Claims

[Claim 1]

A method for manufacturing a magnetoresistive element, comprising:

a step of forming one of a magnetization free layer and a magnetization pinned layer;

a step of forming a tunnel barrier layer on top of the formed one of the magnetization free layer and the magnetization pinned layer; and

a step of forming the other of the magnetization free layer and the magnetization pinned layer on top of the tunnel barrier layer,

wherein the step of forming the tunnel barrier layer comprises

a deposition step of depositing a metal film on top of a substrate, and

an oxidation step of subjecting the metal film to an oxidation process,

wherein the oxidation step comprises

a step of holding the substrate having the metal film formed thereon, on a supporting portion protruding from a substrate holding surface of a substrate holder in a processing container in which the oxidation process is performed,

a step of supplying an oxygen gas to the substrate by introducing the oxygen gas into the processing container, in a state where the substrate is mounted on the supporting portion,

a substrate mounting step of mounting the substrate on the substrate holding surface, after start of introduction of the oxygen gas, and

a heating step of heating the substrate mounted on the substrate holding surface.

[Claim 2]
The method for manufacturing the magnetoresistive element according to claim 1, wherein the step of supplying includes introducing the oxygen gas at a temperature at which the metal film does not sublime.

[Claim 3]
The method for manufacturing the magnetoresistive element according to claim 1, wherein the substrate holding surface is heated before the substrate mounting step.

[Claim 4]
The method for manufacturing the magnetoresistive element according to claim 1, further comprising a step of stopping the introduction of the oxygen gas, before the heating step.

[Claim 5]
The method for manufacturing the magnetoresistive element according to claim 4,
wherein the step of stopping includes stopping the introduction of the oxygen gas before the mounting of the substrate on the substrate holding surface by the substrate mounting step,
wherein the method for manufacturing further comprises an oxygen gas reintroduction step of introducing the oxygen gas into the processing container, after the mounting of the substrate on the substrate holding surface by the substrate mounting step.

[Claim 6]
The method for manufacturing the magnetoresistive element according to claim 5, wherein the oxygen gas reintroduction step includes introducing the oxygen gas, while moving the substrate closer to an oxygen gas

introduction unit provided in the processing container and configured to introduce the oxygen gas thereinto.

[Claim 7]

The method for manufacturing the magnetoresistive element according to claim 5, wherein the oxygen gas reintroduction step includes introducing the oxygen gas, while rotating the substrate in an in-plane direction of the substrate.

[Claim 8]

The method for manufacturing the magnetoresistive element according to claim 1, wherein the metal film is magnesium.

[Claim 9]

A method for manufacturing a magnetoresistive element, comprising:

a step of forming one of a magnetization free layer and a magnetization pinned layer;

a step of forming a tunnel barrier layer on top of the formed one of the magnetization free layer and the magnetization pinned layer; and

a step of forming the other of the magnetization free layer and the magnetization pinned layer on top of the tunnel barrier layer,

wherein the step of forming the tunnel barrier layer comprises

a deposition step of depositing a metal film on top of a substrate, and

an oxidation step of subjecting the metal film to an oxidation process,

wherein the oxidation step comprises

a step of holding the substrate having the metal film formed thereon, on a substrate holder in a processing container in which the oxidation process is performed,

a step of supplying an oxygen gas to the substrate by introducing the oxygen gas into the processing container, at a temperature at which the metal film does not sublime, and

a heating step of heating the substrate simultaneously with or after the introduction of the oxygen gas,

wherein the oxidation step further comprises a step of, after the step of holding, forming in the processing container a space formed by a substrate holding surface of the substrate holder and a surrounding portion provided in the processing container, by changing a relative position of the substrate holder with respect to the processing container, wherein the space is formed such that the substrate holding surface is surrounded by the surrounding portion and a gap is formed between the surrounding portion and the substrate holder,

wherein the oxygen gas introduced into the space is evacuated from the space through the gap.

[Claim 10]

The method for manufacturing the magnetoresistive element according to claim 9,

wherein the step of holding the substrate includes mounting the substrate on a supporting portion protruding from the substrate holding surface,

wherein the step of introducing includes supplying the oxygen gas to the substrate at the temperature at which the metal film does not sublime, in a state where the substrate is mounted on the supporting portion,

wherein the method for manufacturing further comprises a step of mounting the substrate mounted on the supporting portion, on the substrate holding surface,

wherein the heating step includes heating the substrate mounted on the substrate holding surface.

[Claim 11]
The method for manufacturing the magnetoresistive element according to claim 10, wherein the substrate holding surface is heated before the mounting of the substrate on the substrate holding surface.

[Claim 12]
The method for manufacturing the magnetoresistive element according to claim 11,
wherein the introduction of the oxygen gas is stopped before the step of mounting,
wherein the method for manufacturing further comprises an oxygen gas reintroduction step of introducing the oxygen gas into the processing container, after the step of mounting.

[Claim 13]
The method for manufacturing the magnetoresistive element according to claim 12, wherein the oxygen gas reintroduction step includes introducing the oxygen gas, while moving the substrate closer to an oxygen gas introduction unit provided in the processing container and configured to introduce the oxygen gas thereinto.

[Claim 14]
The method for manufacturing the magnetoresistive element according to claim 12, wherein the oxygen gas reintroduction step includes supplying the oxygen gas, while rotating the substrate in an in-plane direction of the substrate.

[Claim 15]
The method for manufacturing the magnetoresistive element according to claim 9, wherein the metal film is magnesium.