o

CLAIMS

1. A scanning electron microscope with a composite detection system, comprising:

a composite objective lens system comprising an immersion magnetic lens and an electro lens, and configured to focus an initial electron beam to a specimen to form a convergent beam spot;

a composite detection system located in the composite objective lens system; and

a detection signal amplification and analysis system, wherein

a magnetic field of the immersion magnetic lens is immersed in the specimen, and an opening direction of a pole piece is directed towards the specimen;

the electro lens comprises the composite detection system, the specimen, a control electrode, and a voltage source, and is configured to decelerate the initial electron beam and focus the initial electron beam onto the specimen, and separate Back-scatter Electrons (BSEs) from a transmission path of an X-ray;

the composite detection system is located below an inner pole piece of the immersion magnetic lens, is located above the control electrode, and comprises an annular BSE detector and an annular X-ray detector that have a same axis center, where the axis center is a center of a principal optic axis of an electron beam produced by an electron source; the BSE detector is located in an inner ring, and the X-ray detector is located in an outer ring; and the detection signal amplification and analysis system comprises: a first signal amplification subdevice, a second signal amplification subdevice, a first signal processing subdevice and a second signal processing subdevice; wherein the first signal amplification subdevice is connected to the annular BSE detector, the first signal processing subdevice is connected to the first signal amplification subdevice, the second signal amplification subdevice is connected to the annular X-ray detector, and the second signal processing subdevice is connected to the second signal amplification subdevice.

o

2. The scanning electron microscope of claim 1, wherein the annular BSE detector and the annular X-ray detector are located on a same plane or on different planes.

3. The scanning electron microscope of claim 1, wherein a distance between the control electrode at a lowermost end of the composite objective lens system and the specimen is less than or equal to 5 mm.

4. The scanning electron microscope of claim 1, wherein a distance between the control electrode located at a lowermost end of the composite objective lens system and the specimen is greater than or equal to 0.5 mm and is less than or equal to 2 mm.

5. The scanning electron microscope of claim 1, wherein a diameter of a center hole of the annular BSE detector is less than or equal to 3 mm.

6. The scanning electron microscope of claim 1, wherein a diameter of a center hole of the annular BSE detector is greater than or equal to 0.5 mm and is less than or equal to 2 mm.

7. The scanning electron microscope of claim 1, wherein a diameter of a center hole of the annular X-ray detector is greater than 3 mm and is less than 10 mm.

8. The scanning electron microscope of claim 1, wherein a diameter of a center hole of the control electrode is greater than that of a center hole of the annular BSE detector and is less than or equal to an external diameter of the annular X-ray detector.

9. The scanning electron microscope of claim 1, wherein the annular BSE detector is a semiconductor detector, and

the annular X-ray detector includes a semiconductor silicon drift detector or a semiconductor lithium drift detector.

o

10. The scanning electron microscope of claim 1, wherein a layer of conductive metal film is disposed on a lower surface of the annular BSE detector; and a hermetic window is disposed on a lower surface of the annular X-ray detector.

11. The scanning electron microscope of claim 1, wherein both a thickness of the annular BSE detector and a thickness of the annular X-ray detector are less than 10 mm.

12. The scanning electron microscope of claim 1, wherein the detection signal amplification and analysis system is connected to at least one of the annular BSE detector or the annular X-ray detector, and is configured to process at least one of the following: a first signal generated by the annular BSE detector based on received back-scatter electrons by the first signal amplification subdevice and first signal processing subdevice, or a second signal generated by the annular X-ray detector based on a received X-ray by the second signal amplification subdevice and the second signal processing subdevice.

13. The scanning electron microscope of claim 12, wherein the detection signal amplification and analysis system further comprises a signal synthesis subdevice, and the signal synthesis subdevice is further configured to synthesize the processed first signal and the processed second signal to form a composite image.

14. A specimen detection method, applied to a scanning electron microscope, with a composite detection system, of claim 1, wherein the method comprises:

enabling an accelerated initial electron beam to enter a composite objective lens system along a principal optic axis, pass through a center hole of a composite detection system, and converge on a specimen to produce signal electrons, wherein the composite detection system comprises an annular Back-scatter Electron (BSE) detector and an annular X-ray detector, wherein the BSE detector has a same axis center as that of the annular X-ray

detector, where the axis center is a center of the principal optic axis of the electron beam; and

respectively receiving, by the annular back-scatter electron BSE detector and the annular X-ray detector, back-scatter electrons BSEs and an X-ray from the signal electrons produced at a same location of the specimen.

15. The specimen detection method of claim 14, wherein the respectively receiving, by the annular Back-scatter Electron (BSE) detector and the annular X-ray detector, Back-scatter Electrons (BSE) and an X-ray from the signal electrons produced at a same location of the specimen comprises:

causing the BSEs in the signal electrons to perform accelerated movement upwards under action of an electric field of an electro lens of the composite objective lens system and under influence of an immersion magnetic lens, and to be received by the annular BSE detector in an inner ring; and

causing the X-ray produced at a same location of the specimen to move upwards, and to be received by the annular X-ray detector in an outer ring.

16. The method according to claim 14, wherein the method further comprises:

processing, by a detection signal amplification and analysis system, the BSEs received by the annular BSE detector and the X-ray received by the annular X-ray detector, and outputting the processed BSEs and the processed X-ray.