Claims

1. A system, comprising: an inspection sub-system including one or more imaging sensors configured to detect one or more defects on one or more wafers; a stage configured to secure the one or more wafers; and a controller communicatively coupled to the one or more imaging sensors of the inspection sub-system, wherein the controller includes one or more processors configured to execute a set of program instructions stored in memory, wherein the program instructions are configured to cause the one or more processors to: acquire one or more low-resolution images of a wafer, wherein the one or more low-resolution images include one or more low-resolution image patches, wherein the one or more low-resolution image patches include one or more sub-pixel shifts; aggregate the one or more low-resolution image patches; and estimate the one or more sub-pixel shifts and simultaneously reconstruct one or more high-resolution point spread functions (PSF) from the aggregated one or more low-resolution image patches and the estimated one or more sub-pixel shifts.

2. The system in claim 1, wherein the one or more sub-pixel shifts are tracked by at least one of: one or more stage encoders tracking the radial motion of the stage or one or more stage encoders tracking the translational motion of the stage.

3. The system in claim 1, wherein the one or more sub-pixel shifts include at least one of: one or more random sub-pixel shifts, one or more controlled sub-pixel shifts, or one or more reported quantized sub-pixel shifts.

4. The system in claim 1, wherein the one or more low-resolution images of one or more inspected regions of the wafer are aggregated with one or more encoders in the inspection sub-system or with one or more encoders in the controller.

5. The system in claim 1, wherein the program instructions are further configured to cause the one or more processors to: reconstruct the one or more high-resolution PSF via one or more super resolution procedures.

6. The system in claim 5, wherein the one or more super resolution procedures include at least a set of linear procedures reliant on the frequency domain of the inspection sub-system.

7. The system in claim 1, wherein the program instructions are further configured to cause the one or more processors to: perform one or more advanced applications with the one or more reconstructed high-resolution PSF.

8. The system in claim 7, wherein the one or more advanced applications includes reducing image speckle and shot noise for films based on speckle pattern.

9. The system in claim 7, wherein the one or more advanced applications includes rejecting one or more cosmic ray events to differentiate noise from true defects.

10. The system in claim 7, wherein the one or more advanced applications includes extending the dynamic range of the inspection sub-system.

11. The system in claim 1, wherein the program instructions are further configured to cause the one or more processors to: receive one or more defect inspection images; and combine the one or more defect inspection images and the reconstructed high-resolution PSF with one or more additional super resolution procedures to differentiate between one or more noises and one or more defects in the one or more defect inspection images.

12. The system in claim 1, wherein the program instructions are further configured to cause the one or more processors to: generate an inspection recipe for the wafer based on the one or more high-resolution PSF.

13. The system in claim 1, wherein the program instructions are further configured to cause the one or more processors to: select one or more optical components of the inspection sub-system, wherein the one or more optical components have one or more operational parameters used for at least one of calibration and design of the inspection sub-system; generate one or more additional calibration metrics for the inspection sub-system, wherein the one or more additional calibration metrics are based on the one or more operational parameters of the one or more optical components; and generate an inspection recipe for the one or more wafers based on the one or more high-resolution PSF and the one or more additional calibration metrics.

14. A method comprising: acquiring one or more low-resolution images of a wafer, wherein the one or more low-resolution images include one or more low-resolution image patches, wherein the one or more low-resolution image patches include one or more sub-pixel shifts; aggregating the one or more low-resolution image patches; and estimating the one or more sub-pixel shifts and simultaneously reconstructing one or more high-resolution point spread functions (PSF) from the aggregated one or more low-resolution image patches and the estimated one or more sub-pixel shifts.

15. The method in claim 14, wherein the one or more sub-pixel shifts are tracked by at least one of: one or more stage encoders tracking the radial motion of the stage or one or more stage encoders tracking the translational motion of the stage, wherein the one or more stage encoders are coupled to a stage configured to secure one or more wafers.

16. The method in claim 14, wherein the one or more sub-pixel shifts include at least one of: one or more random sub-pixel shifts, one or more controlled sub-pixel shifts, or one or more reported quantized sub-pixel shifts.

17. The method in claim 14, wherein the one or more low-resolution images of one or more inspected regions of the wafer are aggregated with one or more encoders in an inspection sub-system or with one or more encoders in a controller.

18. The method in claim 14, further comprising: reconstructing the one or more high-resolution PSF via one or more super resolution procedures.

19. The method in claim 18, wherein the one or more super resolution procedures include at least a set of linear procedures reliant on the frequency domain of an inspection sub-system.

20. The method in claim 14, further comprising: performing one or more advanced applications with the one or more reconstructed high-resolution PSF.

21. The method in claim 20, wherein the one or more advanced applications includes reducing image speckle and shot noise for films based on speckle pattern.

22. The method in claim 20, wherein the one or more advanced applications includes rejecting one or more cosmic ray events to differentiate noise from true defects.

23. The method in claim 20, wherein the one or more advanced applications includes extending the dynamic range of the inspection sub-system.

24. The method in claim 14, further comprising: receiving one or more defect inspection images; and combining the one or more defect inspection images and the reconstructed high-resolution PSF with one or more additional super resolution procedures to differentiate between one or more noises and one or more defects in the one or more defect inspection images.

25. The method in claim 14, further comprising: generating an inspection recipe for the wafer based on the one or more high-resolution PSF.

26. The method in claim 14, further comprising: selecting one or more optical components of an inspection sub-system, wherein the one or more optical components have one or more operational parameters used for at least one of calibration and design of the inspection sub-system; generating one or more additional calibration metrics for the inspection sub-system, wherein the one or more additional calibration metrics are based on the one or more operational parameters of the one or more optical components; and generating an inspection recipe for the wafer based on the one or more high-resolution PSF and the one or more additional calibration metrics.