[CLAIMS]

[Claim 1]

A photomask blank used for fabricating a photomask to which an exposure light with a wavelength of 193 nm is applied, the photomask blank comprising:

a light-transmissive substrate;

a phase shift film formed on the light-transmissive substrate and providing a phase shift effect; and

a light shielding film formed on the phase shift film,

wherein the phase shift film is composed by laminating

a first phase shift film using a silicon nitride-based material, and

a second phase shift film using a silicon oxynitride-based material,

the phase shift film has a light transmittance of 30 % or more with respect to the exposure light,

the first phase shift film has a refractive index n_1 of 2.5 or more and 2.75 or less, and the second phase shift film has a refractive index n_2 of 1.55 or more and 2.20 or less, and

the first phase shift film has an extinction coefficient k_1 of 0.2 or more and 0.4 or less, and the second phase shift film has an extinction coefficient k_2 that is greater than 0 and no greater than 0.1, and

wherein a total film thickness of the phase shift film is greater than 70 nm and is 114 nm or less.

[Claim 2]

The photomask blank according to claim 1,

wherein the phase shift film is composed by laminating the second phase shift film on the first phase shift film that is formed on the light-transmissive substrate.

[Claim 3]

The photomask blank according to claim 1 or claim 2,

wherein in the phase shift film, a film thickness D_1 of the first phase shift film and a film thickness D_2 of the second phase shift film satisfies the following relationship:

D_1 (nm) > -0.5 · D_2 (nm) + 45 nm, and

D_1 (nm) < -0.5 · D_2 (nm) + 75 nm.

[Claim 4]

The photomask blank according to any one of claims 1 through 3,

wherein the light shielding film is substantially not etched by fluorine-based dry etching and is capable of being etched by oxygen-containing chlorine-based dry etching, and has a chromium content of 20 atomic % or more.

[Claim 5]

A photomask to which an exposure light with a wavelength of 193 nm is applied, the photomask comprising a light-transmissive substrate, and a circuit pattern which is a pattern formed on a phase shift film laminated on the light-transmissive substrate,

wherein the phase shift film is composed by laminating

a first phase shift film using a silicon nitride-based material, and

a second phase shift film using a silicon oxynitride-based material,

the phase shift film has a light transmittance of 30 % or more with respect to the exposure light,

the first phase shift film has a refractive index n_1 of 2.5 or more and 2.75 or less, and the second phase shift film has a refractive index n_2 of 1.55 or more and 2.20 or less, and

the first phase shift film has an extinction coefficient k_1 of 0.2 or more and 0.4 or less, and the second phase shift film has an extinction coefficient k_2 that is greater than 0 and no greater than 0.1, and

wherein a total film thickness of the phase shift film is greater than 70 nm and is 114 nm or less.

[Claim 6]

The photomask according to claim 5,

wherein the phase shift film is composed by forming the first phase shift film on the light-transmissive substrate, and further laminating the second phase shift film on the first phase shift film.

[Claim 7]

The photomask according to claim 5 or claim 6,

wherein in the phase shift film, a film thickness D_1 of the first phase shift film and a film thickness D_2 of the second phase shift film satisfies the following relationship:

D_1 (nm) > -0.5 · D_2 (nm) + 45 nm, and

D_1 (nm) < -0.5 · D_2 (nm) + 75 nm.

[Claim 8]

The photomask according to any one of claims 5 through 7,

wherein the photomask comprises a light shielding film laminated on the phase shift film positioned at a periphery portion of an effective area including the circuit pattern, and

the light shielding film is substantially not etched by fluorine-based dry etching and is capable of being etched by oxygen-containing chlorine-based dry etching, and has a chromium content of 20 atomic % or more.

[Claim 9]

The photomask according to claim 8,

wherein a light transmittance to the exposure light of a laminated film conbining with the light shielding film and the phase shift film provided on the periphery portion is 0.1 % or less.

[Claim 10]

A photomask manufacturing method using the photomask blank according to any one of claims 1 through 4, the method comprising:

a step of forming a pattern on the light shielding film by performing dry etching using an oxygen-containing chlorine-based gas to the light shielding film;

a step of forming a circuit pattern and a periphery portion pattern that forms a periphery portion of an area including the circuit pattern on the phase shift film, by performing dry etching using a fluorine-based gas to the phase shift film using the pattern formed on the light shielding film as a mask;

a step of forming a resist pattern on the periphery portion pattern, and performing dry etching using an oxygen-containing chlorine-based gas using the resist pattern as a mask to remove a portion of the light shielding film; and

a step of removing the resist pattern.