

CLAIMS

1. A chipping defect detection system comprising:
a conveyor configured to move a solar wafer in a first direction through an image capture location;

a plurality of imaging means for acquiring images of the position of a solar wafer, the plurality of imaging means comprising at least a first camera, the first camera horizontally offset from the conveyor and disposed on a first side of the image capture location, the first camera having an orientation that positions a focal plane of the first camera within the image capture location at an angle parallel to a chamfered edge of the solar wafer that couples adjacent sides of the solar wafer disposed on the conveyor in the image capture location;

a plurality of illumination means to provide light for the imaging means;

a sensing means providing a signal to trigger the imaging means to start capturing images; and

a strobe light driver which is triggered by the imaging means to drive the illumination means such that the imaging means provides an exposure time which coincides with the illumination means.
2. The chipping defect detection system of claim 1, wherein the angle is 45 degrees.
3. The chipping defect detection system of claim 1, wherein sharp images of a chamfered side wall are obtained by the first camera.
4. The chipping defect detection system of claim 1, wherein the sensing means triggers the first camera to take images along a chamfered edge of the solar wafer.
5. The chipping defect detection system of claim 1, wherein the first camera captures images in burst mode at a fixed frame-per second (FPS) while the solar wafer is moved by the conveyor.

6. The chipping defect detection system of claim 5, wherein the chamfered edges are not positioned at a focal plane of the first camera when the first camera starts the burst mode image capture.

7. The chipping defect detection system of claim 6 further comprising: a computer configured to locate a sharpest image from the plurality of images and to analyze the sharpest image to detect presence of a chipping defect in the chamfered edge.

8. The chipping defect detection system of claim 6, wherein the sensing means is located in a position configured to trigger image capture by the first camera prior to the solar wafer passing through the focal plane of the first camera.

9. The chipping defect detection system of claim 2, wherein the first camera is configured to operate at a frame per second (FPS) that is at least $(2 \times v \times \cos 45^\circ) / \text{DOF}$, wherein v is the speed of the solar wafer moving in the first direction, and DOF is the Depth-Of-Focus range of the first camera.

10. The chipping defect detection system of claim 1 further comprising:
a second camera configured to obtain images of the solar wafer disposed within the image capture location, wherein the images of the solar wafer obtained by the second camera are from a second side of the image capture location that is opposite of the first side of image capture location.

11. The chipping defect detection system of claim 10, wherein the second camera has an orientation that positions a focal plane of the second camera within the image capture location at an angle greater than zero degrees and less than ninety degrees relative to the first direction.

12. A method of chipping defect detection for a solar wafer, the method comprising:

transporting a solar wafer in a first direction through an image capture location having a plurality of cameras, each of the plurality of cameras horizontally offset from

the solar wafer and having a focusing plane arranged in a parallel orientation relative to a chamfered edge of the solar wafer;

detecting the solar wafer with a presence sensor to output a signal to the plurality of cameras;

triggering the plurality of cameras by the signal generated by the presence sensor to capture images of the chamfered edges of the solar wafer;

capturing a burst of images as the chamfered edges of the solar wafer pass through the image capture location;

selecting images with maximum image sharpness from the burst of images; and analyzing the sharpest image to detect presence of a chipping defect in one of the chamfered edges.

13. The chipping defect detection system of claim 10, wherein the sensing means comprises a presence sensor configured to trigger image capture by the first and second cameras.

14. The chipping defect detection system of claim 13, wherein each of the first and second cameras are configured, in response to being triggered by the presence sensor, capture a plurality of images of corresponding chamfered edges of the solar wafer.

15. The chipping defect detection system of claim 10 further comprising:

a third camera configured to obtain images of the solar wafer disposed within the image capture location, the images of the solar wafer obtained by the third camera from the first side of the image capture location, a focal plane of the third camera perpendicular to the focal plane of the first camera; and

a fourth camera configured to obtain images of the solar wafer disposed within the image capture location, the images of the solar wafer obtained by the fourth camera from the second side of the image capture location, a focal plane of the fourth camera parallel to the focal plane of the first camera and perpendicular to the focal plane of the third camera.

16. The chipping defect detection system of claim 11, wherein the second camera has an orientation that positions a focal plane of the second camera within the image capture location at a 45 degree angle relative to the first direction.