

Claims

[Claim 1] A defect detection device, which is configured to detect a defect formed in a coating layer in a workpiece, the workpiece comprising a variable density layer having a variable density pattern derived from a semiconductor manufacturing process and the coating layer, which covers the variable density pattern of the variable density layer,

the defect detection device comprising an observation mechanism, the observation mechanism comprising:

an illuminator configured to illuminate the workpiece;

and

an image pickup device configured to observe an observation site of the workpiece illuminated by the illuminator,

wherein the coating layer is formed of a single layer or a plurality of layers comprising two or more layers,

wherein the illuminator comprises a plurality of light-emitting portions arranged at a predetermined pitch along a circumferential direction of the illuminator, and illumination light emitted from the illuminator, which is light other than visible light, has a wavelength at which an intensity of light that is reflected or scattered from the coating layer to enter the image pickup device is higher than an intensity of light that is reflected from at least the variable density layer to enter the image pickup device, to thereby reduce influence of the variable density pattern of the variable density layer, and

wherein the image pickup device is configured to perform dark-field observation of observing the observation site of the workpiece illuminated by the illuminator from above, and enable detection of a defect formed on a surface or inside the coating layer.

[Claim 2] A defect detection device, which is configured to detect a defect formed in a coating layer in a workpiece, the workpiece comprising a variable density layer having a variable density pattern derived from a semiconductor manufacturing process and the coating layer, which covers the variable density pattern of the variable density layer,

the defect detection device comprising an observation mechanism, the observation mechanism comprising:

an illuminator configured to illuminate the workpiece;

and

an image pickup device configured to observe an observation site of the workpiece illuminated by the illuminator,

wherein the coating layer is formed of a single layer or a plurality of layers comprising two or more layers,

wherein illumination light emitted from the illuminator, which is light other than visible light, has a wavelength at which an intensity of light that is reflected or scattered from the coating layer to enter the image pickup device is higher than an intensity of light that is reflected from at least the variable density layer

to enter the image pickup device, to thereby reduce influence of the variable density pattern of the variable density layer, and

wherein the image pickup device is configured to perform dark-field observation of observing the observation site of the workpiece illuminated by the illuminator and rotated from above, and enable detection of a defect formed on a surface or inside the coating layer.

[Claim 3] The defect detection device according to claim 1 or 2, wherein the coating layer comprises an organic substance layer.

[Claim 4] The defect detection device according any one of claims 1 to 3, wherein, of the illumination light from the illuminator, illumination light to be observed has a wavelength of 450 nm or less, or a wavelength of 1,000 nm or more.

[Claim 5] The defect detection device according any one of claims 1 to 4,

wherein the defect of the workpiece has at least any one of an opening or an inclined surface portion, and

wherein the image pickup device is configured to perform observation of enlarging the defect on an observation image of the defect formed in the workpiece.

[Claim 6] The defect detection device according any one of claims

1 to 5, wherein the illuminator has an illumination direction in which the workpiece and an illumination axis form an angle of from 50° to 85° when a photographing axis and the workpiece are arranged so as to be orthogonal to each other.

[Claim 7] A defect detection method for detecting a defect formed in a coating layer in a workpiece, the workpiece comprising a variable density layer having a variable density pattern and the coating layer, which covers the variable density pattern of the variable density layer,

the method comprising having the coating layer formed of a single layer or a plurality of layers comprising two or more layers,

irradiating the workpiece, from an illuminator comprising a plurality of light-emitting portions arranged at a predetermined pitch along a circumferential direction of the illuminator, with illumination light, which is light other than visible light, having a wavelength at which an intensity of light that is reflected or scattered from the coating layer to enter an image pickup device is higher than an intensity of light that is reflected from at least the variable density layer to enter the image pickup device, to thereby observe the workpiece by reducing influence of the variable density pattern of the variable density layer, and

performing dark-field observation of observing the observation site of the workpiece illuminated by the illuminator from above, and enabling detection of a defect formed on a surface

or inside the coating layer.

[Claim 8] A defect detection method for detecting a defect formed in a coating layer in a workpiece, the workpiece comprising a variable density layer having a variable density pattern and the coating layer, which covers the variable density pattern of the variable density layer,

the method comprising having the coating layer formed of a single layer or a plurality of layers comprising two or more layers,

irradiating the workpiece with illumination light, which is light other than visible light, having a wavelength at which an intensity of light that is reflected or scattered from the coating layer to enter an image pickup device is higher than an intensity of light that is reflected from at least the variable density layer to enter the image pickup device, to thereby observe the workpiece by reducing influence of the variable density pattern of the variable density layer, and

performing dark-field observation of observing the observation site of the workpiece illuminated by the illuminator and rotated from above, and enabling detection of a defect formed on a surface or inside the coating layer.

[Claim 9] A die bonder, which is configured to pick up an individual piece serving as a workpiece at a pickup position, convey the individual piece that has been picked up to a bonding position,

and subject the workpiece to bonding at the bonding position,
the die bonder comprising the defect detection device of any one of claims 1 to 6, which is arranged at any position from the pickup position to the bonding position.

[Claim 10] The die bonder according to claim 9, wherein the die bonder is configured to perform positioning detection at at least one of the pickup position, the bonding position, or an intermediate stage between the pickup position and the bonding position.

[Claim 11] A semiconductor manufacturing method, comprising an inspection step using the defect detection method of claim 7 or 8, and further comprising at least any one of a dicing step of cutting a wafer into an individual piece or a mold sealing step of sealing a semiconductor chip formed into an individual piece with resin.

[Claim 12] A semiconductor device manufacturing method for manufacturing a semiconductor device comprising an individual piece assembly formed of a plurality of individual pieces,

the semiconductor device manufacturing method comprising subjecting at least any one of a target object comprising one individual piece or an assembly of a predetermined number of individual pieces or another individual piece to be assembled to the target object, to inspection through use of the defect detection method of claim 7 or 8.