SUMMARY OF INVENTION

Embodiments of the invention seek to provide a mask blank having few particle defects, especially wherein the number of particle defects with a certain size is zero; and a method for preparing the mask blank.

With respect to a mask blank comprising a substrate which is transparent to exposure light, and a film formed on the substrate and consisting of a single layer or plural layers, the single layer or each of plural layers being selected from an optical functional film and a processing aid film, the inventors have found that the problem may be solved when the film is formed only on the front surface of the substrate, but not on the side surface, chamfer, front surface-chamfer boundary, and back surface-chamfer boundary of the substrate. In the process of preparing the mask blank including the step of handling a substrate with a handling tool by bringing the handling tool in contact with the side surface, chamfer, front surface-chamfer boundary, or back surface-chamfer boundary of the substrate, thus leaving a contact mark at the contact site, the invention avoids the generation of particle defects which are generated in the film if deposited on contact marks. Also in the step of handling the mask blank itself by bringing the handling tool in contact with the side surface, chamfer, front surface-chamfer boundary, or back surface-chamfer boundary of the substrate, the generation of particle defects caused by the contact may be avoided since the film is absent at the contact sites. As a result, there is provided a mask blank wherein few particle defects are generated, especially wherein the number of particle defects with a certain size is zero.

Accordingly, an aspect of the present invention provides a mask blank comprising a substrate which is transparent to exposure light, the substrate having a front surface, back surface,

side surface, and chamfer, and a film (A), wherein the mask blank is a binary mask blank or a phase shift mask blank, said film (A) is formed contiguous to the substrate by sputtering, said film (A)consists of a single layer or plural layers, the single layer or each of said plural layers being selected from an optical functional film and a processing aid film, all of the layer(s) of the film (A) being formed only on the front surface of the substrate, but not on the side surface, the chamfer, the boundary between the front surface and the chamfer, and the boundary between the back surface and the chamfer, and all of the layer(s) of said film (A) being formed only on a region of the front surface that extends inward from a distance of 1 mm from the side surface and not formed on the front surface-chamfer boundary.

In a preferred embodiment, the film is not formed on a region of the front surface that extends a distance of 0.6 mm from the side surface.

In a preferred embodiment, the film consisting of plural layers is formed on the substrate, the plural layers include two contiguous layers, a layer which is disposed adjacent to the substrate and a layer which is disposed remote from the substrate, and the region where the layer disposed remote from the substrate is formed is not wider than the region where the layer disposed adjacent to the substrate is formed.

In a more preferred embodiment, the region where the layer disposed remote from the substrate is formed is narrower than the region where the layer disposed adjacent to the substrate is formed so that a portion of the surface of the layer disposed adjacent to the substrate is exposed.

In a more preferred embodiment, the layer disposed adjacent to the substrate is a conductive film, the layer disposed remote from the substrate is a non-conductive film, and the layer disposed remote from the substrate is not formed on a region of the front surface that extends a distance of 2 mm from the side surface.

Preferably, the conductive film has a sheet resistivity of up to 150 kΩ/□.

CLAIMS:

1. A mask blank comprising

a substrate which is transparent to exposure light, the substrate having a front surface, back surface, side surface, and chamfer, and

a film (A), wherein

the mask blank is a binary mask blank or a phase shift mask blank,

said film (A) is formed contiguous to the substrate by sputtering,

said film (A) consists of a single layer or plural layers, said single layer or each of said plural layers being selected from an optical functional film and a processing aid film,

all of the layer(s) of said film (A) being formed only on the front surface of the substrate, but not on the side surface, the chamfer, the boundary between the front surface and the chamfer, and the boundary between the back surface and the chamfer, and

all of the layer(s) of said film (A) being formed only on a region of the front surface that extends inward from a distance of 1 mm from the side surface and not formed on the front surface-chamfer boundary.

2. The mask blank of claim 1 wherein

said film (A) consists of plural layers,

the plural layers include one or more of combinations consisting of two contiguous layers,

each of the combinations consists of a layer which is disposed adjacent to the substrate and a layer which is disposed remote from the substrate, and

in said each of the combinations, the region where the layer disposed remote from the substrate is formed is not wider than the region where the layer disposed adjacent to the substrate is formed.

3. The mask blank of claim 2 wherein

in any of said combinations, the region where a layer (A) disposed remote from the substrate is formed is narrower than the region where a layer (B) disposed adjacent to the substrate is formed so that a portion of the surface of the layer disposed adjacent to the substrate is exposed.

4. The mask blank of claim 3 wherein the layer (B) is a conductive film, the layer (A) is a non-conductive film, and the layer (A) disposed remote from the substrate is not formed on a region of the front surface that extends a distance of 2 mm from the side surface.

5. The mask blank of claim 4 wherein the conductive film has a sheet resistivity of up to 150 kΩ/□.

6. The mask blank of claim 1 wherein

said film (A) consists of plural layers, and

the plural layers include an outermost layer which is composed of a non-conductive silicon oxide-based material.

7. The mask blank of claim 1 wherein

the optical functional film is selected from a phase shift film composed of a silicon-containing material, a light-shielding film composed of a silicon-containing material, and a light-shielding film composed of a chromium-containing material.

8. The mask blank of claim 1

wherein the processing aid film is selected from a hard mask film composed of a silicon-containing material and a hard mask film composed of a chromium-containing material.

9. The mask blank of claim 1, further comprising a resist film contiguous to said film (A).

10. A method for preparing the mask blank of claim 1, comprising the steps of:

placing a shield member having an opening on the substrate; and

sputter depositing said film (A) on the substrate through the opening of the shield member, wherein

during the sputter deposition, the shield member is placed on the substrate, but closely spaced apart therefrom to cover a predetermined region of the substrate so that said film (A) is formed only on the front surface of the substrate, but not on the side surface, the chamfer, the boundary between the front surface and the chamfer, and the boundary between the back surface and the chamfer.

11. The mask blank of claim 1 wherein

the optical functional film is selected from the group consisting of a light-shielding film, a light-shielding film including an antireflective film, and a phase shift film, and the processing aid film is selected from the group consisting of a hard mask film, an etching stop film and an electrically conductive film.

12. The mask blank of claim 1 wherein

all of the layer(s) of said film (A) is formed only on a region of the front surface that extends inward from a distance of 3 mm from the side surface.

13. The mask blank of claim 1 wherein the substrate is a 6-inch square substrate.