CLAIMS

1. An ion microscope comprising:

a nano-aperture ion source; and

a focusing systems;

wherein the focusing system is configured for selectively coaxially focusing an ion beam generated from an electron beam ionizing an ionizing gas in the nano-aperture ion source and the electron beam such that the electron beam and the ion beam follow the same path through the ion microscope.

2. The microscope of claim 1, wherein the focusing system comprises one or more electrostatic lenses.

3. The microscope of claim 2, wherein the focusing system comprises two or more cylinder lenses, or two or more quadrupole lenses.

4. The microscope of claim 3, wherein the focusing system comprises an Einzel lens.

5. The microscope of any one of claims 1 to 4, comprising an electron injector for generating the electron beam.

6. The microscope of any one of claims 1 to 5, comprising an electrostatic extractor/acceleration section for extracting/accelerating the ion beam from the nano-aperture ion source.

7. The microscope of any one of claims 1 to 6, wherein the nano-aperture ion source is configured for selectively containing the ionizing gas when the ion beam is being focused by the focusing system, and to be free of the ionizing gas when the electron beam is being focused by the focusing system.

8. The microscope of any one of claims 1 to 6, wherein the nano-aperture ion source is configured for selectively moving into a first position relative to the focusing system when the ion beam is being focused by the focusing system, and into a second position relative to the focusing system when the electron beam is being focused by the focusing system, wherein in the first position the electron beam enters an ionization chamber of the nano-aperture ion source for ionizing the ionizing gas, and wherein in the second position, the electron beam by-passes the ionization chamber of the nano-aperture ion source.

9. The microscope of any one of claims 1 to 8, comprising a detection system configured to detect one or more of a group consisting of electron or ion induced charges, electron or ion induced secondary electrons, backscattered ions, and ion or electron induced luminescence.

10. The microscope of any one of claims 1 to 9, comprising a shielding structure for shielding external/stray magnetic fields.

11. A method of constructing an ion microscope comprising the steps of:

providing a nano-aperture ion source; and

providing a focusing system;

wherein the focusing system is configured for selectively coaxially focusing an ion beam generated from an electron beam ionizing an ionizing gas in the nano-aperture ion source and the electron beam such that the electron beam and the ion beam follow the same path through the ion microscope.

12. The method of claim 11, wherein the focusing system comprises one or more electrostatic lenses.

13. The method of claim 12, wherein the focusing system comprises two or more cylinder lenses, or two or more quadrupole lenses.

14. The method of claim 13, wherein the focusing system comprises an Einzel lens.

15. The method of any one of claims 11 to 14, comprising providing an electron injector for generating the electron beam.

16. The method of any one of claims 11 to 15, comprising providing an electrostatic extractor/acceleration section for extracting/accelerating the ion beam from the nano-aperture ion source.

17. The method of any one of claims 11 to 16, wherein the nano-aperture ion source is configured for selectively containing the ionizing gas when the ion beam is being focused by the focusing system, and to be free of the ionizing gas when the electron beam is being focused by the focusing system.

18. The method of any one of claims 11 to 16, wherein the nano-aperture ion source is configured for selectively moving into a first position relative to the focusing system when the ion beam is being focused by the focusing system, and into a second position relative to the focusing system when the electron beam is being focused by the focusing system, wherein in the first position the electron beam enters an ionization chamber of the nano-aperture ion source for ionizing the ionizing gas, and wherein in the second position, the electron beam by-passes the ionization chamber of the nano-aperture ion source.

19. The method of any one of claims 11 to 18, comprising providing a detection system.

20. The method of claim 19, wherein the detection system is configured to detect one or more of a group consisting of electron or ion induced charges, electron or ion induced secondary electrons, backscattered ions, and ion or electron induced luminescence.

21. The method of any one of claims 11 to 20, comprising shielding external/stray magnetic fields.

22. A method of aligning an ion beam in an ion microscope comprising the steps of:
providing a nano-aperture ion source; and
providing a focusing system; and
selectively coaxially focusing the ion beam generated from an electron beam ionizing an ionizing gas in the nano-aperture ion source and the electron beam;
wherein the electron beam and the ion beam follow the same path through the ion microscope.

23. The method of claim 22, wherein the focusing system comprises one or more electrostatic lenses.

24. The method of claim 23, wherein the focusing system comprises two or more cylinder lenses, or two or more quadrupole lenses.

25. The method of claim 24, wherein the focusing system comprises an Einzel lens.

26. The method of any one of claims 22 to 25, comprising providing an electron injector for generating the electron beam.

27. The method of any one of claims 22 to 26, comprising using an electrostatic extractor/acceleration section for extracting/accelerating the ion beam from the nano-aperture ion source.

28. The method of any one of claims 22 to 27, comprising selectively providing the ionizing gas in the nano-aperture ion source when the ion beam is being focused by the focusing system, and to be free of the ionizing gas when the electron beam is being focused by the focusing system.

29. The method of any one of claims 22 to 27, comprising selectively moving the nano-aperture ion source into a first position relative to the focusing system when the ion beam is being focused by the focusing system, and into a second position relative to the focusing system when the electron beam is being focused by the focusing system, wherein in the first position the electron beam enters an ionization chamber of the nano-aperture ion source for ionizing the ionizing gas, and wherein in the second position, the electron beam by-passes the ionization chamber of the nano-aperture ion source.

30. The method of any one of claims 22 to 29, comprising using a detection system to detect one or more of a group consisting of electron or ion beam induced charges, electron or ion induced secondary electrons, backscattered ions, and ion or electron induced luminescence.

31. The method of any one of claims 22 to 30, comprising shielding external/stray magnetic fields.