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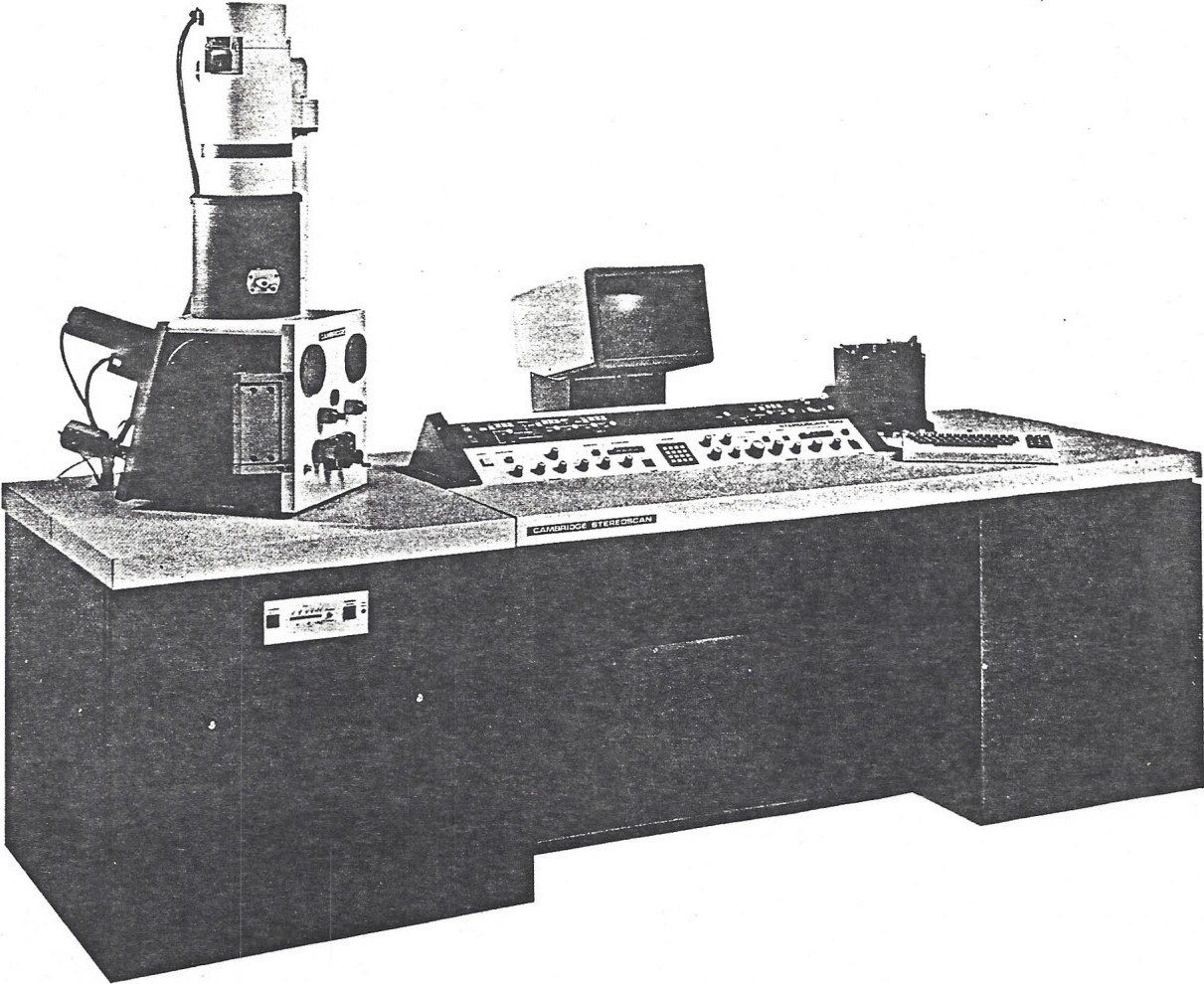
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INSTRUMENTS



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STEREOSCAN200 STUDENT GUIDE

**CAMBRIDGE INSTRUMENTS VIDEO TRAINING SYSTEM**

**STEREOSCAN 200**

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Issued by CAMBRIDGE INSTRUMENTS CUSTOMER SUPPORT GROUP

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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 ofthis modular video trainingsystem is, of course,a video player of the same operating standard as the cassettes you have purchased.Also a lV set or video monitor connected to the player. Please try to arrange your video system sothat you can easily see it, hear it and operate irs 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.

**HOWTO USE THIS COURSE**

It is expected that: l) you have arranged your video system as advised;2)you arefamiliarwith 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.

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

Youwill seeand hearyour Mor describe what he is going to teach you in this particular module and hewill then tellyou what to do. Stop the cassette at these times and do what he has told you. If at first you do not obtainthe 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 completedthe first cassette go on to the next one - No 2 to No 3 and so on. The complete volume numbered 1-8 is a carefu!ly designed and integrated system. Successful completion of one cassette will take you on to the nextone andwill impartthe necessary knowledge for you to operate competently one of the most modern scanning electron microscopes available today.

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**WHO SHOULD USE THIS COURSE**

All persons who intend to operate this scanning electron microscope,whether supeNised or not, who meet your establishments 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 printedherefrom page 4 to 30 is as spoken byyour Mor onthevideo presentation. It is not anexample of written technical English. Read it; certainly be very familiar with it; use it to helpyour understanding of what effect you,with your tutor can achieve. Please read carefully Module 7 Parts l and 2 with particular referenceto Cassette 8and Module 8. All microscopes manufactured during late 1984 have a modified filament assembly requiring a different method of reassemb!y, after removal and cleaning.

**S200 OPERATOR TRAINING VIDEO MODULE NO 1**

**SWITCHING ONTHE MICROSCOPE AND GETIING A WORKING VACUUM**

**INTRODUCTION**

Welcome to the Stereoscan 200 Operator Training Course. Inthis training module we are goingto 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 andvalves don'tworry;the instructions given inthe Operator's Manual will add to what you will learn in this training module.

While you are watchingthis training video, you might liketo follow the corresponding operating routine shown in the flow diagrams. If this is the case,stop the tape in a few moments and then tum to Chapter lin 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 FlRSTSTEP istoturn onthe external power tothe 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 examiningthe push switch which is located onthe 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 sothis should now be illuminated and power will be distributed to the microsope's electronic systems.

THE NEXTSTEP is to get ready to openthe specimen stage door inorder to load the specimen.To dothis 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.

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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 invacuum level but as the system approaches it's ultimate vacuum.the improvement will be very slow.

Usually a working vacuum level is reached inabout 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 onthe 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.

**5200 OPERATOR TRAINING VIDEO MODULE NO 2 OBTAINING A PICTURE**

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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 LaB6 emitter. Ifyour system is fitted with an LaB6 emitter don'tworry, the instructions given in the Operator's manual will add to what youwill learn inthis 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 lof 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.

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**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' onthe controls duringvacuum 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 shouldthen 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 onthe display screen.

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

NEXTcarefully setthe FILAMENTcontrol 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 land watch the first part of the column maintenance procedure whichwill show you howto changethe 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 controlfully anticlockwise,and resetthe beam by pressingthe BEAM push switch once and then again. If the condition persists itcould bethat the low kVanode 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 knownasthe **first** peak andthe **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.

Increasingthe filament current gives you the second peakwhich looks like this andcorresponds 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,allyou will do is dramatically reduce the filament lifetime.

Next reduce the RESOLUTION controlto 3. Now,if necessary, reduce the AUTO LEVEL control to produce a circular imagewith noflare. Usingthe Y and X **SHIFT** GUN ALIGNMENT controls, position the brightest partof thefilament emission image inthe 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.

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

Now usethe FOCUS COARSE and MEDIUMcontrols to obtain a sharp image.

Then,usingthe 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 atvery 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 roughguide,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 sowillyou 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.

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SYNOPSIS

You have now seen how to obtain an image onthe Stereoscan 200 display screen which has involved both completing asystematic '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 atits 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 likethe Stereoscan 200.

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

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

## soo OPRATOR TRAINING

**V DrEO MODULE NO 3**

**iAK NG A MICROGRAPH**

INTRODUCTION

In this training module we are going to see how to take a micrograph usingthe 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. Shouldthis 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 correspondingoperatingroutine shown inthe flow diagrams. If this is the case stop the tape in a few moments and then turn to Chapter lof the Operator's Manual. Remember if at the end of the video you do not fully understand what you have justseen and heard,play thetapethrough again­ perhaps several times -untilyou feel confidentthat 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 needto put into practice what you have learned in video module No.2 which dealt with howto obtain an image.

One goodtipis to optimisethe 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 atvisualscan speed 3. Inthis video we are dealing with a relatively noisefree 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 onthe right hand side of the data zone, are as required.This data is entered via the DATA ENTRY key pad. Extra information can beaddedto the micrograph by means of theTEXT 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 inwhite,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 onthe display screen represent 0% video signalandthe upper represent 100% video signal.

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

It is a good idea atthis pointto 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 instantfilm check thatthe 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 AUT<? LEVEL and CONTRAST whilst in the GRAPH mode. 1f the data zone is notexposed correctly then check the camera aperture,type of film and recordtube 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.

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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 inthe GRAPH mode. We dothis to set upthe photographic exposure for the micrograph. At first you will probably have some difficulty ingetting a satisfactory exposure. Don't worry because it does take quite a lot of practice - especially with 'instanr film. Usually negative films have considerably more exposure

!attitude 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.

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**5200 OPE ATOR TRAINING VIDEO MODULE NO 4 CHANGING THE SPEC;MEN**

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 Manualwilladdto 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 l 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 l.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 turnthe FILAMENT control fully anticlockwise to minimum and switch the BEAM to "OFF".

The NEXTSTEP is to get readyto 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 pressthe CHAMBER VACUUM pushswitch. The system will reach atmospheric pressure after about 40 seconds. NOW open the stage door carefully, adjustingthe 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 helpto avoid contamination which,in extreme cases, can seriously degrade the overall performance of the system.

Nowthatthe door is open,we will take aclose 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 itbackwards or forwards. The Z control moves the specimen holder upor down. The TILT control changes the anglethat 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.

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Now we will examine some of the other important aspects of this 1ype of specimen stage. It is supplied with a kit containing tools,a Z spacer plate and a varie1y 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 avery large specimen you mayfind thatitwill touch the microscope's final lens and cause damage. Inthese 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 haveto fit either the thick, or the thick and thin spacers to ensure that a shortworking 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 1ypically mounted on stubs by means of conductive adhesive which must be allowed to dry fully before putting into the specimen chamber. Loading this 1ype of specimen holder is quite a simple matter.

Pick up the mounted specimen using the special tool. Insertthe 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. NOWcheck the cleanliness ofthe seal and the sealing face of the chamber. Sometimes dust or small fibres may be present whicharefrequently the cause of vacuum leaks. Clean if necessary by means of a standard dusting aerosol. On no accountmustthe aerosol bedirectedtowards any of the precision components inside the specimen chamber.

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Carefully closethe specimenstage 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 aworkingvacuum levelis reachedinabout two to three minutes but if the specimen has a tendency to outgas or the microscope isoperated 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 afterthe 30 secondwarm-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 andthe specimentouch 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. Hereare afew points that you should remember:

Read the Operator's Manual and study the correspondingoperating routine shown inthe 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 hastouched 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 inthe long run.

Finally playthis tapethrough again ifyou don't feel confident in the procedure.

**5200 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 butTotal 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 bcause on the basic instrumentthis will bringthe entire system up to atmospheric pressure. In adverse .oprating conditions this could leadto column ox1dat1on, which could in severe cases seriously degrade the microscope's performance.

Whenever the system is vented,the risk of oxidation should beminimised by backfillingwith a dry inert gas such as nitrogen.

If the instrument has to be left routinely inthe completely switched off state for long priods, ay 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 withthe optional isolationvalvejust 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 give in

the Operator's Manual will add to what you will learn inthis programme.

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

Remember,if atthe endof 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 '.he microscope is in a fully operational state each time.

To begin, let us look at the Partial WJitch-off routine. You would use this if you wanted to switch the microscope off for a short periodof, say. one ortwo 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 thatthe tuedoes not get burnt by taking the necessary action promptly.

Nextturn the FILAMENT control fully anticlockwiseto minimum and then switch *off* the electron beam by pressing the BEAM push switch.This completes the Partialswitch-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,atthe end of the day or when you do not want to use the microscope for several days.

First switch to HOLDby 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 istoo bright ensurethat thetubedoes not get burnt by taking the necessary action promptly.

Nextturn the FILAMENTcontrol fully anticlockwiseto minimum and then switch *off* the electron beam by pressing the BEAM push switch. · .

Finally liftthe 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 itwill bevented fullyor partially, depending on its configuration.

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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 possibleto avoid column oxidation,even duringextended periods when the microscope is not in use,or during major seNicing of the vacuum system. You shouldtherefore only use this routine if it is absolutely necessary.

Firstswitch to HOLD by pressing the pushswitch;this will disable the AUTO SIGNAL LEVEL system. Then check that the visual display brightness is nottoo high.

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

Nextturn 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 onthe dry nitrogen gas for the backfilling system and check that the pressure is correct.

Next, switch off the main power by pressingthe red "OFF" switch located atthe top left handside of the console. Having done so the green "ON" switch underneath it shouldno 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 bevented 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:

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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 checkingthat it isfully anticlockwise before switching the BEAM on or *off.* This is

particularly important if the optional LaB6 emitter is fitted because this is more sensitive to thermal shock.

Partial switch-off is for short periods of upto 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 whenthe 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.

# 5200 OPERATOR TRAINING VIDEO MODULE NO *6* ADVANCED OPERATION

**THE TECHNIQUE OF HIGH RESOLUTION MICROSCOPY**

**INTRODUCTION**

Training Module No 6 is anadvanced 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 befamiliarwiththe positionandfunction of all the controls on the operating console.

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

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 thisvideo. If youhave not read Chapter 5 yet you shouldstopthetape 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 inour factory to monitor instrument performance. Itmust beemphasised 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 withinthe 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 vottage - probably 30KV which is the maximum on the Stereoscan 200.

The reason behind the choice of a high accelerationvoltage will beexplained.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 vottages - for example 2 or 3KV Delicate specimens should be examined with a so called "low dosageM electron beam.This means avery low accelerationvottage 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 bestsolution. is to use a combination of the Lanthanum Hexaboride (LaBa) emitter and the Cambridge Instruments Image Store. The store can- produce very high quality noise tree pictures from beam and charge sensitive specimens examined under 'low dosage' electron beam conditions. ·

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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, Iam 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.

Onefinal word of warning. Do notattemptto try out anything in this advanced operator trainingvideo until you are fully familiar with the basic training package. This means that you shouldhave 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 consoleto 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.

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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 LaB6 system. Check for contamination on the anode and on the gridcap because this could lead to persistent beamtripping -as explained inmodule number 2. Check that the filament is central and that its height adjustment is correct. More information onthis will befound 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' ringvacuum seal and gently close the gun,keeping your fingers well clear for safety reasons.

Stillwearing gloves, the **second** step is to open the door carefully and configure the specimen stage for high resolution microscopy. For best results, our high resolutiontest specimenshouldbeexamined 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 regardingthe 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 withinthe specimen chamber as a result of usingthe very short working distance.

Fastenthe clamp and pumpoutthe 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 io-s Torr before we switch on the electron beam and obtain a picture

While we arewaiting for a really goodvacuum,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 beenchosen for the upper limit of acceleration voltage on the Stereoscan 200.

There are several reasonsfor choosing 30KVforthis 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 signalto 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 LaB6 emitter has adistinct advantage over the tungsten inthat 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.*N* low acceleration voltages chromatic aberration dominates and causes a significant increase inthe 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 betoo high otherwise **loss** of resolution or image quality will occur for the following reasons:

*N* highvoltages the electron beam penetrates the specimen surface to a greater depth andthis 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 havejust spoken about.

Now lets 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 anadverse effect bycausingenlargement of the electron beam diameter an'd a consequent reduction in system resolution. This aberration is particularly dependent on working distance.The loss of system resolutionas afunction 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 OFTHIS. Its 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 assuredthat through computer optimised design and up to date manufacturing technique,the lenses inyour Stereoscan 200 areof the best design,material and construction that existing technology will allow.

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Unfortunately time will notallow usto discuss further the characteristics of electron optical systems. If youwould like more information please study the references given in Chapter 5 of the Operator's Manual.

Having discussed the choice of acceleration voltage andworking distance let us nowcheck the vacuum level - it looks ideal for high resolution work.

Nowthat 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:

1. Select 30 KV acceleration voltage.
2. OPTIBEAM normal. Because we will be using a combination of **high** acceleration voltage and a **short** workingdistance, this is the correctsetting for OPTIBEAM by definition.
3. 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.

Firstturn onthe electron beam and inthe emission image mode adjustthe filament currentfinely 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 usingthe normal routine, adjustingthe 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.

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The **sixth** step is to set the required working distance. First set the working distance readout. shown atthetop of the screen inthe data zone.to 5mm.This is done by means of the medium focus control. By so doing we are making the focusing lens focus atthe specific workingdistance of 5mm. Next, using the specimen stage Z control gently raise or lower the specimen to meetfocus. Focus is metwhen the picture onthe screen is sharp. When focus is achieved in this manner,we can be sure thatthe specimen is at 5mm workingdistance. 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 oneof 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 andwith a 50 microns aperture at 16mm nominally. Select a 20 microns aperture which you know to be clean and ingood condition.Dothis byturning the Y micrometer to the reading on the scale at which you know the required 20 microns aperture will be selected **and** inthe 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 adjustfocus, it is highly probablethat youwill 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 thatthe 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 itas best you can.Now switch onthefocus wobble facility (only useable in *N* 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.Inthis case it is predominantly inthe Y directiononthe screen. This means that the Y micrometer on the aperture changer is out of adjustment.Carefullyadjust the Y micrometer until the Y component of the swing is eliminated. Now we are leftwith a small amount of X swing,so a small adjustmenttothe 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 RESOLUTIONcontrol 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 pressingthe button in.

Whilst obseNing the signal meter,very carefully adjust the filament current control over a small range,stop adjusting whenthe signal onthe 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 notto pass more currentthrough 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 obseNing the filament emission.

Switch the emission image off and then switch to HOLD by pressing the button in again.Whilst obseNingthe signal meter,verycarefully adjust the gun alignmentTILT 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 alignmentTILT 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-alignthe final aperture as before usingthe focus wobble facility.With each increase of the RESOLUTION control settingthe picture gets correspondingly more noisy or 'snowy'.Switch to scanning mode 'VIS l " or 'VIS 2" because this will helpto 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 inthe 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 highenough 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 ex[:Derience. 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 *N* and use the focus wobble facility to check the aperture alignment as before. Then press the HOLD button and whilst obseNing the signal meter,very carefully optimise the gun alignmentTILT 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 hadto 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 inthe picture.

First by means of the IMAGE SHIFT controls, find a region of the specimen which has b\_oth good contrast and clear structure in all directions.

Positionthis regioncentrally on the screen and focus it.

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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 inthe 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. Firstfocus the picture the bestyou 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 stillfurther. It is usual to go aroundthis 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 usingthe 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 andthen 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.

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The **twelfth** stef-' 1;, 1v ''-'"'-- .. . ...

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. Getthe 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.Itwould appear fromthe result that all our hard work has been well

worthwhile.

**SYNOPSIS**

You have now seen a systematic approach to getting the bestperformance 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 boththe 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.

1. 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 usingthe focus wobble facility.

c. astigmatism correction.

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

1. An operating regime that gives the best prformance on one specimen will not necessarily give the best performance on another specimen. You must be prepared to experiment on your own specimens to establishthe best microscope conditions to use.You should spend time optimising all major parameters such as accelerationvoltage,working distance,specimen tilt angle and the resolution controlsetting.
2. 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 Y?u have .to examine beam and charge sens1t1ve specimens do so with a 'low dosage' electron beam and for best results use a combination of the La86 emitter and the Image Store facility.

1. 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 ableto communicatewith people doing similar work and learn about their techniques.
2. Operation under high resolution conditions or on difficult specimens requires patience,skill and experience - even with a high performance

· tote-of-the-arr 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!**

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**500 OIP RATOR TRAINING**

**V DIEO MODULE NO 7 PART 1 BASYC ROUTINE MAINTENANC:C**

**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 mainareas;these arethe vacuum system and the electron optical column.

Please be aware that there is advanced routine maintenance which is beyond the scope of this video butis 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 examinethe tools and equipment needed to carry out basic routine maintenance covered inthis programme efficiently and effectively.

Secondly, we will discuss some ofthe 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.

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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 andturnto page 79 which shows a diagram of the column. Keepthis ready, you will need ita 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 inan efficient and effective manner.

The first itemsthat we have here onthetable are a set oftools which are suppliedasstandardwiththe 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 squareof lOmm plateglass with polished edges,a selection of wooden cocktailsticks 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 andfibrefree tissues for cleaning and polishingvarious 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 bottte.

You must acquire a suitable ultrasonic cleaning tank. This one has a capacity of 2112 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 Petridishes are extremely usefulfor 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.

Havingtaken 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 ':A.rklone" 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:

l.When loading and unloading the ultrasonic cleaning tank, ensure that it is switched off - physicalcontact withthe highfrequency vibrations is saidto be harmful.

1. Openand close the electron gun slowly and carefully to avoid trapping and damaging your fingers.
2. 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 thatthe rotary pump exhaust is routed either to a purpose designed extraction system or to a compatible oil mist filter.

Now lets discuss a number of key points to remember when undertaking routine maintenance.

l. Column cleaning must be done in an atmosphere which is dry and as free of dust as practicably possible. The operator should notwear clothes whichare dust generating such as woollen garments.

1. All freshly cleaned components must be kept covered to protect them from dust. Do not use commercial compressed airfor dusting because it usually contains oilvapour which will cause severe contamination. Use a purpose made aerosol or suitably filtered nitrogen gas.
2. Keep the cleaning solvent well away from the highly absorbent surface of the electron gun ceramic.
3. 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
4. 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.
5. Components with 'O' ring grooves and mating surfaces have to be ultrasonically cleaned very carefully to avoid damage. Place these components inthe bath insuch away that there is no risk of anything whatsoever making contact with either the 'O' ring grooves or the mating surfaces.
6. Do notwet 'O' ringswith solvent as this damages them. If necessary, you can wipe them carefully with a lint free tissue.
7. Keep anything magnetic well away from any part of the microscope in case accidental magnetising takes place with disastrous effects.
8. Wherever possible, keep the microscope under vacuum,this will helpto maintain a good vacuum environment and keep the column cleaner.

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Iknow this seems to beasubstantiallist. but please remember that most hazards can be completely avoided by reasonablecare 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 beginwith, we will examine the AIR ADMITIANCE DRIER ASSEMBLY which is mounted on the rear panel of the plinth.Ifthis unit is allowedto 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 withwater,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 andthorough 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 ADMITIANCE 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 fitter 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 lOOml 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 intoone hole then drip20 ml intothe other hole. Use only the correct specified oil which can besupplied by Cambridge Instruments. 20 mlof oil will now drip slowly from both drainage holes.

Leave the pump in this position for at least 30 minutes to makesurethat all 20 mlof 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 inthe 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 canfoulthe exposed fan.

This procedure should be undertaken *every* six months. The operator should not attempt to change the bearings onthistype 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.

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Now we will leave routine maintenance of the vacuum system and move on to column maintenance; but before we get down to the practicalwork, letme 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 ifthe 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 mindthat 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 thars 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 bya Cambridge Instruments approved service engineer so we will not consider it further.

Nowusingthe pieceof paper,please get ready to write down which items are serviced at each level.

First, the PARTIA L 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 f ilament 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, thiswould 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, eventhe FULL level may not restorethe 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 practicalwork and start with the PART IAL 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 forthe modified holder are demonstrated in video supplement number 1.

First bring the chamber and the column upto atmosphric 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 standingon a platformto gain extra height, liftoutthe anode which fits onthe top ofthe 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.fil.ament 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 skinand 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, polishthe holes,thetaper 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 removethe 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 riskof water droplets forming on the surface of the components since the Arklone evaporates so rapidly that condensation can form. Inspectthe components under the microscope. In particular checkingthatthe three height setting screws inthe 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 arewell alignedwith the slot inthe base of the filament holder.This is very importantandwill avoid the risk of short circuiting the pins.

Now invert the tooland 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 alignmentscrews 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 inthe grid cap. Whilst doing this,occasionally rotate the grid cap because this improves the accuracy.

Whenthe filament is central, the four screws should begently tightened.Do notovertighten the screws because there is a real danger that you might crack or fracture the ceramic base of the filament itself.

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The filament r,c. "" \_

behind the front face of the gnd cap. Ihis roo 1s a difficult adjustment and again takes practice. The use of a microscope and the specialjig 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 becausethis improves the accuracy. When accurate alignment has been achieved, finally tighten the filament holder clamp screws. Finish off by checking thatthe filament is stillcentral.

Then, wrap it in thin polythene membrane if you wish to and place it inthe 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 wecometothe end of part 1 of this module. In part 2 we will move on to the INTERMEDIATE level.

**5200 OPIE A OR TRAINING VIDO MODUL[E NO 7 PART 2 BAs;c 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 puta dish inposition ready to catch the small parts as they are removed.

Using the correct size screw driver and a great dealof care remove the three screws retainingthe 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 cocktailstick. You must pushthetop surface of the aperture well away from the hole as the apertures are made of platinum which is soft and damages very easily.

Cleanthe holes inthe clamp platefrom 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 laidon 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 sing diamond paste followed by thorough rinsing 1n 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 usingthe plastic tweezers. • '-

Please notethat one side of the apertures isfunnel 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 becausethey 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,dustthe top side of theunitand insert it smoothly into the column whilst keeping it level.

Tighten the 4 screws progressively andfinally 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 upto atmospheric pressure,as always dry nitrogen back filling is recommended. Then, open the gun and ren:ove the anode. First we are going to remove item number 4, the gun alignment coils assembly. Start by removing the Mu-metal shield wh.ich 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 provi ed, gently pull the assembly upwards keeping everything vertical. Gently pull until the

?ssmbly is obviouslyfree butthenstop because it 1s wired to the electronics console via a cable with a plug and socket which must not be stretched.

Te cabl.e enters the column through a port hole situated Just above the trim band. Locate the cale and feed it into the column 'v'.(hilst 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.Putthis in a container to protectitfrom dust.

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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 upthe anticontaminator assembly. Using an extended hexagonal socket driver.undo fully the three screws clamping the assembly.

Now liftthe assembly out completely usingthe 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

1. 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 lmicon diamond paste and a piece of specially shaped balsa wood. Clean the flat surfaces using l micron diamond paste and a filter paper laid onthe glass slab. Thoroughly rinse the plate in 'Arklone" and then ultrasonically clean it in 'Arklone" for about 5 minutes.

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

Cleanthe boreof the gun alignment coilassembly using lmicron 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 insolventfor 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' ringshould be lubricated withthe 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.

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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 lmicron diamond paste and a piece of specially shaped balsa wood.

Clean the flat surfaces using lmicron diamond paste and a filter paper laid on the glass slab. Thoroughly rinse the plate in solvent and then ultrasonically clean it in solventfor about 5 minutes. Clean the bore of the inner part using l 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 lmicron diamond paste using cocktail sticks. Clean the flat surfaces using l 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 lmicron 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 severcil 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 inspectthem 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 thatthe collar fits at the **top** of the inner tube which is the end with pumping holes around the circumference. Now place the assembly inthe 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 itunder the microscope and dust if off before you put it back into the column.When puttingthe items back, be patient and don't use any force. The column diagram in the Operator's Manual will *seNe* as a useful guide to where the various assemblies fit.

Start by opening the gun. The first item to fit is the innertube assembly. Using both hands andthetool provided,insert the assembly inthe column.Check that it is in position by obseNing 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 trie tool provided lower the assembly into the column and rotate it until thethree 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 betroublesome 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 columnthen re-connect the cable. Now check the position of the 'O' ringagain.Then using the tool provided continue to lower keepingthe assemblyvertical as you do so.The lower most part of the assembly, towhich an 'O' ring isfitted,hasto

fit into the bore of the anticontaminator outer. As this partof the gun alignment coils assembly enters the bore some resistance will befelt. 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.faJthis point, one goodtip isto removethe final aperture changer,dust it off andthen 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.

Inthis 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 andfaults will be reported along a recognised channel of communication. Please keep a log book on all types of maintenance and seNice work because this provides a case history which isvery usefulfor our seNice 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, playthis tapethrough againif you don't feel confident about this procedure.

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**soo OP!ERATOR TRAI NING 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 inthe 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 l micron grade diamond paste,using a filter paper on the plate glass,and clean the aperture with a cocktailstick. 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 refitthe retainingcirclip.The useof asmall 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 sothat 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 inthe filament holder. Do not overtighten the screws asthere is a realdanger of crackingthe ceramic base of the filament.

Holdthe entire filament assembly bythe 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 springwasher. Continue to screw inthe collar until the tip of the filament is level with the back surface of the grid aperture.

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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 difficultoperation andtakes practice.Theobject 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. Whenthe filament is central, thefour screws should betightenedgently, 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.

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Operator Training Stereoscan 90B Stereoscan 100

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EBMF 6.5

EBMF 10.5

Cl35l Cl358

Autox

BCG365 PGR 3000 MRlOO MR190 MR200

**List of Service Centres**

Scanning Electron Microscopes Scanning Electron Microscopes Scanning Electron Microscopes Scanning Electron Microscopes

EDX-Ray Microanalysis WD X-Ray Microanalysis ImageAnalyser

ImageAnalyser ImageAnalyser ImageAnalyser

Semiconductor Pattern Inspection

Electron Beam Microfabricator Electron Beam Microfabricator Crystal Growth System Crystal Growth System Crystal Growth System Crystal Growth System

Polycrystalline Synthesis Epitaxial Reactor Epitaxial Reactor Epitaxial Reactor

**stereoscan 90B/100 Scanning Electron Microscopes**

**stereoscan 200 Scanning Elecfron 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 lof this manual.

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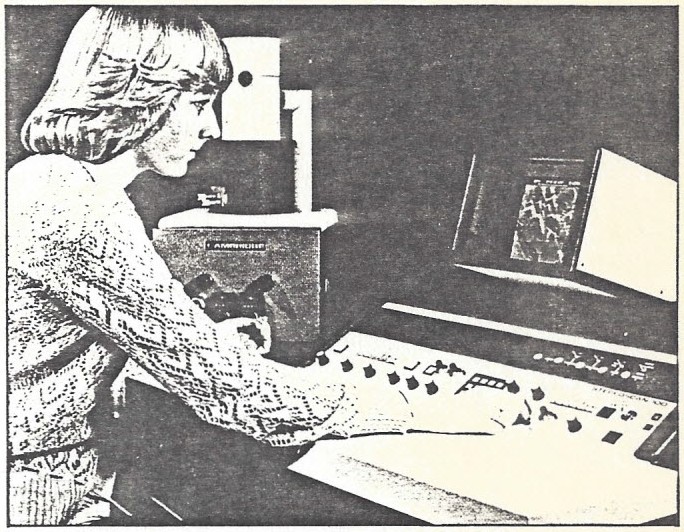
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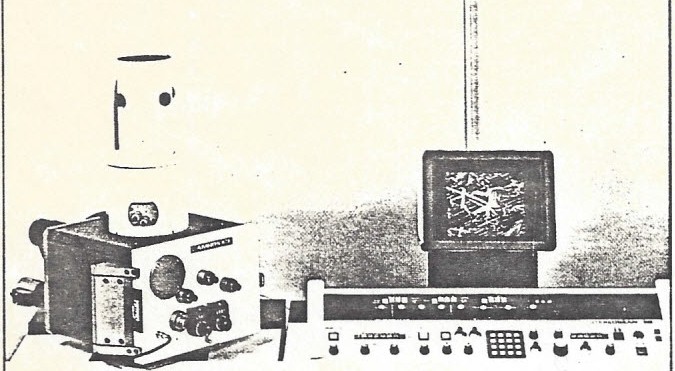
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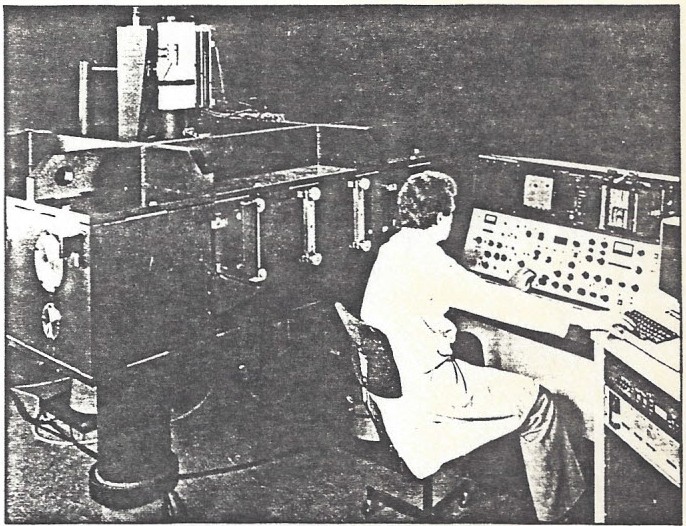


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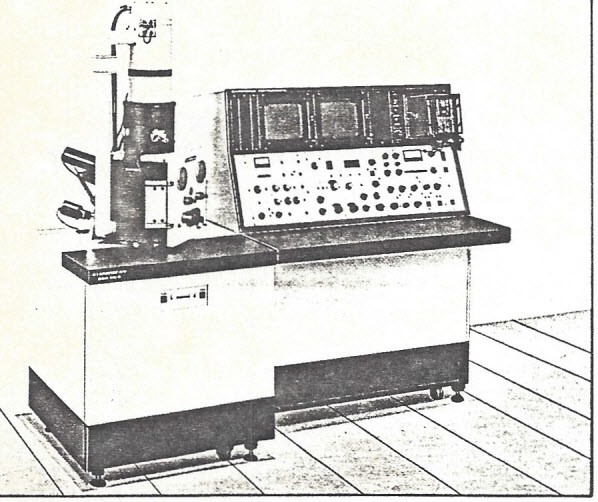
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