Claims

1. An overlay metrology system comprising: a controller communicatively coupled to a telecentric imaging system including one or more cameras configured to capture images through an objective lens at two or more focal positions, the controller including one or more processors configured to execute program instructions causing the one or more processors to: receive two or more alignment images of an overlay target on a sample captured at two or more focal positions by the imaging system, the two or more alignment images including one or more features of the overlay target; generate alignment data indicative of an alignment of the overlay target within the imaging system based on the two or more alignment images; set the two or more alignment images as measurement images when the alignment of the overlay target is within selected alignment tolerances; direct the imaging system to adjust the alignment of the overlay target in the imaging system and further receive one or more measurement images from the imaging system when the alignment of the overlay target is outside the selected alignment tolerances; and determine overlay between two or more layers of the sample based on at least one of the measurement images.

2. The overlay metrology system of claim 1, wherein the imaging system comprises: two or more cameras configured to image the two or more focal positions, wherein the two or more cameras simultaneously generate the two or more alignment images.

3. The overlay metrology system of claim 1, wherein the imaging system comprises: a single camera configured to sequentially generate the two or more alignment images as the focal position of the overlay target is varied.

4. The overlay metrology system of claim 3, wherein the focal position of the overlay target is varied by translating a sample stage securing the sample.

5. The overlay metrology system of claim 3, wherein the focal position of the overlay target is varied by translating an objective lens of the imaging system.

6. The overlay metrology system of claim 3, wherein the focal position of the overlay target is varied by translating a detector of the imaging system.

7. The overlay metrology system of claim 1, wherein determining the overlay between two or more layers of the sample based on at least one of the measurement images comprises: determining the overlay between two or more layers of the sample based on one of the measurement images.

8. The overlay metrology system of claim 1, wherein determining the overlay between two or more layers of the sample based on at least one of the measurement images comprises: determining the overlay between two or more layers of the sample based on at least two of the measurement images.

9. The overlay metrology system of claim 1, wherein the alignment data comprises: focus data indicative of a quality of focus of the overlay target in the two or more alignment images, wherein the selected alignment tolerances include selected focus tolerances.

10. The overlay metrology system of claim 9, wherein the focus data comprises: image contrast data of the two or more alignment images.

11. The overlay metrology system of claim 10, wherein the image contrast data comprises: differences in pixel values between at least some of the one or more features of the overlay target and background areas.

12. The overlay metrology system of claim 10, wherein generating image contrast data for each of the two or more alignment images comprises: performing a spatial frequency analysis of at least some of the one or more features of the overlay target, wherein the image contrast data is based on relative strengths of selected spatial frequencies.

13. The overlay metrology system of claim 10, wherein generating alignment data comprises: generating image contrast data for each of the two or more alignment images; and determining the focus data of the sample by comparing the image contrast data of the two or more alignment images to calibrated image contrast data.

14. The overlay metrology system of claim 13, wherein the calibrated image contrast data comprises: image contrast data from images of test features at a plurality of focal positions.

15. The overlay metrology system of claim 14, wherein the calibrated image contrast data is generated by the controller upon receipt of the images of the test features at the plurality of focal positions.

16. The overlay metrology system of claim 13, wherein the calibrated image contrast data is received by the controller prior to determining the focus data of the sample.

17. The overlay metrology system of claim 1, wherein the alignment data comprises: telecentricity data indicative of a quality of telecentricity of the overlay target in the imaging system, wherein the selected alignment tolerances include selected telecentricity tolerances.

18. The overlay metrology system of claim 17, wherein determining the telecentricity data comprises: determining the telecentricity data based on positional variations of the one or more features in the two or more alignment images.

19. The overlay metrology system of claim 18, wherein determining the telecentricity data based on positional variations of the one or more features in the two or more alignment images comprises: determining positions of the one or more features in each of the two or more alignment images; and measuring a telecentricity error as a rate of positional change of the one or more features as a function of focal position based on the two or more alignment images.

20. The overlay metrology system of claim 1, further comprising: a pattern projector configured to project one or patterns onto one or more cameras of the imaging system, wherein the one or more patterns provide reference data for determining positional variations of the one or more features.

21. The overlay metrology system of claim 20, wherein determining the telecentricity data comprises: determining positions of the one or more features in each of the two or more alignment images relative to the one or more patterns; and measuring a telecentricity error as a rate of positional change of the one or more features as a function of focal position based on the two or more alignment images.

22. The overlay metrology system of claim 20, wherein the one or more patterns comprise: at least one pattern along a first direction; and at least one pattern along a second direction orthogonal to the first direction.

23. The overlay metrology system of claim 20, wherein the one or more patterns comprise: one or more grating patterns including a periodic distribution of pattern elements.

24. The overlay metrology system of claim 20, wherein the pattern projector comprises: a pattern mask including the one or more patterns; an illumination source configured to illuminate the pattern mask; and a pattern imaging system configured to generate an image of the pattern mask on the one or more cameras.

25. The overlay metrology system of claim 24, wherein the one or more patterns comprise: at least one grating pattern including pattern elements periodically distributed along a first direction; and at least one grating pattern including pattern elements periodically distributed along a second direction orthogonal to the first direction.

26. The overlay metrology system of claim 25, wherein the pattern projector further comprises: a darkfield stop located at a pupil plane of the pattern imaging system to receive illumination from the illumination source diffracted by the one or more patterns, wherein an aperture of the darkfield stop passes two selected diffraction orders along the first direction and two selected diffraction orders along the second direction.

27. The overlay metrology system of claim 26, wherein the two selected diffraction orders along the first direction include a +1 diffraction order and a -1 diffraction order, wherein the two selected diffraction orders along the second direction include a +1 diffraction order and a -1 diffraction order.

28. The overlay metrology system of claim 26, wherein the darkfield stop includes an annular aperture.

29. The overlay metrology system of claim 1, wherein directing the imaging system to adjust the alignment of the overlay target in the imaging system comprises: adjusting one or more components of the imaging system to control a focal position of the sample to align the imaging system within the selected focus tolerances.

30. The overlay metrology system of claim 29, wherein adjusting one or more components of the imaging system to control a focal position of the sample to align the imaging system within the selected focus tolerances comprises: adjusting a position of a sample stage securing the sample.

31. The overlay metrology system of claim 29, wherein adjusting one or more components of the imaging system to control a focal position of the sample to align the imaging system within the selected focus tolerances comprises: adjusting a position of an objective lens.

32. The overlay metrology system of claim 29, wherein adjusting one or more components of the imaging system to control a focal position of the sample to align the imaging system within the selected focus tolerances comprises: adjusting a position of a detector.

33. The overlay metrology system of claim 1, wherein the alignment data comprises: focus data indicative of a quality of focus of the overlay target in the two or more alignment images, wherein the selected alignment tolerances include selected focus tolerances; and telecentricity data indicative of a quality of telecentricity of the overlay target in the imaging system, wherein the selected alignment tolerances include selected telecentricity tolerances.

34. The overlay metrology system of claim 33, wherein directing the imaging system to adjust the alignment of the overlay target in the imaging system comprises: adjusting one or more components of the imaging system to align the imaging system within the selected telecentricity tolerances.

35. The overlay metrology system of claim 34, wherein controlling one or more components of the imaging system to align the imaging system within the selected telecentricity tolerances comprises: adjusting a position of an aperture stop.

36. The overlay metrology system of claim 34, wherein controlling one or more components of the imaging system to align the imaging system within the selected telecentricity tolerances comprises: controlling a tilt of the sample using a sample stage.

37. The overlay metrology system of claim 35, wherein the aperture stop is within an optical path of the illumination sub-system.

38. The overlay metrology system of claim 35, wherein the aperture stop is within an optical path of the imaging system.

39. The overlay metrology system of claim 1, wherein directing the imaging system to adjust the alignment of the overlay target in the imaging system comprises: centering at least one selected feature of the overlay target within a field of view of the imaging system.

40. The overlay metrology system of claim 1, wherein the one or more features of the overlay target comprise: a portion of the overlay target.

41. The overlay metrology system of claim 1, wherein the one or more features of the overlay target are located on a selected layer of the overlay target.

42. The overlay metrology system of claim 41, wherein the selected layer of the overlay target comprises: a resist layer.

43. An overlay metrology system comprising: a telecentric imaging system including one or more cameras configured to capture images through an objective lens at two or more focal positions; and a controller communicatively coupled to the imaging system, the controller including one or more processors configured to execute program instructions causing the one or more processors to: receive two or more alignment images of an overlay target on a sample captured at two or more focal positions by the imaging system, the two or more alignment images including one or more features of the overlay target; generate alignment data indicative of an alignment of the overlay target within the imaging system based on the two or more alignment images; set the two or more alignment images as measurement images when the alignment of the overlay target is within selected alignment tolerances; direct the imaging system to adjust the alignment of the overlay target in the imaging system and further receive one or more measurement images from the imaging system when the alignment of the overlay target is outside the selected alignment tolerances; and determine overlay between two or more layers of the sample based on at least one of the measurement images.

44. An overlay metrology method comprising: receiving two or more alignment images of a sample captured at two or more focal positions by a telecentric imaging system, the two or more alignment images including one or more features of an overlay target; generating, with one or more processors, alignment data indicative of an alignment of the overlay target within the imaging system based on the two or more alignment images; setting the two or more alignment images as measurement images when the alignment of the overlay target is within selected alignment tolerances; directing the imaging system to adjust the alignment of the overlay target in the imaging system and further receive one or more measurement images from the imaging system when the alignment of the overlay target is outside the selected alignment tolerances; and determining, with one or more processors, overlay between two or more layers of the sample based on the measurement image.