

CLAIMS

1. A device for inspecting defects in semiconductor wafers comprising a member for detecting surface defects from variations in the slope of a surface of the wafer, characterised in that it comprises:
 - a) a member for detecting surface defects from variations in the intensity of the light reflected by a surface of the wafer at a plurality of points;
 - b) a member for detecting the intensity of the light diffused by the surface of the wafer;
 - c) a light source; and
 - d) a detection and classification mechanism mounted downstream from these detection members.
2. A device according to claim 1, in which the light source comprises a member projecting a pattern comprising an alternation of fringes of continuous light and dark bands onto the surface of the wafer, the projection member comprising a screen having a luminosity of at least 300 cd/cm².
3. A device according to claim 1 or 2, comprising an image capture sensor common to the detection members, the said image capture sensor being capable of measuring local light intensity during displacement of the fringes reflected by the substrate, the member detecting surface defects from variations in the intensity of the reflected light comprising a member calculating the intensity at a plurality of image points to generate an image of the reflected intensities.
4. A device according to any one of the preceding claims, in which the detection and classification mechanism comprises a classification grid according to which a defect is or is not visible in the image of reflected intensities, and is or is not visible in an image of the variations in the slope of the surface of the wafer.
5. A device according to claim 4, in which the inspection device forms part of a machine comprising an arm for transporting wafers equipped with at least one member supporting wafers, a clamp for seizing the wafers having two arms spaced apart configured to hold the opposite edges of the wafer, the clamp being rotatably mounted on a shaft so that it can turn the wafer between a substantially horizontal position and a substantially vertical position, and at least two inspection systems located on both sides of the wafer in a substantially vertical position, symmetrically with respect to the plane passing through the wafer, the detection and classification mechanism being connected to an output from that inspection system, the

classification grid taking into account whether a defect is or is not visible on the two surfaces of the wafer at locations which are close to each other.

6. A device according to claim 4 or 5, comprising at least one wafer transport arm fitted with at least one wafer supporting member, the said arm being configured to move at least one plate along a trajectory comprising at least one substantially straight part, the supporting members forming a substantially horizontal support surface in such a way as to hold the wafer substantially horizontal, the device comprising at least one linear time delay integration camera located above the transport arm, the camera having a field covering the straight part of the said trajectory so that the top surface of a semiconductor wafer can be observed by the camera as it moves along a straight part of the trajectory, the detection and classification mechanism being connected to an output from that camera, the classification grid taking into account whether a defect is or is not visible in an image provided by that camera.

7. A device according to claim 6, comprising at least two linear cameras located above the trajectory.

8. A device according to claim 6 or 7, comprising at least one linear camera located beneath the trajectory to observe the bottom surface of the wafer, the supporting elements having a first spacing or a first shape on an outward path and a second spacing different from the first spacing or a second shape different from the first shape on the return path, enabling inspection of the entire bottom surface of the wafer, part during the outward path and at least a complementary part during the return path of the wafer along the straight part of the trajectory.

9. A device according to any one of the 3 preceding claims, comprising two wafer transport arms fitted with supporting members, the supporting members of a first arm having a spacing which is different from or a shape which is different from the supporting members of the second arm, the first arm being configured to provide an outward path for a wafer, the return path being provided by the second arm, thus permitting inspection of the entire bottom surface of the wafer, partly along the outward path and partly along the return path.

10. A device according to any one of the 4 preceding claims, in which the camera comprises a rectangular matrix of pixels, being of more than 2000 pixels in length and more than 48 pixels in width, and a summing element to sum the pixels in one width when inspecting a surface of a semiconductor wafer, the camera or cameras being sensitive to ultraviolet radiation, the device further comprising a light source comprising a bar of electroluminescent diodes.

11. A device according to any one of claims 4 to 10, comprising a system for inspecting the edge of semiconductor wafers (701), comprising a chromatic confocal microscope (107) provided with a lighting path (110) and an analysis path (120), the lighting path (110) comprising a polychromatic light source (111), a slit (112) and an axially chromatic dispersing objective (115) comprising at least one lens made of a material whose Abbe number is less than 50, and the analysis path (120) comprising the said objective, a chromatic filtering slit (122) and a light intensity sensor (124) in that order, the slit of the lighting path and the slit of the analysis path being located at substantially the same optical distance from the edge of the wafer under inspection, the detection and classification mechanism being connected to an output from the edge inspection system, the classification grid taking into account whether or not a defect is visible on an image provided by the edge inspection system (701).
12. A process for inspecting defects in semiconductor wafers, in which variations in the slope of a surface of the wafer are measured by a first member for detecting surface defects, variations in the intensity of the light reflected by a surface of the wafer are measured by a second member for detecting surface defects, the surface of the wafer being illuminated by a light source, and surface defects are classified by a detection classification mechanism mounted downstream from the detection members.
13. A process according to claim 12, in which the first member detecting the surface defects and the second member detecting surface defects are active concurrently during an inspection for another property of the wafer.
14. A process according to claim 12 or 13, in which a semiconductor wafer resting on at least one supporting member belonging to a transport arm is moved along a trajectory comprising at least one straight part, and in the course of the straight part of the trajectory at least one linear time delay integration camera performs an observation of the top surface of the wafer.
15. A process according to claim 14, in which the inspection is performed before and/or after a static inspection.

Claims

1. A system for inspecting defects in semiconductor wafers comprising:
 - a) a first device for detecting surface defects from variations in the slope of a surface of the wafer
 - b) a second device for detecting surface defects from variations in the intensity of light reflected by a surface of the wafer at a plurality of points, said second device being configured to calculate the intensity of the light at a plurality of image points to generate an image of the reflected intensities;
 - c) a third device for detecting the intensity of the light diffused by the surface of the wafer;
 - d) a detection and classification device coupled to an output of each of the first, second and third devices;
 - e) a light source common to the first device and the second device, the light source comprising a projection member configured to project a pattern of substantially vertical alternate fringes of continuous light and dark bands onto the surface of the wafer, the projection member comprising a screen having a luminosity of at least 300 cd/cm^2 ;
 - f) a controller for displacing the pattern produced by the light source in at least one direction relative to the wafer;
 - g) an image capture sensor common to the first, second and third detection devices, the image capture sensor being capable of measuring local light intensity during displacement pattern reflected by the wafer.
2. The system according to claim 1, in which the detection and classification device comprises a classification grid according to which a defect is or is not visible in the image of reflected intensities, and is or is not visible in an image of the variations in the slope of the surface of the wafer.

3. The system according to claim 2, in which the inspection system forms part of a machine comprising an arm for transporting wafers equipped with at least one member supporting wafers, a clamp for seizing the wafers having two arms spaced apart configured to hold the opposite edges of the wafer, the clamp being rotatably mounted on a shaft so that it can turn the wafer between a substantially horizontal position and a substantially vertical position, and at least two inspection systems located on both sides of the wafer in a substantially vertical position, symmetrically with respect to the plane passing through the wafer, the detection and classification mechanism being connected to an output from that inspection system, the classification grid taking into account whether a defect is or is not visible on the two surfaces of the wafer at locations which are close to each other.

4. The system according to claim 2, comprising at least one wafer transport arm fitted with at least one wafer supporting member, the said arm being configured to move at least one plate along a trajectory comprising at least one substantially straight part, the supporting members forming a substantially horizontal support surface in such a way as to hold the wafer substantially horizontal, the device comprising at least one linear time delay integration camera located above the transport arm, the camera having a field covering the straight part of the said trajectory so that the top surface of a semiconductor wafer can be observed by the camera as it moves along a straight part of the trajectory, the detection and classification mechanism being connected to an output from that camera, the classification grid taking into account whether a defect is or is not visible in an image provided by that camera.

5. The system according to claim 4, comprising at least two linear cameras located above the trajectory.

6. The system according to claim 4, comprising at least one linear camera located beneath the trajectory to observe the bottom surface of the wafer, the supporting elements having a first spacing or a first shape on an outward path and a second spacing different from the first spacing or a second shape different from the first shape on the return path, enabling inspection of the entire bottom surface of the wafer, part during the outward path and at least a complementary part during the return path of the wafer along the straight part of the trajectory.

7. The system according to claim 4, comprising two wafer transport arms fitted with supporting members, the supporting members of a first arm having a spacing which is different from or a shape which is different from the supporting members of the second arm, the first arm being configured to provide an outward path for a wafer, the return path being provided by the second arm, thus permitting inspection of the entire bottom surface of the wafer, partly along the outward path and partly along the return path.

8. The system according to claim 4, wherein the camera comprises a rectangular matrix of pixels, being of more than 2000 pixels in length and more than 48 pixels in width, and a summing element to sum the pixels in one width when inspecting a surface of a semiconductor wafer, the camera or cameras being sensitive to ultraviolet radiation, the device further comprising a light source comprising a bar of electroluminescent diodes.

9. The system according to claim 2, comprising a system for inspecting the edge of semiconductor wafers, comprising a chromatic confocal microscope provided with a lighting path and an analysis path, the lighting path comprising a polychromatic light source, a slit and an axially chromatic dispersing objective comprising at least one lens made of a material whose Abbe number is less than 50, and the analysis path comprising the said objective, a chromatic filtering slit and a light intensity sensor in that order, the slit of the lighting path and the slit of the analysis path being located at substantially the same optical distance from the edge of the wafer under inspection, the

detection and classification mechanism being connected to an output from the edge inspection system, the classification grid taking into account whether or not a defect is visible on an image provided by the edge inspection system.

10. A process for inspecting defects in semiconductor wafers, comprising:

measuring the slope of a surface of the wafer using a first device for detecting surface defects;

measuring variations in the intensity of the light reflected by a surface of the wafer at a plurality of points using a second device for detecting surface defects, wherein the variations of the intensity of the light reflected by the surface of the wafer at a plurality of points is used to generate an image of reflected intensities;

detecting an intensity of light diffused by the surface of the wafer using a third device for detecting surface defects;

illuminating the surface of the wafer with a light source common to the first device and the second device, the light source comprising a projection member, wherein the surface of the wafer is illuminated by projecting a pattern of substantially vertical alternate fringes of continuous light and dark bands from the projection member;

displacing the pattern produced by the light source in at least one direction relative to the wafer;

measuring local light intensity during displacement of the pattern reflected by the wafer; and;

classifying surface defects using a detection and classification device coupled to the output of each of the first, second, and third devices.

11. The process according to claim 10, wherein the first device for detecting surface defects and the second device for detecting surface defects are active concurrently during an inspection for another property of the wafer.

12. The process according to claim 10, wherein the wafer rests on at least one supporting member belonging to a transport arm and wherein the method further comprises moving the wafer along a trajectory comprising at least one straight part, and, in the course of the straight part of the trajectory, at least one linear time delay integration camera performs an observation of the top surface of the wafer.

13. The process according to claim 12, in which the inspection is performed before a static inspection.

14. The process according to claim 12, wherein the inspection is performed after a static inspection.