Claims

1. A multipole illumination system comprising: an illumination source configured to generate a source beam; one or more acousto-optic deflectors to diffract the source beam along at least a first direction and a second direction different than the first direction; one or more collection lenses to collect at least some of the diffracted light from the one or more acousto-optic deflectors; and a controller communicatively coupled to the one or more acousto-optic deflectors, the controller including one or more processors configured to execute program instructions causing the one or more processors to: generate one or more drive signals for the one or more acousto-optic deflectors, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate a symmetric distribution of two or more illumination beams formed from light diffracted from the one or more acousto-optic deflectors and collected by the one or more collection lenses, wherein a distribution of wavelength and intensity of the two or more illumination beams is symmetric in a plane formed by the first and second directions.

2. The multipole illumination system of claim 1, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate the two or more illumination beams simultaneously.

3. The multipole illumination system of claim 1, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate the two or more illumination beams sequentially.

4. The multipole illumination system of claim 1, wherein the symmetric distribution of the two or more illumination beams is radially symmetric.

5. The multipole illumination system of claim 1, wherein the symmetric distribution of the two or more illumination beams is symmetric with respect to at least one axis of symmetry in the plane formed by the first and second directions.

6. The multipole illumination system of claim 1, wherein the symmetric distribution of the two or more illumination beams is symmetric with respect to at least one of the first direction or the second direction.

7. The multipole illumination system of claim 1, wherein intensities of the two or more illumination beams are selectable based on intensities of the one or more drive signals to the first and second acousto-optic deflectors.

8. The multipole illumination system of claim 1, wherein locations of the two or more illumination beams in the plane formed by the first and second directions are

selectable based on frequencies of the one or more drive signals to the one or more acousto-optic deflectors.

9. The multipole illumination system of claim 1, further comprising: one or more apertures to block at least some light diffracted by at least one of the one or more acousto-optic deflectors.

10. The multipole illumination system of claim 1, wherein the symmetric distribution of the two or more illumination beams comprises: at least one of two illumination beams arranged in a dipole distribution or four illumination beams arranged in a quadrupole distribution.

11. The multipole illumination system of claim 1, wherein the one or more acousto-optic deflectors are formed from two or more transducers and a common acoustic medium.

12. The multipole illumination system of claim 1, wherein at least one of the one or more acousto-optic deflectors is oriented in a Raman-Nath configuration to symmetrically diffract light.

13. The multipole illumination system of claim 1, wherein the one or more acousto-optic deflectors comprise: a first acousto-optic deflector oriented to receive the source beam in a Raman-Nath configuration to symmetrically diffract light along the first direction; and a second acousto-optic deflector oriented to receive light from the first acousto-optic deflector in a Raman-Nath configuration to symmetrically diffract light along the second direction.

14. The multipole illumination system of claim 1, wherein at least one of the one or more acousto-optic deflectors is oriented in a Bragg configuration.

15. The multipole illumination system of claim 1, wherein the one or more acousto-optic deflectors comprise: a first acousto-optic deflector oriented to receive the source beam in a Bragg configuration; a first aperture to selectively pass +/-1 diffraction orders distributed along the first direction from the first acousto-optic deflector; and a second acousto-optic deflector oriented to receive at least one of the +/-1 diffraction orders from the first aperture in a Bragg configuration and diffract light along the first direction, wherein the second deflector at least partially corrects asymmetric dispersion from the first acousto-optic deflector.

16. The multipole illumination system of claim 15, wherein the one or more acousto-optic deflectors further comprise: a third acousto-optic deflector oriented to receive the diffracted light along the first direction in a Bragg configuration and diffract the light along the second direction; a second aperture to selectively pass +/-1 diffraction orders distributed along the second direction from the third acousto-optic deflector;

and a fourth acousto-optic deflector oriented to receive the +/-1 diffraction orders from the second aperture in a Bragg configuration and diffract light along the second direction, wherein the fourth acousto-optic deflector at least partially corrects asymmetric dispersion from the third deflector.

17. The multipole illumination system of claim 1, wherein the second direction is orthogonal to the first direction.

18. The multipole illumination system of claim 1, wherein the illumination source is spatially coherent.

19. The multipole illumination system of claim 1, wherein the wavelengths of the source beam from the illumination source are tunable.

20. The multipole illumination system of claim 1, wherein the illumination source includes a single-mode fiber.

21. The multipole illumination system of claim 20, wherein the single-mode fiber comprises: a photonic crystal fiber.

22. The multipole illumination system of claim 1, wherein the illumination source comprises: a laser source.

23. The multipole illumination system of claim 22, wherein the illumination source comprises: a supercontinuum laser source.

24. The multipole illumination system of claim 1, wherein the illumination source comprises: a broadband illumination source; and a spectral filter.

25. An overlay metrology system comprising: an illumination source configured to generate a source beam; one or more acousto-optic deflectors to diffract light along a first direction; an objective lens, wherein the objective lens directs at least some of the diffracted light as two or more illumination beams from the one or more acousto-optic deflectors to a sample; a detector configured to capture light from the sample in response to the two or more illumination beams to generate a measurement signal; and a controller communicatively coupled to the one or more acousto-optic deflectors and the detector, the controller including one or more processors configured to execute program instructions causing the one or more processors to: generate one or more drive signals for the one or more acousto-optic deflectors, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate a symmetric distribution on the sample of the two or more illumination beams formed from light diffracted from the one or more acousto-optic deflectors and collected by the objective lens, wherein a distribution of wavelength and intensity of the two or more illumination beams is symmetric with respect to the

first direction; and determine a metrology measurement of the sample based on the measurement signal.

26. The overlay metrology system of claim 25, wherein the sample includes overlaid diffraction gratings on two or more sample layers, wherein the measurement signal includes a pupil plane signal, wherein the one or more processors are further configured to execute program instructions causing the one or more processors to: determine overlay between the two or more sample layers based on the measurement signal.

27. The overlay metrology system of claim 25, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate the two or more illumination beams simultaneously.

28. The overlay metrology system of claim 25, wherein the one or more drive signals cause the one or more acousto-optic deflectors to generate the two or more illumination beams sequentially.

29. The overlay metrology system of claim 25, wherein intensities of the two or more illumination beams are selectable based on at least one of intensities or frequencies of the one or more drive signals to the first and second acousto-optic deflectors.

30. The overlay metrology system of claim 25, further comprising: one or more apertures to block at least some light diffracted by at least one of the one or more acousto-optic deflectors.

31. The overlay metrology system of claim 25, wherein the controller is further communicatively coupled to the illumination source, wherein the one or more processors are further configured to execute program instructions causing the one or more processors to: generate a first illumination drive signal to cause the illumination source to generate the source beam having a first spectrum; generate the drive signals for the one or more acousto-optic deflectors to provide a symmetric distribution of the one or more illumination beams on the sample based on the first spectrum; determine a first metrology measurement of the sample based on the first spectrum; generate a second illumination drive signal to cause the illumination source to generate the source beam having a second spectrum; generate the drive signals for the one or more acousto-optic deflectors to provide a symmetric distribution of the one or more illumination beams on the sample based on the second spectrum; and determine a second metrology measurement of the sample based on the second spectrum.

32. The overlay metrology system of claim 25, wherein at least one of the one or more acousto-optic deflectors is oriented in a Raman-Nath configuration to symmetrically diffract light.

33. The overlay metrology system of claim 25, wherein at least one of the one or more acousto-optic deflectors is oriented in a Bragg configuration.

34. The overlay metrology system of claim 25, wherein the one or more acousto-optic deflectors comprise: a single acousto-optic deflector.

35. The overlay metrology system of claim 25, wherein the one or more acousto-optic deflectors comprise: two or more acousto-optic deflectors placed in series.

36. A method for scatterometry overlay determination comprising: generating a source beam; diffracting the source beam along at least a first direction and a second direction different than the first direction with one or more acousto-optic deflectors; directing at least some of the diffracted light from the one or more acousto-optic deflectors as two or more illumination beams to a sample; generating one or more drive signals for the one or more acousto-optic deflectors to provide the two or more illumination beams on a sample at a symmetric distribution of incident angles, wherein a distribution of wavelength and intensity of the two or more illumination beams is symmetric with respect to the first and second directions; capturing light from the sample in response to the illumination beams to generate a measurement signal; and determining a metrology measurement of the sample based on the measurement signal.