

What is claimed is:

1. A method for inspecting semiconductor wafers comprising:

illuminating a moving wafer disposed on an R-Theta stage with an illumination field;

collecting light from the moving wafer;

receiving a first image stream from a time-delay integration sensor during rotational scanning and delaying the first image stream by a duration corresponding to a linear speed of the moving wafer; and

integrating the first delayed image stream to produce a first wafer image,

wherein:

the time-delay integration sensor comprises one or more readout elements corresponding to a section of long dimension of the time-delay integration sensor, each of the one or more readout elements associated with a clock, a first readout element of the one or more readout elements associated with the first image stream; and

a first clock signal associated with the first readout element is configured to reduce a blur caused by a linear speed disparity.

2. The method of claim 1, wherein:

illuminating the moving wafer comprises illuminating the moving wafer at an angle; and

collecting the light comprises excluding unscattered photons.

3. The method of claim 1, further comprising intensifying the first image stream wherein the first image stream requires high sensitivity.

4. The method of claim 1, further comprising:
splitting the collected light into a second image stream;
receiving the second image stream by a time-delay integration charge coupled device; and
integrating the second delayed image stream to produce a second wafer image,
wherein a second clock signal associated with the second image stream is configured to reduce a blur caused by a linear speed disparity.
5. The method of claim 4, further comprising intensifying at least one of the first image stream and the second image stream with either a discrete intensifier or an electron-bombarded device.
6. The method of claim 4, further comprising analyzing at least one of the first image stream and the second image stream to detect defects in the moving wafer.
7. The method of claim 4, wherein the first image stream and second image stream are received by separate portions of the same time-delay integration charge coupled device.
8. The method of claim 7, further comprising inverting the second image, wherein the first image stream corresponds to a first direction of wafer movement and the second image stream corresponds to an opposite direction.
9. The method of claim 1, further comprising adjusting an intensity of the narrow illumination field based on a distance of a TDI from an axis of rotation of the moving wafer.
10. The method of claim 1, wherein the first clock signal comprises a varying frequency corresponding to a linear speed disparity of a time-delay integration charge coupled device relative to the moving wafer during different portions of a rotation cycle.

11. The method of claim 1, wherein illuminating the moving wafer comprises generating a tophat illumination pattern by at least one of a diffractive optical element or two or more overlapped Gaussian spots.

12. The method of claim 1, wherein the illumination field comprises a flat-top profile.

13. The method of claim 1, wherein the illumination field comprises a Gaussian profile.

14. The method of claim 1, wherein the illumination field comprises a supergaussian profile.

15. The method of claim 1, wherein the moving wafer is unpatterned.

16. The method of claim 1, wherein the moving wafer is patterned.

17. An wafer inspection apparatus comprising:
an illumination system including an illumination source configured to illuminate a field of a moving wafer;
an image collection apparatus comprising one or more lenses configured to collect light from the moving wafer;
a beam splitter configured to split the collected light into a first image stream and a second image stream;
a first time-delay integration sensor configured to receive and delay the first image stream by a duration corresponding to a linear speed of the moving wafer, the time-delay integration sensor comprising at least one readout element associated with the first image stream, corresponding to a section of long dimension of the time-delay integration sensor, and associated with a clock configured to reduce a blur caused by a linear speed disparity;

- a second time-delay integration sensor configured to receive and delay the second image stream by a duration corresponding to a linear speed of the moving wafer; and
- an image processing computer configured to produce a first wafer image from the first delayed image stream and a second wafer image from the second delayed image stream.

18. The apparatus of claim 17, wherein the illumination system is configured to illuminate the moving wafer at an angle, and wherein the one or more lenses of the image collection apparatus are configured to exclude unscattered photons.

19. The apparatus of claim 18, wherein the illumination source of the illumination system comprises one or more lasers.

20. The Apparatus of claim 19, wherein each of the one or more lasers is configured to operate in different wavelengths.

21. The apparatus of claim 18, wherein the illumination system is configured to illuminate the moving wafer at an angle of between 60° and 85°.

22. The apparatus of claim 17, wherein the image collection apparatus comprises a refractive based collection system.

23. The apparatus of claim 17, wherein the image collection apparatus comprises a catadioptric based collection system.

24. The apparatus of claim 17, further comprising one or more intensifiers, each of the one or more intensifiers configured to intensify one or more of the first image stream and the second image stream.

25. The apparatus of claim 17, wherein the illumination system is configured to adjust an intensity of the narrow illumination field based on a distance of a TDI from an axis of rotation of the moving wafer.

26. The apparatus of claim 17, wherein the illumination system is configured to control the polarization of emitted light.

27. The apparatus of claim 17, wherein the image collection apparatus is configured to filter the collected light based on polarization.

28. The apparatus of claim 17, wherein the first time-delay integration sensor is associated with a first magnification.

29. The apparatus of claim 28, wherein the second time-delay integration sensor is associated with a second magnification.

30. The apparatus of claim 17, wherein the moving wafer is unpatterned.

31. The apparatus of claim 17, wherein the moving wafer is patterned.

32. A wafer imaging device comprising:

an illumination means for illuminating a moving wafer;
an image collection apparatus comprising one or more lenses configured to collect scattered light from the moving wafer;

a beam splitting means for splitting the collected scattered light into a first image stream and a second image stream;

a first time-delay imaging means for receiving and delaying the first image stream by a duration corresponding to a linear speed of the moving wafer, the time-delay integration sensor comprising at least one readout element associated with the first image stream, corresponding to a section of long dimension of the time-

delay integration sensor, and associated with a clock configured to reduce a blur caused by a linear speed disparity;

a second time-delay imaging means for receiving and delaying the second image stream by a duration corresponding to a linear speed of the moving wafer; and
an image processing means for producing a first wafer image base on the first delayed image stream and a second wafer image based on the second delayed image stream.

33. The device of claim 32, wherein:

the illumination means is configured for illuminating the moving wafer at an angle; and

the image collection apparatus is configured to exclude unscattered photons.

34. The device of claim 32, further comprising an intensifying means for intensifying the first image stream.

35. The device of claim 32, wherein:

the beam splitting means is further configured to split the collected, scattered light into a third image stream;

the first time-delay imaging means is further configured for receiving and delaying the third image stream by a duration corresponding to a linear speed of the moving wafer; and

the image processing means is further configured for producing a third image based on the third image stream.

36. The device of claim 35, further comprising a processing element configured to receive and analyze one or more of the first image stream, second image stream and third image stream to detect defects in the moving wafer.

37. The device of claim 35, wherein the beam splitter is further configured to split the collected, scattered light into a fourth image stream.

38. The device of claim 37, wherein the beam splitter is further configured to split the collected, scattered light into a fifth image stream.

39. The device of claim 38, wherein the beam splitter is further configured to split the collected, scattered light into a sixth image stream.

40. The device of claim 32, wherein the illumination means is configured to adjust an intensity of the narrow illumination field based on a distance of a TDI from an axis of rotation of the moving wafer.

41. A method for inspecting semiconductor wafers comprising:

- illuminating a moving wafer disposed on an R-Theta stage with an illumination field;

- collecting light from the moving wafer;

- receiving a first image stream from a time-delay integration sensor during rotational scanning and delaying the first image stream by a duration corresponding to a linear speed of the moving wafer; and

- integrating the first delayed image stream to produce a first wafer image,

wherein:

- the time-delay integration sensor bins pixels along the direction of integration;

- the time-delay integration sensor comprises one or more readout elements corresponding to a section of long dimension of the time-delay integration sensor, each of the one or more readout elements associated with a clock, a first readout element of the one or more readout elements associated with the first image stream; and

- a first clock signal associated with the first readout element is configured to reduce a blur caused by a linear speed disparity.