In the embodiment, the target 104A used when forming the phase-shift layer 12 contains dopants reducing a specific resistance of silicon. As the boron concentration is set in the above-mentioned range, the specific resistance of the target 104A can be set in the aforementioned range. Therefore, electric power for forming plasma is stabilized, plasma in a state of forming a film is stabilized, and it is possible to form the phase-shift layer 12. As a result, the film formation characteristics can be improved. Additionally, it is possible to cause dopants to be contained in the phase-shift layer 12, and it is possible to improve the film characteristics of the mask layer including the phase-shift layer 12.

[0109]

Additionally, the etching rate with respect to the mask layer increases, and it is possible to reduce the etching time with respect to the mask layer during pattern formation. Furthermore, since the etching rate of the mask layer with respect to the glass substrate increases, etching processing can be easily controlled in accordance with determination of an end point for determining completion of etching. Consequently, a depth at which the glass substrate 11 is excessively etched can be minimally reduced.

[0110]

Moreover, the target 104A is silicon single crystal or polycrystalline silicon and is formed by an FZ method, a CZ method, or a cast growth method. The uniformity of a state in which the target 104A contains the dopants is maintained, the uniformity of a dopant concentration is maintained even in an atmosphere in which plasma is generated, and the uniformity of the dopant concentration in the formed mask layer can be maintained.

[0111]

Furthermore, in the method of manufacturing the mask blank according to the embodiment, since the DC sputtering is used as the sputtering of the mask-layer

	FILM FORMATION TIME (sec)	TOTAL NUMBER OF DEFECTS GREATER THAN OR EQUAL TO 0.5 μm	REPRODUCIBILITY OF PHASE DIFFERENCE IN CASE OF CONTINUOUSLY FORMING FILMS 10 TIMES (deg)
EXPERIMENTAL EXAMPLE 1	850	3	2
EXPERIMENTAL EXAMPLE 2	980	33.9	3.9
EXPERIMENTAL EXAMPLE 3	1750	5.5	6.1

[0129]

Here, since it is necessary to induce a voltage to the surface of the target in a case of carrying out reactive sputtering, it is necessary to reduce the electrical resistance of the target for DC sputtering. However, in order to cause a high resistance target such as non-doped silicon to be subjected to sputtering, it was necessary to apply a high-frequency thereto and RF sputtering was thereby required.

From the above-described results, DC sputtering was possible by adding dopants to Si, and it was understood that the film formation time, defects, and the reproducibility were improved.

[0130]

Particularly, as compared with the case of carrying out DC sputtering using the non-doped silicon target such as Experimental Example 2, in the case of carrying out DC sputtering using the high-concentrated B-doped silicon target in Experimental Example 1, the reproducibility of the phase difference was higher, and it was possible to carry out film formation in a state in which the number of defects was extremely low.

Furthermore, as compared with the case of carrying out RF sputtering using the non-doped silicon target such as Experimental Example 3, in the case of the DC sputtering using the high-concentrated B-doped silicon target in Experimental Example 1, it was understood that the reproducibility of the phase difference was extremely

boron-doped (B-doped) target, it was understood that the etching rate was higher under the same bias value. Moreover, it was understood that the selection ratio of the boron-doped (B-doped) target was improved.

[0135]

<Experimental Example 6>

A light-shielding layer containing Cr as a main component and an antireflection layer were stacked on the mask layer obtained by Experimental Example 1 in layers, and a resist layer was formed on the antireflection layer.

Next, the aforementioned multi-layered body was subjected to dry etching under the same conditions as those of Experimental Examples 4 and 5. Thereafter, the cross-sectional configuration of the multi-layered body was observed.

Here, the bias power was 100 W.

A SEM image of Experimental Example 6 is shown in FIG. 14. Note that, in FIG. 14, the surface of the quartz substrate close to the mask layer on which a pattern was formed is represented by a dotted line.

[0136]

<Experimental Example 7>

Similarly to Experimental Example 6, a light-shielding layer containing Cr as a main component and an antireflection layer were stacked on the mask layer obtained by Experimental Example 3 in layers, and a resist layer was formed on the antireflection layer.

Next, the aforementioned multi-layered body was subjected to dry etching under the same conditions as those of Experimental Examples 4 and 5. Thereafter, the cross-sectional configuration of the multi-layered body was observed.

Here, the bias power was 100 W.

A SEM image of Experimental Example 7 is shown in FIG. 15. Note that, in FIG. 15, the surface of the quartz substrate close to the mask layer on which a pattern was formed is represented by a dotted line.

[0137]

From the results shown in FIG. 15, in Experimental Example 7 in which film formation was carried out using a non-doped target, it was understood that, since the selection ratio was low, a degree of over etching of the quartz substrate increased. Accordingly, since displacement of phase difference occurred in Experimental Example 7, it was understood that the optical characteristics of a photomask became degraded.

[0138]

In contrast, from the results shown in FIG. 15, in Experimental Example 6 in which film formation was carried out using the boron-doped (B-doped) target, it was understood that, since the selection ratio was large, a degree of over etching of the quartz substrate decreased. For this reason, in Experimental Example 6, it was understood that the displacement of phase difference was reduced and the optical characteristics of the photomask were improved.

[0139]

In the method of manufacturing the mask blank according to the invention, the sputtering may be carried out under conditions in which DC input power is set to be 0.1 to 0.2 to 4.0 kW and film formation pressure is set to be 0.05 to 0.6 to 0.7 Pa.

Consequently, it is possible to stabilize electric discharge.

[0140]

In the method of manufacturing the photomask according to the invention, the plasma forming power may be set to be 0.2 to 1.0 kW, the bias power may be set to be 10 to 80 W, and CF_4 may be set to be 100 to 200 sccm in the dry etching conditions of the