

CLAIMS

1. A semiconductor wafer mass metrology apparatus comprising:

5 a measurement chamber (5) configured for measuring the weight and/or the mass of a semiconductor wafer;

10 a first temperature changing part (7) configured for changing a temperature of the semiconductor wafer before the semiconductor wafer is transported into the measurement chamber; and

15 a first temperature sensor (8) configured for sensing a first temperature, ~~wherein~~ the semiconductor wafer mass metrology apparatus being characterized in that the first temperature is:

_____ a temperature of the first temperature changing part; ~~or~~

20 ~~_____ a temperature of the semiconductor wafer when the semiconductor wafer is on the first temperature changing part, or when the semiconductor wafer leaves the first temperature changing part.~~

2. The semiconductor wafer mass metrology apparatus according to claim 1, wherein: the first temperature changing part is for passively cooling the semiconductor wafer

3. The semiconductor wafer mass metrology apparatus according to claim 1 or claim 2, wherein the apparatus further comprises a second temperature changing part for actively cooling the semiconductor wafer.

4. The semiconductor wafer mass metrology apparatus according to any one of the previous claims, wherein the temperature of the first temperature changing part is measured when the semiconductor wafer is on the first temperature changing part, or when the semiconductor wafer leaves the first temperature changing part.

5. The semiconductor wafer mass metrology apparatus according to any one of the previous claims, wherein the first temperature sensor is configured to detect:

a change in the temperature of the first temperature changing part caused by the semiconductor wafer; and/or

a maximum temperature of the first temperature changing part caused by the semiconductor wafer.

6. The semiconductor wafer mass metrology apparatus according to any one of the previous claims, wherein the apparatus further comprises a control unit configured to control an operation of the apparatus based on:

the sensed first temperature; and/or

a change in the sensed first temperature; and/or

a difference between the sensed first temperature and a second temperature that is a temperature of the measurement chamber; wherein optionally the control unit is configured to:

generate an alert; and/or

correct a mass measurement for the semiconductor wafer based on the difference between the first temperature and the second temperature and a predetermined relationship between the difference between the first temperature and the second temperature and a mass measurement error,

wherein optionally the predetermined relationship is derived from a plurality of mass metrology measurements for one or more semiconductor wafers for different differences between the first temperature and the second temperature, and a known mass of the semiconductor wafer.

~~7. The semiconductor wafer mass metrology apparatus according to claim 6, wherein the control unit is configured to:~~

~~— generate an alert; and/or~~
~~— correct a mass measurement for the semiconductor wafer based on the difference between the first temperature and the second temperature and a predetermined relationship between the difference between the first temperature and the second temperature and a mass measurement error.~~

~~8. The semiconductor wafer mass metrology apparatus according to claim 7, wherein the predetermined relationship is derived from a plurality of mass metrology measurements for one or more semiconductor wafers for different differences between the first temperature and the second temperature, and a known mass of the semiconductor wafer.~~

~~97.~~ The semiconductor wafer mass metrology apparatus according to any one of the previous claims, wherein the first temperature changing part comprises a first thermal transfer plate thermally coupled to the measurement chamber; wherein optionally the apparatus is configured to load the semiconductor wafer on to the first thermal transfer plate for a predetermined period of time

sufficient to achieve thermal equilibrium between the semiconductor wafer and the first thermal transfer plate.

~~10. The semiconductor wafer mass metrology apparatus according to claim 9, wherein the apparatus is configured to load the semiconductor wafer on to the first thermal transfer plate for a predetermined period of time sufficient to achieve thermal equilibrium between the semiconductor wafer and the first thermal transfer plate.~~

~~11~~8. The semiconductor wafer mass metrology apparatus according to claim ~~9 or claim 10~~7, wherein:

the apparatus comprises a vacuum clamp for vacuum clamping the semiconductor wafer to the thermal transfer plate;

the apparatus comprises a sensor for sensing incomplete vacuum clamping of the semiconductor wafer to the thermal transfer plate; and

the apparatus comprises a control unit configured to control an operation of the apparatus based on an output of the sensor for sensing incomplete vacuum clamping of the semiconductor wafer to the thermal transfer plate.

~~12~~9. The semiconductor wafer mass metrology apparatus according to any one of the previous claims, wherein:

the first temperature changing part comprises a first thermal transfer plate; and

the first temperature sensor is embedded in the first thermal transfer plate, wherein optionally the first temperature sensor is embedded in the first thermal transfer plate at a distance between 1 to 18 mm from a semiconductor wafer supporting surface of the first

thermal transfer plate, wherein the distance is optionally between 2 to 12 mm; or

the first temperature sensor is provided on a surface of the first thermal transfer plate; or

the first temperature sensor is a non-contact temperature sensor that is not in direct contact with the first thermal transfer plate.

~~13.— The semiconductor wafer mass metrology apparatus according to claim 12, wherein the first temperature sensor is embedded in the first thermal transfer plate at a distance between 1 to 18 mm from a semiconductor wafer supporting surface of the first thermal transfer plate, wherein the distance is optionally between 2 to 12 mm.~~

~~14~~10. A semiconductor wafer mass metrology method comprising:

changing a temperature of a semiconductor wafer using a first temperature changing part (7) before the semiconductor wafer is transported into a measurement chamber (5) for measuring the weight and/or the mass of the semiconductor wafer; and

sensing a first temperature, ~~wherein the~~ semiconductor wafer mass metrology method being characterized in that the first temperature is:

a temperature of the first temperature changing part; ~~or~~

~~———— a temperature of the semiconductor wafer when the semiconductor wafer is on the first temperature changing part, or when the semiconductor wafer leaves the first temperature changing part.~~

~~15~~11. The semiconductor wafer mass metrology method according to claim ~~14~~10, wherein the temperature of the first temperature changing part is measured when the semiconductor wafer is on the first temperature changing part, or when the semiconductor wafer leaves the first temperature changing part.

~~16~~12. The semiconductor wafer mass metrology method according to claim ~~14~~10 or claim ~~15~~11, wherein the method comprises detecting:

a change in the temperature of the first temperature changing part caused by the semiconductor wafer; and/or

a maximum temperature of the first temperature changing part caused by the semiconductor wafer.

~~17~~13. The semiconductor wafer mass metrology method according to any one of claims ~~14~~10 to ~~16~~12, wherein:

the method further comprises changing the temperature of the semiconductor wafer using a second temperature changing part before the temperature of the semiconductor wafer is changed using the first temperature changing part;

the first temperature changing part is for passively cooling the semiconductor wafer; and

the second temperature changing part is for actively cooling the semiconductor wafer.

~~18~~14. The semiconductor wafer mass metrology method according to any one of claims ~~14~~10 to ~~17~~13, wherein the method further comprises performing an operation based on:

the sensed first temperature; and/or
 a change in the sensed first temperature; and/or
 a difference between the sensed first temperature and
 a second temperature that is a temperature of the
 measurement chamber; wherein optionally performing the
 operation comprises:

generating an alert; or
correcting a mass measurement for the
semiconductor wafer based on the difference between the
first temperature and the second temperature and a
predetermined relationship between the difference between
the first temperature and the second temperature and a
mass measurement error,
wherein optionally the predetermined relationship is
derived from a plurality of mass metrology measurements
for one or more semiconductor wafers for different
differences between the first temperature and the second
temperature, and a known mass of the semiconductor wafer.

~~19. The semiconductor wafer mass metrology method
 according to claim 18, wherein performing the operation
 comprises:~~

~~generating an alert; or~~
~~correcting a mass measurement for the~~
~~semiconductor wafer based on the difference between the~~
~~first temperature and the second temperature and a~~
~~predetermined relationship between the difference between~~
~~the first temperature and the second temperature and a~~
~~mass measurement error.~~

~~20. The semiconductor wafer mass metrology method
 according to claim 19, wherein the predetermined
 relationship is derived from a plurality of mass metrology~~

~~measurements for one or more semiconductor wafers for different differences between the first temperature and the second temperature, and a known mass of the semiconductor wafer.~~

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2115. The semiconductor wafer mass metrology method according to any one of claims 1410 to 2014, wherein the temperature changing part comprises a thermal transfer plate thermally coupled to the measurement chamber.

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2216. The semiconductor wafer mass metrology method according to any one of claims 1410 to 2115, wherein:

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the method comprises vacuum clamping the semiconductor wafer to the thermal transfer plate; sensing incomplete vacuum clamping of the semiconductor wafer to the thermal transfer plate; and performing an operation based on the sensing of the incomplete vacuum clamping of the semiconductor wafer to the thermal transfer plate.

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