.

Clean the bore of the inner tube with 0.25 micron diamond paste applied to a piece of fibre-free tissue attached to the plastic cleaning rod. You may need to change the tissue several times. This operation is particularly time consuming and you must polish from both ends. When you have finished, thoroughly rinse the tube in solvent and then ultrasonically clean it for about 5 minutes.

Remove all the parts from the ultasonic bath and dry them immediately, using the hot air blower. Then carefully inspect them under the microscope. The bore of the inner tube is extremely sensitive to cleanliness so pay particular attention to the inspection of this item especially the small holes in the tube. Next re-assemble the inner tube. The spray apertures are identical and can be assembled either way up. Note that the collar fits at the **top** of the inner tube which is the end with pumping holes around the circumference. Now place the assembly in the container for temporary storage.

To finish off the FULL level of basic routine column maintenance, we must now put the clean assemblies back into the column. As each item is needed, inspect it under the microscope and dust if off before you put it back into the column. When putting the items back, be patient and don't use any force. The column diagram in the Operator's Manual will serve as a useful guide to where the various assemblies fit.

Start by opening the gun. The first item to fit is the inner tube assembly. Using both hands and the tool provided, insert the assembly in the column. Check that it is in position by observing that the top pumping holes are just visible and that the lower holes are not visible.

The second item to fit is the anticontaminator assembly. Check that the 'O' ring in the bottom of the assembly is in position. Using the tool provided lower the assembly into the column and rotate it until the three captive screws correspond with their holes. This is quite difficult to do and you will probably need several attempts before you succeed. Using an extended hexagonal socket driver, progressively tighten the screws.

The third and final item to fit is the gun alignment coils assembly. Check that the 'O' ring is located; this one can be troublesome because it has a habit of falling out of position. Now fit the three screws. Lift the assembly and lower it part way into the column then re-connect the cable. Now check the position of the 'O' ring again. Then using the tool provided continue to lower keeping the assembly vertical as you do so. The lower most part of the assembly, to which an 'O' ring is fitted, has to fit into the bore of the anticontaminator outer. As this part of the gun alignment coils assembly enters the bore some resistance will be felt. The "Fomblin" grease already applied to the 'O' ring will help to ensure that the two assemblies fit together smoothly. Rotate the assembly until the screws correspond with their holes. Now progressively tighten the screws. Now replace the Mu-metal shield and replace the anode as you have been shown before. Tidy-up the cable from the coils assembly ensuring that it is not under any tension. Check the gun 'O' ring for contamination. Close the gun. At this point, one good tip is to remove the final aperture changer, dust it off and then replace it. Now pump out the system.

The instrument will take much longer to pump down than usual because the column parts have been exposed to the atmosphere. Once the vacuum ready condition has been achieved, test the microscope's performance using the gold on carbon high resolution test specimen.

This completes basic routine column maintenance at the FULL level.

In this training module we have examined the basic routine maintenance operations the operator is expected to carry out to keep the Stereoscan 200 in good working order. This has entailed working on both the vacuum system and the column. Here are some points that you should bear in mind:

Read chapter 3 of the Operator's Manual because it supplements this video.

If your SEM is used by several different people please make sure that one person is made responsible for the overall system and for routine maintenance. In this way routine maintenance will not be neglected and faults will be reported along a recognised channel of communication. Please keep a log book on all types of maintenance and service work because this provides a case history which is very useful for our service department. The log book could also contain information about the calibration of the record tube brightness and contrast controls and information about the micrometer positions relating to various final aperture sizes.

Cambridge Instruments run advanced maintenance courses and if you would like further information on these please contract your local Representative.

Finally, play this tape through again if you don't feel confident about this procedure.

S200 OPERATOR TRAINING VIDEO MODULE NO 8 MODIFIED FILAMENT ASSEMBLY

This is the procedure for replacing the filament in the modified filament holder introduced in late 1984.

First, using the tool provided remove the filament retaining collar; then remove the filament holder from the grid cap.

Position the filament holder with the filament uppermost and loosen the filament retaining screws accessed through the large holes in the holder. The old filament will now drop out and should be discarded. Now carefully remove the height adjustment spring washer by unhooking it with a stout pair of tweezers. Invert the grid cap and gently push out the aperture along with its retaining circlip.

Now clean the aperture disc with 1 micron grade diamond paste, using a filter paper on the plate glass, and clean the aperture with a cocktail stick. Clean the filament holder in the same way, and ultrasonically clean all the parts in solvent.

Replace the cleaned aperture disc into the grid cap and refit the retaining circlip. The use of a small nylon dowel will help you to do this without scratching the aperture disc. Replace the height adjustment spring washer, which is held in by the two protruding pins.

Next select a new filament and insert it into the upturned holder so that the connection pins are in line with the oval hole in the holder assembly. Gently tighten the four filament holding screws, making sure that the filament ceramic remains central in the filament holder. Do not overtighten the screws as there is a real danger of cracking the ceramic base of the filament.

Hold the entire filament assembly by the pins of the filament itself – replace the holder into the grid cap, taking note of the correct orientation. Replace the filament retaining collar, and screw it gently in, against the pressure of the height adjustment spring washer. Continue to screw in the collar until the tip of the filament is level with the back surface of the grid aperture.

Next using the microscope, accurately centralise the filament by means of the four filament alignment screws which are now accessed through special holes in the grid cap. This is a difficult operation and takes practice. The object is to get the tip of the filament as central as possible in relation to the hole in the grid cap. Whilst doing this occasionally rotate the grid cap because this improves the accuracy. When the filament is central, the four screws should be tightened gently, but not overtightened. Now recheck the filament height. Removal and refitting of both types of filament assembly from and to the column is identical. If desired the modified filament assembly may be retrofitted directly to existing microscopes.

SCHEDULED TRAINING COURSES AVAILABLE

Operator Training

Stereoscan 90B	Scanning Electron Microscopes
Stereoscan 100	Scanning Electron Microscopes
Stereoscan 200	Scanning Electron Microscopes
Stereoscan 250 MkIII	Scanning Electron Microscopes
AN10000	ED X-Ray Microanalysis
Microspec WDX 2A	WD X-Ray Microanalysis
Quantimet Q800	Image Analyser
Quantimet Q900	Image Analyser
Quantimet Q920	Image Analyser
Quantimet Q10	Image Analyser
Chipcheck	Semiconductor Pattern Inspection
EBMF 6.5	Electron Beam Microfabricator
EBMF 10.5	Electron Beam Microfabricator
CI351	Crystal Growth System
CI358	Crystal Growth System
Autox	Crystal Growth System
BCG 365	Crystal Growth System
PGR 3000	Polycrystalline Synthesis
MR100	Epitaxial Reactor
MR190	Epitaxial Reactor
MR200	Epitaxial Reactor

VIDEO BASED OPERATOR TRAINING COURSES

Stereoscan 90B/100 Scanning Electron Microscopes
Stereoscan 200 Scanning Electron Microscope

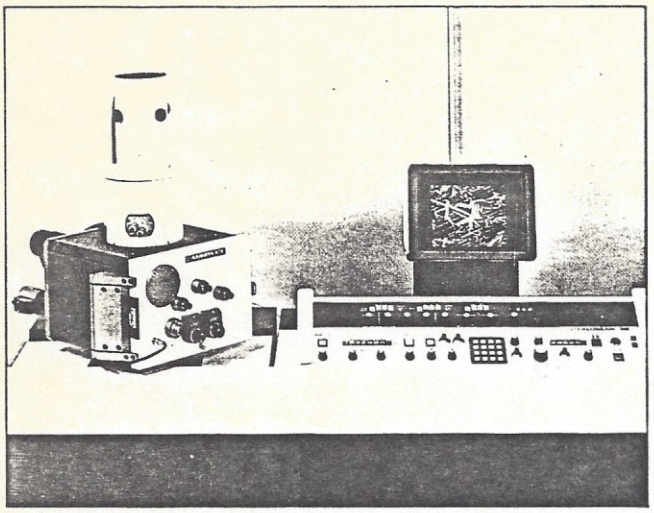
Many specially structured training courses are available. Please contact the training manager through your local representative or direct at the address shown on Page 1 of this manual.

List of Service Centres

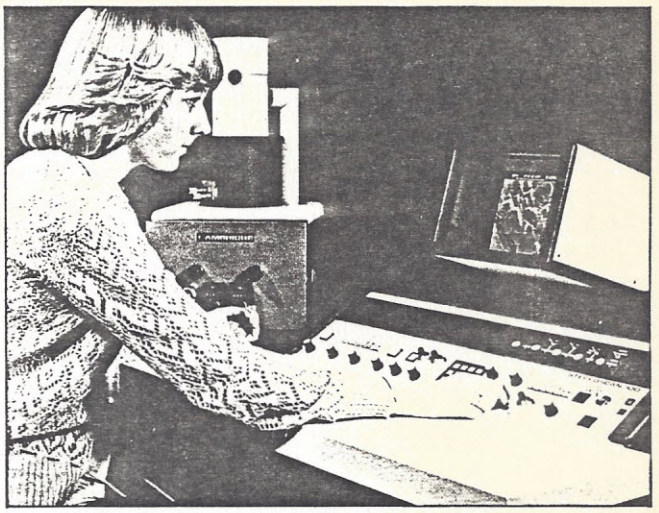
UK Cambridge Instruments Ltd, Viking Way, Bar Hill, Cambridge CB3 8EL,
tel (0954) 82020, telex 81494, FAX (0954) 82415
USA Cambridge Instruments Inc, 40 Robert Pitt Drive, Monsey, New York 10952, USA,
tel (914) 356 3331, telex 137305 FAX (914) 425 9699
CANADA Cambridge Instruments (Canada) Inc, 2545 de Miniac, Montreal, Quebec H4S 1E5, Canada,
tel (514) 337 4343, telex 5824784
W GERMANY Cambridge Instruments GmbH, Harnackstrasse 35-43, D4600 Dortmund 1, W Germany,
tel (0231) 12 60 86, telex 8227346
FRANCE Cambridge Instruments SARL, Centre d'Affaires Paris Nord, 93153 Le Blanc Mesnil, France,
tel (01) 8670134, telex 230185
EASTERN EUROPE Cambridge Instruments GmbH, A-3430 Tulin Frauenhofner Strasse, 40 Austria,
tel 02272-3177, telex 135556
JAPAN Cambridge Instruments KK, Shuwa Shiba Park Bldg, A 2F, 4-1 Shiba Koen 2-Chome, Minato-Ku, Tokyo 105, Japan,
tel (03) 432 7776, telex 26533 FAX (03) 436 5389

For description of service contracts available please contact one of the above offices, or the Service Manager at the address shown at the beginning of this Manual.

THE COMPREHENSIVE CAMBRIDGE INSTRUMENTS SEM RANGE



Stereoscan 90



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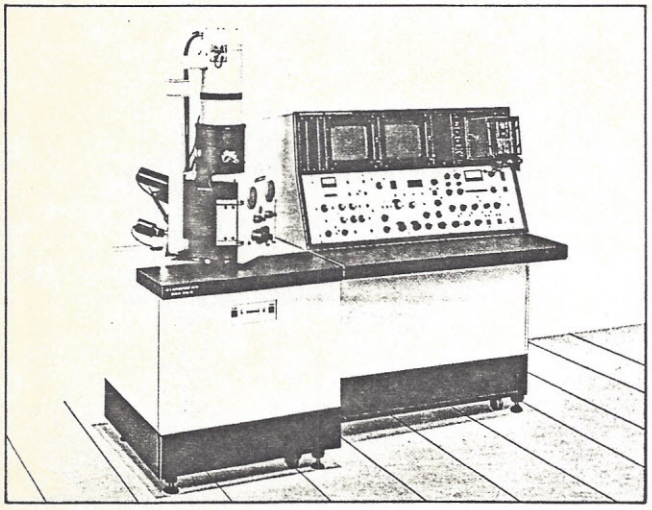

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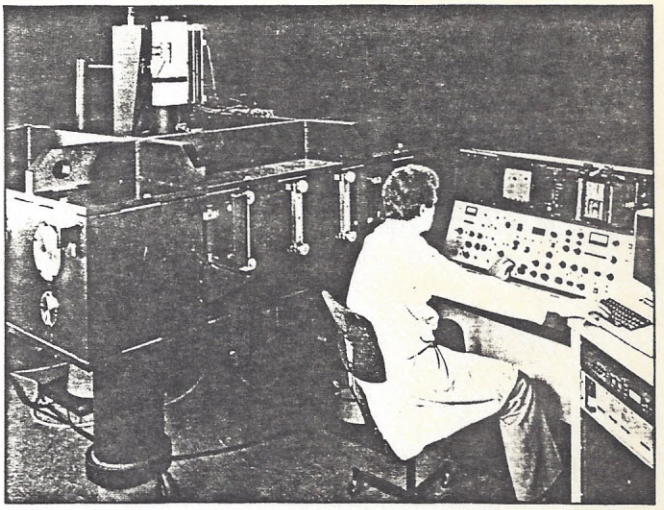

Stereoscan with large customised chamber

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