

ELECTRON MICROSCOPE

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the priority to the Chinese Patent Application No. 202122127340.9, filed on September 03, 2021, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure belongs to the technical field of microscopes, and in particular relates to an electron microscope.

BACKGROUND

[0003] In the related art, an electron microscope is a commonly used microscopic analysis instrument. Usually, an electron beam is converged onto a sample to be detected through an objective lens of the electron microscope to generate a micro beam spot. In this micro area, the electron beam acts on the sample to be detected to generate signal electrons, such as Secondary Electrons (SE) and Backscattered Electrons (BSE), so that the morphology of the surface of the sample to be detected may be observed and the material composition of the sample to be detected may be analyzed through a detector.

[0004] With the continuous development of science and technology, the electron microscope is also continuously improved. In order to simplify the structure and optimize the operating system, sample tables of some existing electron microscopes adopt a ground mode, that is, the voltage value of the sample table is zero. In this way, the sample to be detected is not charged, so that the voltage value of the sample to be detected is zero. The signal electrons generated by the electron beam acting on the sample to be detected are received by a photodetector.

[0005] However, although the electron microscope with the abovementioned structure

can observe an uncharged sample to be detected, the imaging speed of such an electron microscope is relatively low. It can be seen that it is urgent to solve the problem of the imaging speed of the electron microscope when the sample to be detected is not charged.

[0006] In view of this, the present disclosure is particularly proposed.

SUMMARY

[0007] The technical problem to be solved by the present disclosure is to provide an electron microscope to overcome the deficiencies in the related art. A high-voltage detection unit operates at a preset level, so that the speed of signal electrons can be increased, and the energy of the signal electrons can be improved. Thus, more high-energy signal electrons are received by the high-voltage detection unit, so that the imaging speed and the imaging quality of the electron microscope can be improved.

[0008] In order to solve the abovementioned technical problems, the basic concept of the technical solution adopted by the present disclosure is as follows.

[0009] An electron microscope, which includes:

[0010] a sample table configured to place a sample to be detected;

[0011] an electron optical column configured to emit an electron beam, and converge the electron beam onto the sample to be detected;

[0012] a high-voltage detection unit configured to receive signal electrons generated by the electron beam acting on the sample to be detected, and output a voltage signal, and

[0013] a high-voltage power supply unit electrically connected to the high-voltage detection unit, and configured to control the high-voltage detection unit to reach a preset level.

[0014] Further, the high-voltage detection unit includes a semiconductor detector, a preamplifier and an optical fiber emitter sequentially connected to each other through electrical signals.

[0015] The electron microscope further includes a high-voltage power transmission bracket and a driving power supply module which are electrically connected to the high-voltage power supply unit.

[0016] Each of the semiconductor detector, the preamplifier, the optical fiber emitter, and the driving power supply module is electrically connected to the high-voltage power

transmission bracket.

[0017] Further, the electron microscope further includes:

[0018] a low-voltage power supply unit electrically connected to the driving power supply module, in which the driving power supply module is electrically connected to the optical fiber emitter, the driving power supply module is electrically connected to the preamplifier, and the preamplifier is electrically connected to the semiconductor detector.

[0019] Further, the high-voltage power transmission bracket is a rectangular frame with cross beams. The preamplifier is connected to an upper surface of the rectangular frame through conductive screws. The optical fiber emitter is connected to the upper surface of the rectangular frame through conductive screws. The driving power supply module includes a high-voltage unit and a low-voltage unit. The high-voltage unit is connected to a lower surface of the rectangular frame by mating conductive screws with conductive pillars with threaded holes. The low-voltage unit is connected to the lower surface of the rectangular frame through insulating pillars.

[0020] Further, the high-voltage detection unit further includes a support frame. The support frame is connected to the upper surface of the rectangular frame through conductive screws. The semiconductor detector is connected to the support frame through conductive screws.

[0021] In some optional embodiments, the high-voltage detection unit further includes an insulating bottom plate. One end of the insulating bottom plate is connected to the lower surface of the rectangular frame through insulating pillars, and the other end of the insulating bottom plate is connected to a lower surface of the driving power supply module through insulating pillars.

[0022] Further, the high-voltage detection unit further includes a first shielding box. The semiconductor detector, the preamplifier, the optical fiber emitter, the driving power supply module, the high-voltage power transmission bracket, and the insulating bottom plate are arranged in the first shielding box.

[0023] The first shielding box includes a first casing, a second casing, a front end cap, and a rear end cap. The front end cap is provided with an opening for entry of the signal electrons. An inner side of the opening corresponds to the semiconductor detector. An outer side of the opening corresponds to a screen mesh, and the screen mesh is connected to an outer side wall of the front end cap.

- [0024] Further, the high-voltage power transmission bracket is provided with a high-voltage wiring terminal. The low-voltage unit is provided with a low-voltage wiring terminal. The optical fiber emitter is provided with an optical fiber emitting wiring terminal.
- [0025] The rear end cap is provided with:
- [0026] a first through hole corresponding to the high-voltage wiring terminal;
- [0027] a second through hole corresponding to the low-voltage wiring terminal; and
- [0028] a third through hole corresponding to the optical fiber emitting wiring terminal.
- [0029] In some optional embodiments, the high-voltage detection unit further includes:
- [0030] an optical fiber receiver connected to the optical fiber emitter through optical signals; and
- [0031] a second shielding box, in which the optical fiber receiver is arranged in the second shielding box.
- [0032] Further, the electron microscope further includes:
- [0033] a main amplifier connected to the optical fiber receiver through the electrical signals; and
- [0034] a processor in communication connection with the main amplifier.
- [0035] By adopting the abovementioned technical solutions, the present disclosure has the following beneficial effects compared with the related art.
- [0036] In the present disclosure, the high-voltage power supply unit supplies power to the high-voltage detection unit, and the high-voltage detection unit operates at the preset level, so that the speed of the signal electrons can be increased, and the energy of the signal electrons can be improved. Thus, more high-energy signal electrons are received by the high-voltage detection unit, so that the imaging speed and the imaging quality of the electron microscope can be improved.
- [0037] Specific embodiments of the present disclosure will be further described in detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0038] The accompanying drawings, which constitute a part of the present disclosure,

are used to provide a further understanding of the disclosure. The illustrative embodiments of the present disclosure and the illustrations thereof, which are used for explaining the disclosure, do not constitute improper definitions on the present disclosure. It is apparent that the accompanying drawings in the following description are only some embodiments, and persons of ordinary skill in the art may still derive other drawings from these accompanying drawings without any creative effort. In the accompanying drawings:

[0039] FIG. 1 is a schematic diagram of an electron microscope according to the present disclosure;

[0040] FIG. 2 is a schematic diagram of a high-voltage detection unit according to the present disclosure; and

[0041] FIG. 3 is an exploded view of a high-voltage detection unit according to the present disclosure.

[0042] In the accompanying drawings: 1-electron optical column; 101-electron source; 102-objective lens system; 103-deflection device; 2-electron beam; 3-secondary electron; 4-sample to be detected; 5-sample table; 6-screen mesh; 7-front end cap; 8-rear end cap; 9-first casing; 10-second casing; 11-semiconductor detector; 12-support frame; 13-high-voltage power transmission bracket; 14-preamplifier; 15-optical fiber emitter; 16-optical fiber emitting wiring terminal; 17-high-voltage wiring terminal; 18-first shielding box; 19-optical fiber receiving wiring terminal; 20-integrated terminal; 21-optical fiber receiver; 22-low-voltage wiring terminal; 23-second shielding box; 24-driving power supply module; 241-low-voltage unit; 242-high-voltage unit; 25-insulating bottom plate; 26- insulating pillar; and 27-conductive pillar.

[0043] It should be noted that these accompanying drawings and textual descriptions are not intended to limit the scope of the concept of the present disclosure in any manner, but to explain the concept of the present disclosure to those skilled in the art with reference to specific embodiments.

DETAILED DESCRIPTION

[0044] In order to make the purposes, technical solutions, and advantages of the embodiments of the present disclosure clearer, the technical solutions in the embodiments

will be described clearly and completely below with reference to the accompanying drawings in the embodiments of the present disclosure. The following embodiments are used to illustrate the present disclosure, but are not used to limit the scope of the present disclosure.

[0045] In the description of the present disclosure, it should be noted that the terminologies “upper”, “lower”, “front”, “rear”, “left”, “right”, “vertical”, “inner”, “outer” and the like that indicate relations of directions or positions are based on the relations of directions or positions shown in the accompanying drawings, which are only to facilitate description of the present disclosure and to simplify the description of the present disclosure, rather than to indicate or imply that the referred device or element is limited to the specific direction or to be operated or configured in the specific direction. Thus, the above-mentioned terminologies shall not be interpreted as confine to the present disclosure.

[0046] In the description of the present disclosure, it should be noted that, unless otherwise definitely specified and limited, terms “install”, “mutually connect”, and “connect” should be broadly understood. For example, the terms may refer to fixed connection and may also refer to detachable connection or integral connection. The terms may refer to mechanical connection and may also refer to electrical connection. The terms may refer to direct mutual connection, may also refer to indirect connection through an intermediate medium. For those of ordinary skill in the art, specific meanings of the abovementioned terms in the present disclosure can be understood according to a specific condition.

[0047] As shown in FIG. 1 to FIG. 3, the present disclosure provides an electron microscope. The electron microscope includes: a sample table 5, an electron optical column 1, a high-voltage detection unit, and a high-voltage power supply unit.

[0048] The sample table 5 is configured to place a sample to be detected 4. The electron optical column 1 is configured to emit an electron beam 2, and to converge the electron beam 2 onto the sample to be detected 4. The high-voltage detection unit is configured to receive signal electrons generated by the electron beam 2 acting on the sample to be detected 4, and output a voltage signal. The high-voltage power supply unit is electrically connected to the high-voltage detection unit, and configured to control the high-voltage detection unit to reach a preset level.

[0049] The sample table 5 of the electron microscope adopts a ground mode, that is, the voltage value of the sample table 5 is zero. The sample to be detected 4 is placed on the sample table 5, so that the sample to be detected 4 is not charged. That is, the voltage value of the sample to be detected 4 is zero. The electron optical column 1 emits an electron beam 2, and converges the electron beam 2 onto the sample to be detected 4. The converged electron beam 2 acts on the sample to be detected 4 to generate the signal electrons. The high-voltage power supply unit is electrically connected to the high-voltage detection unit. The high-voltage power supply unit may control the high-voltage detection unit to reach the preset level. The high-voltage detection unit operates at the preset level, so that the high-voltage detection unit can receive the signal electrons generated by the electron beam 2 acting on the sample to be detected 4, and output the voltage signal. The high-voltage power supply unit supplies power to the high-voltage detection unit, and the high-voltage detection unit operates at the preset level, so that the speed of the signal electrons can be increased, and the energy of the signal electrons can be improved. Thus, more high-energy signal electrons are received by the high-voltage detection unit, so that the imaging speed and the imaging quality of the electron microscope can be improved.

[0050] Further, the-voltage detection unit includes a semiconductor detector 11, a preamplifier 14, and an optical fiber emitter 15 which are sequentially connected to each other through electrical signals. The electron microscope provided by the present disclosure further includes a high-voltage power transmission bracket 13 and a driving power supply module 24 which are electrically connected to the high-voltage power supply unit.

[0051] Specifically, the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, and the driving power supply module 24 are all electrically connected to the high-voltage power transmission bracket 13. The high-voltage power supply unit may supply the high-voltage power. The high-voltage power supply unit is electrically connected to the high-voltage power transmission bracket 13. The high-voltage power transmission bracket 13 is electrically connected to each of the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, and the driving power supply module 24. The high-voltage power supplied by the high-voltage power supply unit supplies the high-voltage power to the semiconductor detector 11, the preamplifier 14, the optical

fiber emitter 15 and the driving power supply module 24 through the high-voltage power transmission bracket 13, so that each of the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15 and the driving power supply module 24 reaches the preset level.

[0052] The high-voltage power supply unit supplies power to the high-voltage detection unit, and the semiconductor detector 11 operates at the preset level, so that the speed of the signal electrons can be increased, and the energy of the signal electrons can be improved. Thus, more high-energy signal electrons are detected and received by the semiconductor detector 11, so that the imaging quality of the electron microscope can be improved.

[0053] The high-voltage detection unit adopts the semiconductor detector 11 to perform detection. The basic principle of the semiconductor detector 11 is that charged particles generate electron-hole pairs in the sensitive volume of the semiconductor detector 11, and the electron-hole pairs drift under the action of an external electric field to output signals. By using the semiconductor detector 11, the detection speed can be increased, so that the imaging speed of the electron microscope can be increased.

[0054] Further, the electron microscope provided by the present disclosure further includes a low-voltage power supply unit. The low-voltage power supply unit is electrically connected to the driving power supply module 24. The driving power supply module 24 is electrically connected to the optical fiber emitter 15. The driving power supply module 24 is electrically connected to the preamplifier 14. The preamplifier 14 is electrically connected to the semiconductor detector 11.

[0055] The low-voltage power supply unit may supply the low-voltage power. The low-voltage power supply unit is electrically connected to the driving power supply module 24. The low-voltage power supplied by the low-voltage power supply unit supplies the low-voltage power to the optical fiber emitter 15 and the preamplifier 14 through the driving power supply module 24. The preamplifier 14 is electrically connected to the semiconductor detector 11. The low-voltage power supplied by the low-voltage power supply unit supplies the low-voltage power to the semiconductor detector 11 through the preamplifier 14.

[0056] Further, the high-voltage power transmission bracket 13 is a rectangular frame with cross beams. The preamplifier 14 is connected to an upper surface of the rectangular

frame through conductive screws. The optical fiber emitter 15 is connected to the upper surface of the rectangular frame through the conductive screws. The driving power supply module 24 includes a high-voltage unit 242 and a low-voltage unit 241. The high-voltage unit 242 is connected to a lower surface of the rectangular frame by mating the conductive screws with conductive pillars 27 with threaded holes. The low-voltage unit 241 is connected to the lower surface of the rectangular frame through insulating pillars 26.

[0057] In order to collect more signal electrons, the high-voltage detection unit should maintain a relatively close detection distance from an action point of the electron beam 2 acting on the sample to be detected 4. Since the electron optical column 1 needs to converge the electron beam 2 onto the sample to be detected 4, the distance between the electron optical column 1 and the sample to be detected 4 is relatively small. In order to ensure the detection distance, the overall dimension of the high-voltage detection unit should be small. In order to make the structure of the high-voltage detection unit to be compact, in this embodiment, the high-voltage power transmission bracket 13 is configured as a rectangular frame with cross beams. The preamplifier 14 is connected to the upper surface of the rectangular frame through the conductive screws, and the optical fiber emitter 15 is connected to the upper surface of the rectangular frame through the conductive screws. The driving power supply module 24 includes the high-voltage unit 242 and the low-voltage unit 241, the high-voltage unit 242 is connected to the lower surface of the rectangular frame by mating the conductive screws with the conductive pillars 27 with the threaded holes, and the low-voltage unit 241 is connected to the lower surface of the rectangular frame through the insulating pillars 26. In this way, the safety and the reliability of power supply can be ensured, and the overall structure of the high-voltage detection unit can also be more compact, and the overall dimension of the high-voltage detection unit can be reduced.

[0058] Furthermore, the high-voltage detection unit further includes a support frame 12. The support frame 12 is connected to the upper surface of the rectangular frame through the conductive screws. The semiconductor detector 11 is connected to the support frame 12 through the conductive screws.

[0059] Specifically, the support frame 12 is integrally arranged on a side of the rectangular frame. The support frame 12 is provided with bosses. Each boss is provided

with a through hole. The conductive screws penetrate through the through holes to connect the support frame 12 to the upper surface of the rectangular frame. The semiconductor detector 11 is connected to the support frame 12 through the conductive screws.

[0060] As shown in FIG. 1 to FIG. 3, in some optional embodiments, the high-voltage detection unit further includes an insulating bottom plate 25. One end of the insulating bottom plate 25 is connected to the lower surface of the rectangular frame through the insulating pillars 26, and the other end of the insulating bottom plate is connected to a lower surface of the driving power supply module 24 through the insulating pillars 26.

[0061] The insulating bottom plate 25 may provide support for the installation of each of the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, and the high-voltage power transmission bracket 13, and can insulate the abovementioned components from the outside.

[0062] It should be noted that all insulating pillars 26 provided by the present disclosure are cylinders each provided with at least one boss on an outer side wall of each cylinder. The arrangement of the bosses may achieve a better insulating effect.

[0063] Optionally, the boss and the cylinder are integrally formed.

[0064] Optionally, there are multiple bosses, and the multiple bosses are arranged parallel to each other on the outer wall of the cylinder.

[0065] The boss, the cylinder, and the insulating bottom plate 25 are made of engineering plastics, or other insulating materials. Those skilled in the art can select the suitable materials.

[0066] Further, the high-voltage detection unit further includes a first shielding box 18. The semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, the high-voltage power transmission bracket 13, and the insulating bottom plate 25 are arranged in the first shielding box 18.

[0067] The first shielding box 18 encloses the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, the high-voltage power transmission bracket 13, and the insulating bottom plate 25, which can prevent the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, the high-voltage power transmission bracket 13 and the insulating bottom plate 25 from being interfered by the external electric field, the

external magnetic field and the like, and can also prevent the electric field and the magnetic field generated by the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, the high-voltage power transmission bracket 13 and the insulating bottom plate 25 from interfering with other components of the electron microscope.

[0068] Specifically, the first shielding box 18 includes a first casing 9, a second casing 10, a front end cap 7, and a rear end cap 8. The front end cap 7 is provided with an opening for entry of the signal electrons. An inner side of the opening corresponds to the semiconductor detector 11. An outer side of the opening corresponds to a screen mesh 6. The screen mesh 6 is connected to an outer side wall of the front end cap 7.

[0069] A voltage is applied to the screen mesh 6, so that an electric field will be generated around the screen mesh 6. The sample table 5 of the electron microscope adopts the ground mode, that is, the voltage value of the sample table 5 is zero. The sample to be detected 4 is placed on the sample table 5, so that the sample to be detected 4 is not charged, and the voltage value of the sample to be detected 4 is zero. The electron optical column 1 emits the electron beam 2, and converges the electron beam 2 onto the sample to be detected 4. The converged electron beam 2 acts on the sample to be detected 4 to generate the signal electrons. The electric field generated around the screen mesh 6 will change the movement direction of the signal electrons, so that the generated signal electrons will move towards the screen mesh 6 under the action of the electric field. The signal electrons move towards the screen mesh 6, penetrate through the screen mesh 6 firstly, and then penetrate through the opening on the front end cap 7 to impinge onto the semiconductor detector 11.

[0070] Further, the high-voltage power transmission bracket 13 is provided with a high-voltage wiring terminal 17. The low-voltage unit 241 is provided with a low-voltage wiring terminal 22. The optical fiber emitter 15 is provided with an optical fiber emitting wiring terminal 16.

[0071] The rear end cap 8 is provided with a first through hole, a second through hole, and a third through hole. The first through hole corresponds to the high-voltage wiring terminal 17. The second through hole corresponds to the low-voltage wiring terminal 22. The third through hole corresponds to the optical fiber emitting wiring terminal 16.

[0072] The high-voltage power supply unit is connected to the high-voltage wiring

terminal 17 through a cable, so as to supply power to the high-voltage power transmission bracket 13.

[0073] The low-voltage power supply unit is connected to the low-voltage wiring terminal 22 through a cable, so as to supply power to the driving power supply module 24.

[0074] As shown in FIG. 1 to FIG. 3, in some optional embodiments, the high-voltage detection unit further includes an optical fiber receiver 21 and a second shielding box 23. The optical fiber receiver 21 is connected to the optical fiber emitter 15 through optical signals, and the optical fiber receiver 21 is arranged in the second shielding box 23.

[0075] The optical fiber receiver 21 is arranged in the second shielding box 23, which can prevent the optical fiber receiver 21 from being interfered by the external electric field, the external magnetic field and the like, and can also prevent the electric field and the magnetic field generated by the optical fiber receiver 21 from interfering with other components of the electron microscope.

[0076] The second shielding box 23 is provided with a fourth through hole and a fifth through hole. The optical fiber receiver 21 is provided with an optical fiber receiving wiring terminal 19 and an integrated terminal 20. The fourth through hole corresponds to the optical fiber receiving wiring terminal 19, and the fifth through hole corresponds to the integrated terminal 20.

[0077] The optical fiber emitting wiring terminal 16 of the optical fiber emitter 15 is connected to the optical fiber receiving wiring terminal 19 of the optical fiber receiver 21 through optical fibers.

[0078] Further, the electron microscope provided by the present disclosure further includes a main amplifier and a processor. The main amplifier is connected to the optical fiber receiver 21 through electrical signals, and the processor is in communication connection with the main amplifier.

[0079] The function of the main amplifier is to amplify the input voltage electrical signal. The main amplifier is configured to obtain a stronger output voltage signal than the input voltage signal. The main amplifier is connected to the optical fiber receiver 21 through electrical signals by the integrated terminal 20, and the processor is in communication connection with the main amplifier. The processor generates an image according to the voltage signal output by the main amplifier.

- [0080] It should be noted that the integrated terminal 20 refers to a plurality of joints, such as power supply joints and electrical signal transmission joints, which are arranged together in order, and are not interfered with each other or not connected with each other.
- [0081] As shown in FIG. 1 to FIG. 3, the electron microscope provided by the present disclosure is described below with a specific embodiment. The semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, the driving power supply module 24, the high-voltage power transmission bracket 13, and the insulating bottom plate 25 are all arranged in the first shielding box 18. The high-voltage power transmission bracket 13 is provided with a high-voltage wiring terminal 17. The driving power supply module 24 includes a high-voltage unit 242 and a low-voltage unit 241. The low-voltage unit 241 is provided with a low-voltage wiring terminal 22. The optical fiber emitter 15 is provided with an optical fiber emitting wiring terminal 16.
- [0082] The first shielding box 18 is enclosed by a first casing 9, a second casing 10, a first end cap 7, and a rear end cap 8. The rear end cap 8 is provided with a first through hole, a second through hole, and a third through hole. The first through hole corresponds to the high-voltage wiring terminal 17. The second through hole corresponds to the low-voltage wiring terminal 22. The third through hole corresponds to the optical fiber emitting wiring terminal 16.
- [0083] The high-voltage power supply unit is connected to the high-voltage wiring terminal 17 through a cable, so as to supply power to the high-voltage power transmission bracket 13. The high-voltage power supply unit may supply the high-voltage power. Preferably, taking the voltage value of 10 kv as an example for description, the voltage value of the high-voltage power transmission bracket 13 is 10 kv, and the high-voltage power transmission bracket 13 is a rectangular frame with cross beams. The high-voltage power transmission bracket 13 is electrically connected to each of the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, and the driving power supply module 24.
- [0084] The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the semiconductor detector 11, so that the voltage value of the semiconductor detector 11 is 10 kv.
- [0085] Specifically, the high-voltage detection unit further includes a support frame 12. The support frame 12 is connected to the upper surface of the rectangular frame

through the conductive screws. The semiconductor detector 11 is connected to the support frame 12 through the conductive screws. The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the support frame 12 through the conductive screws, and then the support frame 12 transmits the high-voltage power with the voltage value of 10 kv to the semiconductor detector 11 through the conductive screws, so that the voltage value of the semiconductor detector 11 is 10 kv.

[0086] The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the preamplifier 14, so that the voltage value of the preamplifier 14 is 10 kv.

[0087] Specifically, the preamplifier 14 is connected to the upper surface of the rectangular frame through the conductive screws. The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the preamplifier 14 through the conductive screws, so that the voltage value of the preamplifier 14 is 10 kv.

[0088] The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the optical fiber emitter 15, so that the voltage value of the optical fiber emitter 15 is 10 kv.

[0089] Specifically, the optical fiber emitter 15 is connected to the upper surface of the rectangular frame through the conductive screws. The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the optical fiber emitter 15 through the conductive screws, so that the voltage value of the optical fiber emitter 15 is 10 kv.

[0090] The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the high-voltage unit 242 of the driving power supply module 24, so that the voltage value of the high-voltage unit 242 is 10 kv.

[0091] Specifically, the driving power supply module 24 includes the high-voltage unit 242 and the low-voltage unit 241. The high-voltage unit 242 is connected to the lower surface of the rectangular frame by mating the conductive screws with the conductive pillars 27 with the threaded holes. The low-voltage unit 241 is connected to the lower surface of the rectangular frame through the insulating pillars 26.

[0092] The conductive screw passes through the rectangular frame and is screwed into

the threaded hole at an end of the conductive pillar 27, and the other end of the conductive pillar 27 is connected to the high-voltage unit 242, so as to connect the high-voltage unit 242 to the lower surface of the rectangular frame. The high-voltage power transmission bracket 13 transmits the high-voltage power with the voltage value of 10 kv to the high-voltage unit 242 through the conductive screws and the conductive pillars 27 in sequence, so that the voltage value of the high-voltage unit 242 is 10 kv.

[0093] The high-voltage power supply unit supplies the high-voltage power to the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, and the high-voltage unit 242 of the driving power supply module 24 through the high-voltage power transmission bracket 13, so that each of the semiconductor detector 11, the preamplifier 14, the optical fiber emitter 15, and the high-voltage unit 242 of the driving power supply module 24 reaches the preset level of 10 kv.

[0094] The low-voltage power supply unit is connected to the low-voltage wiring terminal 22 through a cable, so as to supply power to the low-voltage unit 241 of the driving power supply module 24. The low-voltage power supply unit can supply the low-voltage power. Preferably, taking the voltage value of 24 v as an example for description, the voltage value of the low-voltage unit 241 is 24 v. The low-voltage unit 241 transmits the low-voltage power with the voltage value of 24 v to the high-voltage unit 242 at the preset level of 10 kv, and the high-voltage unit 242 outputs the low-voltage power of 5 v through transforming process. The high-voltage unit 242 transmits the low-voltage power of 5 v to each of the preamplifier 14 at the preset level of 10 kv and the optical fiber emitter 15 at the preset level of 10 kv through wires. Then, the preamplifier 14 transmits the low-voltage power of 5 v to the semiconductor detector 11 at the preset level of 10 kv through the wire. The low-voltage power supply unit supplies the low-voltage power to each of the preamplifier 14, the optical fiber emitter 15 and the semiconductor detector 11 at the preset level of 10 kv through the low-voltage unit 241 and the high-voltage unit 242 of the driving power supply module 24, so that the low-voltage power can drive each of the preamplifier 14, the optical fiber emitter 15 and the semiconductor detector 11 at the preset level of 10 kv to operate.

[0095] The electron optical column 1 is configured to emit the electron beam 2, and to converge the electron beam 2 onto the sample to be detected 4. The electron optical column 1 includes an electron source 101, an electron acceleration structure, and an

objective lens system 102.

[0096] The electron source 101 is configured to emit the electron beam 2. The electron acceleration structure is an anode, and is configured to form an electric field in the emitting direction of the electron beam 2, so as to increase the movement speed of the electron beam 2. The objective lens system 102 is configured to control the beam size of the electron beam 2 and the traveling direction of the electron beam 2 emitted by the electron source 101.

[0097] The objective lens system 102 includes an objective lens and a deflection device 103. The objective lens may be a magnetic lens, an electric lens, or an electromagnetic compound lens. The deflection device 103 may be a magnetic deflection device, or an electric deflection device. The deflection device 103 is configured to change the moving direction of the electron beam 2 emitted by the electron source 101, and can generate a scanning field in any deflection direction.

[0098] The sample table 5 of the electron microscope adopts a ground mode, that is, the voltage value of the sample table 5 is 0 v. The sample to be detected 4 is placed on the sample table 5, so that the sample to be detected 4 is not charged, that is, the voltage value of the sample to be detected 4 is 0 v. The electron optical column 1 emits the electron beam 2, and converge the electron beam 2 onto the sample to be detected 4. The converged electron beam 2 acts on the sample to be detected 4 to generate the signal electrons. The signal electrons include backscattered electrons and secondary electrons 3. The energy of the secondary electrons 3 is low, while the energy of the backscattered electrons is high. A screen mesh 6 power supply applies a voltage to the screen mesh 6, and the value of the applied voltage is 300 v. An electric field will be generated around the screen mesh 6. The electric field generated around the screen mesh 6 will change the moving direction of the signal electrons. Since the energy of the secondary electrons 3 in the signal electrons is low, the secondary electrons 3 are greatly affected by the electric field generated around the screen mesh 6, so that the moving directions of most of the secondary electrons 3 will be greatly changed. The secondary electrons 3 are affected by the electric field generated around the screen mesh 6, so that the moving directions of the secondary electrons are changed, and thus the secondary electrons move towards the screen mesh 6. The semiconductor detector 11 is at a preset level of 10 kv, and the voltage value of the screen mesh 6 is 300 v. An acceleration electric field is formed

between the screen mesh 6 and the semiconductor detector 11. The secondary electrons 3 are attracted by the screen mesh 6 to move towards the screen mesh 6 and pass through the screen mesh 6. After the secondary electrons 3 pass through the screen mesh 6, the secondary electrons 3 are attracted and accelerated under the action of the acceleration electric field formed between the screen mesh 6 and the semiconductor detector 11, and then pass through the opening formed on the front end cap 7 and impinge onto the semiconductor detector 11. The accelerated secondary electrons 3 at a high speed impinge onto the semiconductor detector 11, so that the semiconductor detector 11 generates a current after being impinged by the secondary electrons 3. The semiconductor detector 11 is connected to the preamplifier 14 through electrical signals. The current generated by the semiconductor detector 11 is transmitted to the preamplifier 14, and the preamplifier 14 converts and amplifies a current signal into a voltage signal. The preamplifier 14 is connected to the optical fiber emitter 15 through electrical signals, and the preamplifier 14 transmits the converted and amplified voltage signal to the optical fiber emitter 15. The optical fiber emitter 15 converts the voltage signal into an optical signal. The optical fiber emitting wiring terminal 16 of the optical fiber emitter 15 is connected to the optical fiber receiving wiring terminal 19 of the optical fiber receiver 21 through the optical fibers. The optical fiber emitter 15 transmits the converted optical signal to the optical fiber receiver 21, and the optical fiber receiver 21 converts the optical signal into the voltage signal. The optical fiber receiver 21 is connected to the main amplifier through electrical signals by the integrated terminal 20. The optical fiber receiver 21 transmits the voltage signal to the main amplifier, and the main amplifier amplifies the input voltage electrical signal. The main amplifier is configured to obtain a stronger output voltage signal than the input voltage signal. The main amplifier transmits the amplified output voltage signal to the processor, and the processor generates an image according to the voltage signal output by the main amplifier.

[0099] It should be noted that this embodiment is described by taking the preset level of 10 kv as an example, the low-voltage power supply unit is described by taking 24 v as an example, the driving voltage of each component is described by taking 5 v as an example, and the value of the voltage applied to the screen mesh 6 is described by taking 300 v as an example. In actual use, the specific voltage value of the preset level, the specific voltage value of the low-voltage power supply unit, the specific value of the

driving voltage of each component, and the specific value of the voltage applied to the screen mesh 6 can be set by those skilled in the art according to actual needs, as long as they satisfy the operation of the high-voltage detection unit.

[00100] In the electron microscope provided by this embodiment, the high-voltage power supply unit supplies power to the high-voltage detection unit, and the high-voltage detection unit operates at a preset level, so that the speed of the signal electrons can be increased, and the energy of the signal electrons can be improved. Thus, more high-energy signal electrons are received by the high-voltage detection unit, so that the imaging quality of the electron microscope can be improved.

[00101] The high-voltage detection unit adopts the semiconductor detector 11 to perform detection. The basic principle of the semiconductor detector 11 is that charged particles generate electron-hole pairs in the sensitive volume of the semiconductor detector 11, and the electron-hole pairs drift under the action of an external electric field to output signals. By using the semiconductor detector 11, the detection speed can be increased, so that the imaging speed of the electron microscope can be increased.

[00102] The above description is only the preferred embodiments of the present disclosure, and is not intended to limit the present disclosure in any manner. Although the present disclosure has been disclosed as above with the preferred embodiments, it is not intended to limit the present disclosure. The technical contents disclosed above may be changed or modified into equivalent embodiments of equivalent changes by any of those skilled in the art without departing from the scope of the technical solutions of the present disclosure. Therefore, any simple changes, equivalent changes and modifications to the above embodiments according to the technical essence of the present disclosure which does not depart from the contents of the technical solutions of the present disclosure still fall within the protection scope of the technical solutions of the present disclosure.

CLAIMS

1. An electron microscope, comprising:

- a sample table configured to place a sample to be detected;
- an electron optical column configured to emit an electron beam, and converge the electron beam onto the sample to be detected;
- a high-voltage detection unit configured to receive signal electrons generated by the electron beam acting on the sample to be detected, and output a voltage signal; and
- a high-voltage power supply unit electrically connected to the high-voltage detection unit, and configured to control the high-voltage detection unit to reach a preset level.

2. The electron microscope according to claim 1, wherein the high-voltage detection unit comprises a semiconductor detector, a preamplifier and an optical fiber emitter sequentially connected to each other through electrical signals;

wherein the electron microscope further comprises a high-voltage power transmission bracket and a driving power supply module which are electrically connected to the high-voltage power supply unit; and

wherein each of the semiconductor detector, the preamplifier, the optical fiber emitter, and the driving power supply module is electrically connected to the high-voltage power transmission bracket.

3. The electron microscope according to claim 2, further comprising:

a low-voltage power supply unit electrically connected to the driving power supply module, wherein the driving power supply module is electrically connected to the optical fiber emitter, the driving power supply module is electrically connected to the preamplifier, and the preamplifier is electrically connected to the semiconductor detector.

4. The electron microscope according to claim 3, wherein the high-voltage power transmission bracket is a rectangular frame with cross beams, the preamplifier is connected to an upper surface of the rectangular frame through conductive screws, and the optical fiber emitter is connected to the upper surface of the rectangular frame through conductive screws,

and wherein the driving power supply module comprises a high-voltage unit and a low-voltage unit, the high-voltage unit is connected to a lower surface of the rectangular frame by mating conductive screws with conductive pillars with threaded holes, and the low-voltage unit is connected to the lower surface of the rectangular frame through insulating pillars.

5. The electron microscope according to claim 4, wherein the high-voltage detection unit further comprises a support frame, the support frame is connected to the upper surface of the rectangular frame through conductive screws, and the semiconductor detector is connected to the support frame through conductive screws.

6. The electron microscope according to claim 4, wherein the high-voltage detection unit further comprises an insulating bottom plate, one end of the insulating bottom plate is connected to the lower surface of the rectangular frame through insulating pillars, and the other end of the insulating bottom plate is connected to a lower surface of the driving power supply module through insulating pillars.

7. The electron microscope according to claim 6, wherein the high-voltage detection unit further comprises a first shielding box, wherein the semiconductor detector, the preamplifier, the optical fiber emitter, the driving power supply module, the high-voltage power transmission bracket and the insulating bottom plate are arranged in the first shielding box; and

wherein the first shielding box comprises a first casing, a second casing, a front end cap, and a rear end cap, the front end cap is provided with an opening for entry of the signal electrons, an inner side of the opening corresponds to the semiconductor detector, an outer side of the opening corresponds to a screen mesh, and the screen mesh is connected to an outer side wall of the front end cap.

8. The electron microscope according to claim 7, wherein the high-voltage power transmission bracket is provided with a high-voltage wiring terminal, the low-voltage unit is provided with a low-voltage wiring terminal, and the optical fiber emitter is provided with an optical fiber emitting wiring terminal; and

wherein the rear end cap is provided with:

- a first through hole corresponding to the high-voltage wiring terminal;
- a second through hole corresponding to the low-voltage wiring terminal; and
- a third through hole corresponding to the optical fiber emitting wiring terminal.

9. The electron microscope according to any one of claims 2 to 8, wherein the high-voltage detection unit further comprises:

- an optical fiber receiver connected to the optical fiber emitter through optical signals;

and

- a second shielding box, wherein the optical fiber receiver is arranged in the second shielding box.

10. The electron microscope according to claim 9, further comprising:

- a main amplifier connected to the optical fiber receiver through the electrical signals;

and

- a processor in communication connection with the main amplifier.