Claims

1. An overlay metrology system comprising: a controller communicatively coupled to a particle-beam metrology tool, the controller including one or more processors configured to execute program instructions configured to cause the one or more processors to: receive a scan signal from the particle-beam metrology tool, wherein the particle-beam metrology tool is configured to scan a particle beam across an overlay target on a sample, the overlay target including a first-layer target element on a first layer of the sample and a second-layer target element on a second layer of the sample fabricated subsequent to the first layer, wherein the particle-beam metrology tool is further configured to capture a scan signal associated with interaction of the particle beam with both the first-layer target element and the second-layer target element; determine one or more symmetry measurements for the scan signal with respect to one or more symmetry metrics; and generate an overlay measurement between the first layer and the second layer based on the one or more symmetry measurements, wherein an asymmetry of the scan signal is indicative of a misalignment of the second-layer target element with respect to the first-layer target element, wherein a value of the overlay measurement is based on the one or more symmetry measurements.

2. The overlay metrology system of claim 1, wherein the one or more processors are further configured to execute program instructions to cause the one or more processors to provide overlay correctables based on the value of the overlay measurement to a lithography system to modify exposure conditions of at least one subsequent exposure.

3. The overlay metrology system of claim 1, wherein the scan signal comprises: at least one of a backscattered particle beam signal or a secondary emission signal.

4. The overlay metrology system of claim 1, wherein the one or more processors are further configured to: receive a calibration dataset including one or more calibration scan signals generated by the particle-beam metrology tool based on one or more known overlay configurations of the first-layer target element and the second-layer target element on one or more calibration samples; and determine one or more calibration symmetry measurements for the one or more calibration scan signals based on the one or more symmetry metrics, wherein generating the overlay measurement comprises: determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements.

5. The overlay metrology system of claim 4, wherein determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements comprises: determining the value of the overlay measurement based on a comparison of the one or more

symmetry measurements with the calibration symmetry measurements using a pattern comparison technique.

6. The overlay metrology system of claim 4, wherein determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements comprises: determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements using a machine learning technique.

7. The overlay metrology system of claim 1, wherein the one or more symmetry metrics include a number of peaks in the scan signal.

8. The overlay metrology system of claim 1, wherein the one or more symmetry metrics include locations of peaks of the scan signal.

9. The overlay metrology system of claim 8, wherein the one or more symmetry metrics include locations of peaks of the scan signal with respect to a center position of the scan signal.

10. The overlay metrology system of claim 1, wherein the one or more symmetry metrics include separation distances between two or more peaks of the scan signal.

11. The overlay metrology system of claim 1, wherein the one or more symmetry metrics include an integral of the scan signal.

12. The overlay metrology system of claim 1, wherein an energy of the particle ~~electron~~ beam is selected to provide an interaction depth in ~~the~~ a sample matching a depth of the first-layer target element.

13. The overlay metrology system of claim 1, wherein the first-layer target element is one of a set of first-layer target elements, wherein the second-layer target element is one of a set of second-layer target elements, wherein the scan signal received by the controller is one of a set of scan signals received by the controller associated with the set of first-layer target elements and the set of second-layer target elements, wherein the one or more processors are further configured to execute program instructions causing the one or more processors to: determine a set of symmetry measurements for the set of scan signals with respect to the one or more symmetry metrics; and generate an overlay measurement between the first layer and the second layer based on the set of symmetry measurements.

14. The overlay metrology system of claim 1, wherein the set of first-layer target elements are distributed with a first pitch, wherein the set of second-layer target elements are distributed with a second pitch.

15. The overlay metrology system of claim 14, wherein the first pitch equals the second pitch.

16. The overlay metrology system of claim 14, wherein the first pitch and the second pitch are different.

17. An overlay metrology system comprising: a particle-beam metrology tool configured to scan a particle beam across an overlay target on a sample, the overlay target including a first-layer target element on a first layer of the sample and a second-layer target element on a second layer of the sample fabricated subsequent to the first layer, the particle-beam metrology tool further configured to capture a scan signal associated with interaction of the particle beam with both the first-layer target element and the second-layer target element; and a controller communicatively coupled to the particle-beam metrology tool, the controller including one or more processors configured to execute program instructions configured to cause the one or more processors to: receive the scan signal from the particle-beam metrology tool; determine one or more symmetry measurements for the scan signal with respect to one or more symmetry metrics; and generate an overlay measurement between the first layer and the second layer based on the one or more symmetry measurements, wherein an asymmetry of the scan signal is indicative of a misalignment of the second-layer target element with respect to the first-layer target element, wherein a value of the overlay measurement is based on the one or more symmetry measurements.

18. The overlay metrology system of claim 17, wherein the one or more processors are further configured to execute program instructions to cause the one or more processors to provide overlay correctables based on the value of the overlay measurement to a lithography system to modify exposure conditions of at least one subsequent exposure.

19. The overlay metrology system of claim 17, wherein the particle-beam metrology tool comprises: an electron-beam metrology tool.

20. The overlay metrology system of claim 17, wherein the particle-beam metrology tool comprises: a focused ion beam metrology tool.

21. The overlay metrology system of claim 17, wherein the scan signal comprises: at least one of a backscattered particle beam signal or a secondary emission signal.

22. The overlay metrology system of claim 17, wherein the one or more processors are further configured to: receive a calibration dataset including one or more calibration scan signals generated by the particle-beam metrology tool based on one or more known overlay configurations of the first-layer target element and the

second-layer target element on one or more calibration samples; and determine one or more calibration symmetry measurements for the one or more calibration scan signals based on the one or more symmetry metrics, wherein generating the overlay measurement comprises: determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements.

23. The overlay metrology system of claim 22, wherein determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements comprises: determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements using a pattern comparison technique.

24. The overlay metrology system of claim 22, wherein determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements comprises: determining the value of the overlay measurement based on a comparison of the one or more symmetry measurements with the calibration symmetry measurements using a machine learning technique.

25. The overlay metrology system of claim 17, wherein the one or more symmetry metrics include a number of peaks in the scan signal.

26. The overlay metrology system of claim 17, wherein the one or more symmetry metrics include locations of peaks of the scan signal.

27. The overlay metrology system of claim 26, wherein the one or more symmetry metrics include locations of peaks of the scan signal with respect to a center position of the scan signal.

28. The overlay metrology system of claim 17, wherein the one or more symmetry metrics include separation distances between two or more peaks of the scan signal.

29. The overlay metrology system of claim 17, wherein the one or more symmetry metrics include an integral of the scan signal.

30. The overlay metrology system of claim 17, wherein an energy of the particle ~~electron~~ beam is selected to provide an interaction depth in ~~the~~ a sample matching a depth of the first-layer target element.

31. The overlay metrology system of claim 17, wherein the first-layer target element is one of a set of first-layer target elements, wherein the second-layer target element is one of a set of second-layer target elements, wherein the scan signal received by

the controller is one of a set of scan signals received by the controller associated with the set of first-layer target elements and the set of second-layer target elements, wherein the one or more processors are further configured to execute program instructions causing the one or more processors to: determine a set of symmetry measurements for the set of scan signals with respect to the one or more symmetry metrics; and generate an overlay measurement between the first layer and the second layer based on the set of symmetry measurements.

32. The overlay metrology system of claim 17, wherein the set of first-layer target elements are distributed with a first pitch, wherein the set of second-layer target elements are distributed with a second pitch.

33. The overlay metrology system of claim 32, wherein the first pitch equals the second pitch.

34. The overlay metrology system of claim 32, wherein the first pitch and the second pitch are different.

35. An overlay metrology method comprising: scanning a particle beam across an overlay target on a sample, the overlay target including a first-layer target element on a first layer of the sample and a second-layer target element on a second layer of the sample fabricated subsequent to the first layer; capturing a scan signal associated with interaction of the particle beam with both the first-layer target element and the second-layer target element; determining one or more symmetry measurements for the scan signal with respect to one or more symmetry metrics; generating an overlay measurement between the first layer and the second layer based on the one or more symmetry measurements, wherein an asymmetry of the scan signal is indicative of a misalignment of the second-layer target element with respect to the first-layer target element, wherein a value of the overlay measurement is based on the one or more symmetry measurements; and providing overlay correctables based on the value of the overlay measurement to a lithography system to modify exposure conditions of at least one subsequent exposure.