CLAIMS

1. A scanning electron microscopy apparatus comprising:

an electron beam source configured to generate an electron beam;

a set of electron-optical elements to direct at least a portion of the electron beam onto a portion of the sample;

an emittance analyzer assembly;

a splitter element configured to direct at least a portion of at least one of secondary electrons or backscattered electrons emitted by a surface of the sample to the emittance analyzer assembly,

wherein the emittance analyzer assembly is configured to image at least one of the secondary electrons or the backscattered electrons, wherein the emittance analyzer assembly includes:

a set of deflection optics;

a first electron-optic lens;

a first electron detector including a center aperture, wherein the first electron detector is configured to collect at least one of a portion of the secondary electrons or a portion of the backscattered electrons;

a first mesh element disposed downstream from the first electron detector;

a second mesh element disposed downstream from the first mesh element, wherein the first electron detector and the first mesh element form a deceleration region, wherein the first mesh element and the second mesh element form a drift region;

an energy filter disposed downstream from the second mesh element;

a second electron-optic lens; and

a second electron detector configured to collect at least one of an additional portion of the secondary electrons or an additional portion of the backscattered electrons.

2. The scanning electron microscopy apparatus of Claim 1, wherein the set of

deflection optics is configured to align the image beam with one or more components of the emittance analyzer assembly.

3. The scanning electron microscopy apparatus of Claim 1, wherein the set of deflection optics include at least one of a set of electrostatic deflectors or magnetic deflectors.

4. The scanning electron microscopy apparatus of Claim 1, wherein the set of deflection optics are disposed within an acceleration liner.

5. The scanning electron microscopy apparatus of Claim 1, wherein the first electron-optic lens is disposed downstream from the set of deflection optics.

6. The scanning electron microscopy apparatus of Claim 1, wherein the first electron-optic lens comprises:

at least one of an electrostatic lens or a magnetic lens.

7. The scanning electron microscopy apparatus of Claim 1, wherein the first electron detector is held at ground.

8. The scanning electron microscopy apparatus of Claim 1, wherein the first mesh element is disposed downstream from the first electron detector and is held at a potential equal to the surface potential of the sample.

9. The scanning electron microscopy apparatus of Claim 1, wherein the second mesh element is disposed downstream from the first mesh element and is held at a potential equal to the surface potential of the sample.

10. The scanning electron microscopy apparatus of Claim 1, wherein the first mesh element comprises a planar wire mesh.

11. The scanning electron microscopy apparatus of Claim 1, wherein the

second mesh element comprises a hemispherical wire mesh.

12. The scanning electron microscopy apparatus of Claim 1, wherein the energy filter comprises a hemispherical wire mesh.

13. The scanning electron microscopy apparatus of Claim 1, wherein at least one of the first electron detector or the second electron detector comprise:
at least one of a multi-channel plate detector, a solid state detector or a scintillator detector.

14. The scanning electron microscopy apparatus of Claim 1, wherein at least one of the first electron detector or the second electron detector are segmented into two or more segments.

15. The scanning electron microscopy apparatus of Claim 1, wherein the emittance analyzer assembly is configured to operate in secondary electron and backscattered electron imaging mode.

16. The scanning electron microscopy apparatus of Claim 1, wherein the emittance analyzer assembly is configured to operate in backscattered electron and high aspect ratio electron imaging mode.

17. The scanning electron microscopy apparatus of Claim 1, wherein the emittance analyzer assembly is configured to operate in backscattered electron only imaging mode.

18. The scanning electron microscopy apparatus of Claim 1, wherein the electron source is configured to apply an in-situ flood pre-dose to the sample.

19. The scanning electron microscopy apparatus of Claim 1, further comprising:

a flood gun configured to apply an in-situ flood pre-dose to the sample.

20. The scanning electron microscopy apparatus of Claim 1, further comprising:

a gated integrator.

21. The scanning electron microscopy apparatus of Claim 1, wherein the gated integrator is configured to lock one or more components of the emittance analyzer assembly to the surface potential of the sample.

22. An emittance analyzer assembly comprising:

a set of deflection optics;

a first electron-optic lens;

a first electron detector including a center aperture, wherein the first electron detector is configured to collect at least one of a portion of the secondary electrons or a portion of the backscattered electrons;

a first mesh element disposed downstream from the first electron detector;

a second mesh element disposed downstream from the first mesh element, wherein the first electron detector and the first mesh element form a deceleration region, wherein the first mesh element and the second mesh element form a drift region;

an energy filter disposed downstream from the second mesh element;

a second electron-optic lens; and

a second electron detector configured to collect at least one of an additional portion of the secondary electrons or an additional portion of the backscattered electrons.

23. The emittance analyzer assembly of Claim 22, wherein the emittance analyzer assembly is configured to operate in secondary electron and backscattered electron imaging mode.

24. The emittance analyzer assembly of Claim 22, wherein the emittance analyzer assembly is configured to operate in backscattered electron and high

aspect ratio electron imaging mode.

25. The emittance analyzer assembly of Claim 22, wherein the emittance analyzer assembly is configured to operate in backscattered electron only imaging mode.

26. The emittance analyzer assembly of Claim 22, wherein the emittance analyzer assembly is configured to switch between a secondary electron and backscattered electron imaging mode, a backscattered electron and high aspect ratio electron imaging mode and a backscattered electron only imaging mode.

27. A system for comprising:

a first emittance analyzer assembly; and

a second emittance analyzer assembly, wherein at least one of the first emittance analyzer assembly or the second emittance analyzer assembly comprises:

a set of deflection optics;

a first electron-optic lens;

a first electron detector including a center aperture, wherein the first electron detector is configured to collect at least one of a portion of the secondary electrons or a portion of the backscattered electrons;

a first mesh element disposed downstream from the first electron detector;

a second mesh element disposed downstream from the first mesh element, wherein the first electron detector and the first mesh element form a deceleration region, wherein the first mesh element and the second mesh element form a drift region;

an energy filter disposed downstream from the second mesh element;

a second electron-optic lens; and

a second electron detector configured to collect at least one of an additional portion of the secondary electrons or an additional portion of the backscattered electrons.

28. A system for comprising:

a first emittance analyzer assembly;

a second emittance analyzer assembly; and

a third emittance analyzer assembly, wherein at least one of the first emittance analyzer assembly, the second emittance analyzer assembly or the third emittance analyzer assembly comprises:

a set of deflection optics;

a first electron-optic lens;

a first electron detector including a center aperture, wherein the first electron detector is configured to collect at least one of a portion of the secondary electrons or a portion of the backscattered electrons;

a first mesh element disposed downstream from the first electron detector;

a second mesh element disposed downstream from the first mesh element, wherein the first electron detector and the first mesh element form a deceleration region, wherein the first mesh element and the second mesh element form a drift region;

an energy filter disposed downstream from the second mesh element;

a second electron-optic lens; and

a second electron detector configured to collect at least one of an additional portion of the secondary electrons or an additional portion of the backscattered electrons.