that transmitted through the phase shift film and an exposure light that transmitted through air for a same distance as a thickness of the phase shift film.

[0026]

(Configuration 19)

The transfer mask according to Configuration 18 including a light shielding film having a light shielding pattern with a light shielding band on the phase shift film.

[0027]

(Configuration 20)

The transfer mask according to Configuration 19, in which the light shielding film includes a material containing chromium.

[0028]

(Configuration 21)

A method of manufacturing a semiconductor device including the step of using the transfer mask according to any of Configurations 11 to 20 and exposure-transferring the pattern on the transfer mask to a resist film on a semiconductor substrate.

[Effect of the Invention]

[0029]

The mask blank of this invention has a structure where an etching stopper film and a thin film for pattern formation are stacked in this order on a transparent substrate, featured in that the thin film includes a material containing silicon, the etching stopper film includes a material containing hafnium, aluminum, and oxygen, and a ratio by atom% of an amount of the hafnium to a total amount of hafnium and aluminum in the etching stopper film is 0.86 or less. With the mask blank having such a structure, the etching stopper film can simultaneously achieve the functions of high durability to dry etching with fluorine-based gas used in

Claims

[Claim 1]

A mask blank having a structure where a transparent substrate has stacked thereon an etching stopper film and a thin film for pattern formation in this order,

wherein the thin film comprises a material containing silicon,

wherein the etching stopper film comprises a material containing hafnium, aluminum, and oxygen, and

wherein a ratio by atom% of an amount of the hafnium to a total amount of the hafnium and the aluminum in the etching stopper film is 0.86 or less.

[Claim 2]

The mask blank according to claim 1, wherein a ratio by atom% of an amount of the hafnium to a total amount of the hafnium and the aluminum in the etching stopper film is 0.60 or more.

[Claim 3]

The mask blank according to claim 1 or 2, wherein an oxygen content of the etching stopper film is 60atom% or more.

[Claim 4]

The mask blank according to any of claims 1 to 3, wherein the etching stopper film has an amorphous structure in a state comprising a bond of hafnium and oxygen and a bond of aluminum and oxygen.

[Claim 5]

The mask blank according to any of claims 1 to 4, wherein the etching stopper film consists of hafnium, aluminum, and oxygen.

[Claim 6]

The mask blank according to any of claims 1 to 5, wherein the etching stopper film is formed in contact with a main surface of the transparent substrate.

[Claim 7]

The mask blank according to any of claims 1 to 6, wherein the etching stopper film has a thickness of 2nm or more.

[Claim 8]

The mask blank according to any of claims 1 to 7, wherein the thin film is a phase shift film, having a function to generate a phase difference of 150 degrees or more and 210 degrees or less between an exposure light that transmitted through the phase shift film and an exposure light that transmitted through air for a same distance as a thickness of the phase shift film.

[Claim 9]

The mask blank according to claim 8, wherein a light shielding film is provided on the phase shift film.

[Claim 10]

The mask blank according to claim 9, wherein the light shielding film comprises a material containing chromium.

[Claim 11]

A transfer mask having a structure where a transparent substrate has stacked thereon an etching stopper film and a thin film having a transfer pattern in this order,

wherein the thin film comprises a material containing silicon,

wherein the etching stopper film comprises a material containing hafnium, aluminum, and oxygen, and

wherein a ratio by atom% of an amount of the hafnium to a total amount of the hafnium and the aluminum in the etching stopper film is 0.86 or less.

[Claim 12]

The transfer mask according to claim 11, wherein a ratio by atom% of an amount of the hafnium to a total amount of the hafnium and the aluminum in the etching stopper film is 0.60 or more.

[Claim 13]

The transfer mask according to claim 11 or 12, wherein an oxygen content of the etching stopper film is 60atom% or more.

[Claim 14]

The transfer mask according to any of claims 11 to 13, wherein the etching stopper film has an amorphous structure in a state including a bond of hafnium and oxygen and a bond of aluminum and oxygen.

[Claim 15]

The transfer mask according to any of claims 11 to 14, wherein the etching stopper film consists of hafnium, aluminum, and oxygen.

[Claim 16]

The transfer mask according to any of claims 11 to 15, wherein the etching stopper film is formed in contact with a main surface of the transparent substrate.

[Claim 17]

The transfer mask according to any of claims 11 to 16, wherein the etching stopper film has a thickness of 2nm or more.

[Claim 18]

The transfer mask according to any of claims 11 to 17, wherein the thin film is a phase shift film, the phase shift film having a function to generate a phase difference of 150 degrees or more and 210 degrees or less between an exposure light that transmitted through the phase shift film and an exposure light that transmitted through air for a same distance as a thickness of the phase shift film.

[Claim 19]

The transfer mask according to claim 18 comprising a light shielding film having a light shielding pattern with a light

shielding band on the phase shift film.

[Claim 20]

The transfer mask according to claim 19, wherein the light shielding film comprises a material containing chromium.

[Claim 21]

A method of manufacturing a semiconductor device comprising the step of using the transfer mask according to any of claims 11 to 20 and exposure-transferring the pattern on the transfer mask to a resist film on a semiconductor substrate.