CLAIMS

[Claim 1] A system for monitoring alignment of a second component relative to a first component, the system comprising:

a camera positioned in fixed relationship to the first component and operable to capture images of the first component and the second component during an operation of the second component, wherein one of the first component and the second component is darker than the other of the first component and the second component;

a controller including a processor and a non-transitory memory storing instructions executed by the processor to configure the controller, the controller configured to:

receive a first captured image from the camera when the second component is in a predetermined position relative to the first component;

receive a selection of a region of interest (ROI) in the first captured image including at least a portion of the first component and at least a portion of the second component;

identify a visible feature of the second component within the ROI of the first captured image;

select a first point on the first component in the ROI of the first captured image and a second point on the second component in the ROI of the first captured image;

receive captured images from the camera during a subsequent operation;

monitor an intensity of the first point and the second point in the received captured images during the subsequent operation;

identify a second captured image from the received captured images during the subsequent operation when the second component is expected to be in the predetermined position relative to the first component based on the monitored intensities of the first point and the second point in the received captured images during the subsequent operation; and

determine if the second component is in the predetermined position relative to the first component based on the second captured image and the identified visible feature of the second component within the ROI of the first captured image.

[Claim 2] The system of claim 1, wherein the second component comprises a robotic arm moveable relative to the first component.

[Claim 3] The system of claim 2, wherein the first component comprises a wafer chamber, and the robotic arm is configured to place a semiconductor wafer in the wafer chamber during the operation and the subsequent operation.

[Claim 4] The system of any one previous claim, wherein the controller is further configured to:

determine first coordinates of the identified visible feature of the second component within the ROI of the first captured image;

store the first coordinates in the memory;

identify the visible feature of the second component in the second captured image; and

determine second coordinates of the identified visible feature of the second component in the second captured image, wherein the controller is configured to determine if the second component is in the predetermined position relative to the first component by comparison of the second coordinates to the first coordinates.

[Claim 5] The system of claim 4, wherein the controller is configured to determine that the second component is in the predetermined position relative to the first component when the second coordinates equal the first coordinates.

[Claim 6] The system of claim 4, wherein the controller is configured to determine that the second component is in the predetermined position relative to the first component when the second coordinates are within predetermined threshold distances from the first coordinates.

[Claim 7] The system of claim 4, wherein the controller is configured to identify the visible feature of the second component in the first captured image and the second captured image based on intensity values of pixels within the first captured image and the second captured image.

[Claim 8] The system of claim 4, wherein the controller is further configured to generate an alarm when the controller determines that the second component is not

in the predetermined position relative to the first component.

[Claim 9] The system of claim 4, wherein the controller is configured to determine if the second component is in the predetermined position relative to the first component during a predetermined step of the operation.

[Claim 10] The system of claim 9, wherein the controller is further configured to determine that the operation is at the predetermined step based on intensity values in the captured images during the subsequent operation.

[Claim 11] A method for monitoring alignment of a second component relative to a first component comprising:

capturing a first captured image when the second component is in a predetermined position relative to the first component using a camera positioned in fixed relationship to the first component and operable to capture images of the first component and the second component during an operation of the second component, wherein one of the first component and the second component is darker than the other of the first component and the second component;

receiving a selection of a region of interest (ROI) in the first captured image including at least a portion of the first component and at least a portion of the second component;

identifying a visible feature of the second component within the ROI of the first captured image;

selecting a first point on the first component in the ROI of the first captured image and a second point on the second component in the ROI of the first captured image;

receiving captured images from the camera during a subsequent operation;

monitoring an intensity of the first point and the second point in the received captured images during the subsequent operation;

identifying a second captured image from the received captured images during the subsequent operation when the second component is expected to be in the predetermined position relative to the first component based on the monitored intensities of the first point and the second point in the received captured images during the subsequent operation; and

determining if the second component is in the predetermined position relative to the first component based on the second captured image and the identified visible feature of the second component within the ROI of the first captured image.

[Claim 12] The method of claim 11, wherein the second component comprises a robotic arm moveable relative to the first component.

[Claim 13] The method of claim 12, wherein the first component comprises a wafer chamber, and the robotic arm is configured to place a semiconductor wafer in the wafer chamber during the operation and the subsequent operation.

[Claim 14] The method of any one of claims 11 to 13, further comprising:

determining first coordinates of the identified visible feature of the second component within the ROI of the first captured image;

storing the first coordinates in a memory;

identifying the visible feature of the second component in the second captured image; and

determining second coordinates of the identified visible feature of the second component in the second captured image, wherein determining if the second component is in the predetermined position relative to the first component comprises determining if the second component is in the predetermined position relative to the first component by comparison of the second coordinates to the first coordinates.

[Claim 15] The method of claim 14, wherein determining if the second component is in the predetermined position relative to the first component comprises determining that the second component is in the predetermined position relative to the first component when the second coordinates equal the first coordinates.

[Claim 16] The method of claim 14, wherein determining if the second component is in the predetermined position relative to the first component comprises determining that the second component is in the predetermined position relative to the first component when the second coordinates are within predetermined threshold distances from the first coordinates.

[Claim 17] The method of claim 14, wherein:

identifying the visible feature of the second component in the first captured image comprises identifying the visible feature based on intensity values of pixels within the first captured image; and

identifying the visible feature of the second component in the second captured image comprises identifying the visible feature based on intensity values of pixels within the second captured image.

[Claim 18] The method of claim 14, further comprising generating an alarm when the second component is determined not to be in the predetermined position relative to the first component.

[Claim 19] The method of claim 14, wherein determining if the second component is in the predetermined position relative to the first component is performed during a predetermined step of the operation.

[Claim 20] The method of claim 19, further comprising determining that the operation is at the predetermined step based on intensity values in the captured images during the subsequent operation.