substrate is for use in a transfer mask (for example, a transmission-type mask such as a binary mask, ~~a transmission-type mask such as~~ a phase shift mask, and so on) for manufacture of a semiconductor device. Therefore, the transparent substrate 1 is not particularly limited as far as the substrate is transparent with respect to an exposure wavelength to be used. A synthetic quartz substrate and other glass substrates of various kinds (for example, soda lime glass, aluminosilicate glass, and so on) may be used. Among others, the synthetic quartz substrate is particularly preferably used because it is highly transparent with respect to an ArF excimer laser (wavelength of 193 nm) effective in fine pattern formation or in a shorter-wavelength region.

[0043]

In case of a mask blank for manufacture of a transmission-type mask, a light-shielding film, a semi-transmissive film, a phase shift film, or a multilayer film comprising those films is used as the thin film 2. If the thin film 2 is the phase shift film, the thin film preferably has a function of transmitting, for example, exposure light of an ArF excimer laser (wavelength of 193 nm) at a transmittance of 2% or more and a function of causing the exposure light having been transmitted through the thin film to have a phase difference of 150 degrees or more and 200 degrees or less with respect to the exposure light having passed through air for the same distance as a thickness of the thin film. Depending on purposes, a hard mask film or an etching stopper film may be further added. The thin film 2 may be a single-layer film or a multilayer film comprising multiple films of the same kind or different kinds. As a material of the thin film 2, for example, a material containing chromium (Cr), a material containing silicon (Si), a material containing silicon (Si) and transition metal (such as Mo), a material containing tantalum (Ta) may be used, of course not being limited to those materials.

[0044]

A method for forming the thin film 2 on the transparent substrate 1 such as

CLAIMS

1. A transmission-type mask blank comprising a transparent substrate having a main surface on which a thin film for forming a transfer pattern is formed, wherein:

a defect is present on the main surface of the transparent substrate, and the defect has no effect on a transferred image by a transmission-type transfer mask manufactured using the transmission-type mask blank when the defect is not overlapped with the thin film, in the case where; and

the defect satisfies a relationship:

$L \leq 97.9 \times w^{-0.4}$

where w represents a width of the defect as seen from the side of the main surface and L represents a length of the defect from the main surface to an end of the defect in a direction that is perpendicular to the main surface; and

the defect has no effect on a transferred image by a transfer mask when the transfer mask is manufactured using the mask blank the length of the defect is 4 nm or more.

2. The transmission-type mask blank according to claim 1, wherein the length L of the defect is 13 nm or less.

3. The transmission-type mask blank according to claim 1 or 2, wherein the width w of the defect is 200 nm or less.

4. The transmission-type mask blank according to any one of claims 1 to 3, wherein the defect is present on the main surface of the transparent substrate in a region where a transfer pattern is to be formed on the thin film.

5. The transmission-type mask blank according to any one of claims 1 to 4, wherein the defect contains silicon and oxygen.

6. The transmission-type mask blank according to any one of claims 1 to 5,

wherein the thin film has a function of transmitting exposure light of an ArF excimer laser at a transmittance of 2% or more and a function of causing the exposure light having been transmitted through the thin film to have a phase difference of 150 degrees or more and 200 degrees or less with respect to exposure light having passed through air for the same distance as a thickness of the thin film.

7. A transmission-type transfer mask comprising a transparent substrate having a main surface on which a thin film formed with a transfer pattern is provided, wherein:

a defect is present on the main surface of the transparent substrate, and the defect has no effect on a transferred image by the transmission-type transfer mask when the defect is not overlapped with the thin film, in the case where; and

the defect satisfies a relationship:

$L \leq 97.9 \times w^{-0.4}$

where w represents a width of the defect as seen from the side of the main surface and L represents a length of the defect from the main surface to an end of the defect in a direction that is perpendicular to the main surface; and

the defect has no effect on a transferred image by the transfer mask the length of the defect is 4 nm or more.

8. The transmission-type transfer mask according to claim 7, wherein the length L of the defect is 13 nm or less.

9. The transmission-type transfer mask according to claim 7 or 8, wherein the width w of the defect is 200 nm or less.

10. The transmission-type transfer mask according to any one of claims 7 to 9, wherein the defect is present on the main surface of the transparent substrate in a region where a transfer pattern is formed on the thin film.

11. The transmission-type transfer mask according to any one of claims 7 to 10, wherein the defect contains silicon and oxygen.

12. The transmission-type transfer mask according to any one of claims 7 to 11, wherein the thin film has a function of transmitting exposure light of an ArF excimer laser at a transmittance of 2% or more and a function of causing the exposure light having been transmitted through the thin film to have a phase difference of 150 degrees or more and 200 degrees or less with respect to exposure light having passed through air for the same distance as a thickness of the thin film.

13. A method for manufacturing a semiconductor device, comprising a step of exposure-transferring a transfer pattern onto a resist film on a semiconductor substrate by using the transmission-type transfer mask according to any one of claims 7 to 12.