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Daily Maintenance and Common Troubleshooting of Cold Field Emission Scanning Electron Microscopy

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Abstract: Scanning electron microscopy (SEM) is a large-scale precision equipment for observing and analyzing the surface morphology of materials. With the rapid development of technology, the application of scanning electron microscopy in scientific research, teaching, and laboratories is becoming increasingly widespread. This article provides a detailed introduction to the key operating procedures for daily maintenance of the JSM-6701F cold field emission scanning electron microscope through an example, and proposes corresponding handling measures for several common faults that occur during its use and maintenance.

Keywords: Scanning Electron Microscopy; Daily Maintenance; Troubleshooting

Introduction

With the rapid development of electron microscopes, scanning electron microscopes have been widely used in natural science research due to their advantages such as high resolution, three-dimensional image, and continuously adjustable magnification, greatly promoting the development of technology. In the process of using scanning electron microscopy, it is very important to carry out daily maintenance correctly, analyze and handle scanning electron microscopy faults correctly. Cold field scanning electron microscopy is a type of electron gun that utilizes cold field emission to generate a low-frequency electron beam with uniform energy, good monochromaticity, high brightness, high resolution, and low thermal effect. It is suitable for high-resolution observation of samples with high thermal sensitivity. This article provides a detailed description of the routine maintenance points for the JSM-6701F cold field emission scanning electron microscope, and proposes solutions to several common faults that occur during its use and maintenance.

1. Daily Maintenance of Scanning Electron Microscopy

1.1 Maintenance of Good Hygiene of the Electron Microscope and Electron Microscope Room

JSM-6701F is a new type of field emission scanning electron microscope (FESEM) that uses cold cathode to emit electron beam, ultra-high vacuum and high-precision digital imaging, working requirements of which are dry, constant temperature (about 20℃) and dust-free conditions. Therefore, equipment management personnel should strengthen the hygiene management of the electron microscope room.

1.2 Maintenance of Vacuum State of Electron Microscope

The JSM-6701F scanning electron microscope needs to be operated under high vacuum conditions of 10-4-10-5 pa. The main purpose is to prevent air from entering the interior of the electron gun, lens barrel, sample chamber, etc., and to avoid oxidative damage to the electron lens filament and various sensors. If not used for a long time, it is necessary to vacuum every 3-5 days.

1.3 Regular Examination, Timely Addition and Replacement of Oil Level of Mechanical Pump

Before conducting scanning electron microscopy operations, the oil level of the mechanical pump should be first observed to confirm that it is at a safe level on the scale line. When the oil level is below the safety line, the oil of the mechanical pump needs to be immediately topped up. If a brown color is observed in the oil, the pump oil needs to be replaced immediately. Before changing the oil product, the machine must be shut down and opened for 2-3 minutes to cause vibration of the old oil product inside the machine. Then, the machine must be shut down to discharge the old oil product and replace it with a new one.

1.4 Regular Inspection of Circulating Water Condition

It is necessary to regularly check the condition of the circulating water. When the water level drops below the warning value, water should be added immediately. If turbidity or impurities are found in the circulating water, it should be replaced immediately to prevent the circulating water from flowing normally and affecting the cooling effect. The grid sheath outside the circulating water constant temperature box should be frequently removed for cleaning and dust removal to avoid blockage and affecting the heat dissipation of the compressor.

1.5 Regular Activation of Infrequent Functions

To avoid the aging of electronic components, it is necessary to frequently open less commonly used functions such as electronic images and component analysis. If it has not been used for a long time, the part of the probe exposed to the outside of the sample needs to be wiped clean with a lint-free tissue dipped in alcohol, and then coated with a small amount of vacuum oil to ensure lubrication.

2. Troubleshooting Common Faults in Scanning Electron Microscopy

Scanning electron microscopy is a large and valuable instrument, and both the management and operation personnel of the instrument need to have a high sense of responsibility and high skills. Therefore, the correct use and maintenance of the instrument is crucial. However, an electron microscope is composed of multiple systems, and its structure is very complex. There are not only a small number of mechanical components, but also a large number of electrical components. Long-term use can cause pollution or aging damage to these components, leading to instrument failure.

When an electron microscope malfunctions, the main part or cause of the malfunction should be analyzed first, followed by layer by layer inspection to minimize the scope of the malfunction and ultimately identify the cause or specific component of the malfunction, in order to solve the problem. This article introduces some problems that arise during the use of Japanese electronics company JSM-6701F scanning electron microscopy, and provides solutions.

2.1 Fault 1

Failure phenomenon: After replacing the scanning electron microscope with a new sample, the vacuum degree of the instrument is very slow and can not reach 4.41E10-4Pa.

Reasons for failure: The placed sample is wet; the injection rod is contaminated; there is a slight gas leakage in the sample exchange room.

Solution: The sample is removed and heated with infrared light for 5-10 minutes. In the absence of a sample, the evacuation rate is observed. If the vacuum pumping rate is still very slow at this time, it is very likely that the injection rod has been contaminated. At this point, a lint free paper can be dipped in a little alcohol to wipe, and then vacuum grease can be evenly applied to the injection rod.

2.2 Fault 2

Failure phenomenon: After an unexpected power outage and shutdown, the machine cannot restart.

Reasons for failure: After analysis, the reasons for unsuccessful startup are usually fuse burning, insufficient nitrogen cylinder pressure, and cooling water shutdown.

Solution: First, a multimeter is used to check the fuse on the back of the main control board, and everything is normal. Second, the outlet pressure of the nitrogen cylinder should be tested to reach 0.6MPa within the normal range. Afterwards, whether the water temperature of the water-cooled unit is at 20°C and whether it is working properly should be checked. By checking the cooling water inlet and outlet at the host end, it is found that the scale on the water pressure indicator is changed. It is suspected that after cutting off the power supply, the equipment works for too long, resulting in valve failure. An instrument is used to adjust the pressure nut on the top of the imported water pressure valve to reach the required value for the electron microscope, and the electron microscope can start normally.

2.3 Fault 3

Failure phenomenon: The vacuum degree of PVG in the electron microscope sampling room suddenly drops to 0Pa, and the mechanical pump stops running.

Reasons for failure: It may be due to the porous structure of the sample, which suddenly deflates under the action of high-energy electron beams, causing a sudden increase in air pressure in the sample chamber, or the failure of the diffusion pump due to the damage of the heating component of the diffusion pump.

Solution: The high-pressure HT and sample room doors are closed, waiting for the PVG to drop to the rated pressure. The pressure is increased again, and the machine is observed and shut down again. Alternatively, the control board under the sample

injection rod of the instrument can be opened, and the diffusion pump heating plate is located. Then a multimeter is used to test. If the heating plate is found to be damaged, it is replaced with a new heating plate, restarting, and the mechanical pump returns to normal.

2.4 Fault 4

Failure phenomenon: Images can not be seen.

Reasons for failure: It may be due to a change in the distance between the test sample and the measuring head due to the replacement of a new one. Alternatively, due to improper operation during the use of the electron microscope, the aperture of the movable objective lens has undergone severe deviation, preventing the electronic light source from shining on the surface of the sample. It is also possible that the energy spectrum or EBSD occupies the signal receiving channel.

Solution: First, the menu "ACB" that automatically adjusts brightness and contrast is clicked with the mouse. The X-axis and Y-axis apertures are manually adjusted to the overall center position, and then the position of the aperture is selected to the maximum hole until the sample can be seen. When neither of the above methods can solve the problem, the electron gun needs to be checked. If there is no current value, it indicates that the power integrated electronic circuit board that controls the operation of the electron gun has malfunctioned. At this point, a multimeter combined with the electrical circuit diagram is used to inspect the suspected components and replace the damaged silicon rectifier, so that the problem can be resolved. Alternatively, the energy spectrum and EBSD software or the computer connected to them can be turned off, waiting for the image to appear and then opening other attachments.

2.5 Fault 5

Failure phenomenon: At the end of the sample test, the lower end of the injection rod cannot clamp the sample and extract the sample. After multiple consecutive attempts, the phenomenon of the injection rod not reaching the bottom end occurs.

Reasons for failure: The sample stage is contaminated or the super spring is aged.

Solution: The sample table is removed and wiped with lint free paper dipped in a little alcohol. Then the sample table is vacuumed and the problems are troubleshooted. If the sample table still cannot be taken out, the super spring needs to be replaced.

3. Conclusions

Scanning electron microscopy has a complex structure, high precision, and high cost. Therefore, not only does it require strict and correct instrument operation by relevant personnel, but also careful daily maintenance of the instrument to ensure its normal operation. In the daily use and maintenance of scanning electron microscopes, if there are some problems, maintenance personnel should be able to quickly analyze the cause of the problem and provide corresponding solutions. They should also maintain good contact with professional maintenance personnel from the manufacturer to avoid irreparable damage to the instrument. Strengthening the daily maintenance of scanning electron microscopes and timely and accurate troubleshooting is an important factor in improving their service life and reducing maintenance costs.

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