using exposure light of wavelength up to 200 nm, the photomask blank comprising a transparent substrate, a first film disposed on the substrate and formed of a material which is etchable by chlorine/oxygen-based dry etching with a gas mixture of chlorine and oxygen gases and resistant against fluorine-based dry etching with a fluorine-containing gas, and a second film disposed contiguous to the first film and formed of a silicon-containing material which is not substantially etched during the chlorine/oxygen-based dry etching of the first film. The second film is composed of multiple layers including at least one layer having a refractive index n of at least 1.6 or an extinction coefficient k of at least 0.3 with respect to the wavelength of inspection light used in a defect inspection step, which is longer than the exposure light wavelength, and the difference in refractive index n with respect to the inspection light wavelength between a layer having the highest refractive index and a layer having the lowest refractive index is at least 0.5, or the difference in extinction coefficient k with respect to the inspection light wavelength between a layer having the highest extinction coefficient and a layer having the lowest extinction coefficient is at least 0.3.

In a preferred embodiment, the second film has a thickness of 2 nm to 20 nm.

In a preferred embodiment, the silicon-containing material of the second film is silicon alone, a silicon-containing compound containing silicon and at least one light element selected from oxygen, nitrogen and carbon, or a transition metal/silicon-containing compound containing silicon, at least one light element selected from oxygen, nitrogen and carbon, and up to 20 at% of a transition metal. Typically the light element comprises oxygen and/or nitrogen.

In a preferred embodiment, the second film is composed of multiple layers, and the difference in refractive index n with respect to inspection light wavelength between a layer having the highest refractive index and a layer having the lowest refractive index is at least 0.5, or the difference in extinction coefficient k with respect to inspection light wavelength between a layer having the highest extinction coefficient and a layer having the lowest extinction coefficient is at least 0.3.

In a preferred embodiment, in the second film, a layer disposed remotest from the first film has a total content of oxygen and nitrogen and a layer disposed contiguous to the first film has a total content of oxygen and nitrogen, the former content being higher than the latter content.

Often the defects are penetrating pinhole defects. Typically, the exposure light is ArF excimer laser light and the inspection light has a wavelength of up to 600 nm.

The invention also provides a method for preparing the photomask blank, comprising the step of inspecting the photomask blank for defects at the inspection light wavelength.

CLAIMS:

1. A photomask blank which is processed into a transmissive photomask for use in photolithography for forming a pattern on a recipient using exposure light of wavelength up to 200 nm, the photomask blank comprising

a transparent substrate,

a first film disposed on the substrate and formed of a material which is etchable by chlorine/oxygen-based dry etching with a gas mixture of chlorine and oxygen gases and resistant against fluorine-based dry etching with a fluorine-containing gas, and

a second film disposed contiguous to the first film and formed of silicon-containing material which is not substantially etched during the chlorine/oxygen-based dry etching of the first film,

said second film being composed of multiple layers including at least one layer having a refractive index n of at least 1.6 or an extinction coefficient k of at least 0.3 with respect to the wavelength of inspection light used in a defect inspection step, which is longer than the exposure light wavelength, and

- the difference in refractive index n with respect to the inspection light wavelength between a layer having the highest refractive index and a layer having the lowest refractive index is at least 0.5, or

- the difference in extinction coefficient k with respect to the inspection light wavelength between a layer having the highest extinction coefficient and a layer having the lowest extinction coefficient is at least 0.3.

2. A photomask blank of claim 1 wherein the second film has a thickness of 2 nm to 20 nm.

3. A photomask blank of claim 2 wherein the second film has a thickness of at least 5 nm.

4. A photomask blank of any one of the preceding claims wherein the second film is composed of two to four layers.

5. A photomask blank of any one of the preceding claims wherein the silicon-containing materials of the layers of the second film are selected from silicon alone, silicon-containing compounds containing silicon and at least one light element selected from oxygen, nitrogen and carbon, and transition metal/silicon-containing compounds containing silicon, at least one light element selected from oxygen, nitrogen and carbon, and up to 20 at% of a transition metal.

6. A photomask blank of claim 5 wherein the light element comprises oxygen and/or nitrogen.

7. A photomask blank of any one of the preceding claims wherein in the second film the layer disposed remotest from the first film has a total content of oxygen and nitrogen which is higher than that of the layer disposed contiguous to the first film.

8. A photomask blank of any one of the preceding claims wherein in the second film the layer disposed remotest from the substrate is of silicon dioxide SiO2.

9. A photomask blank of any one of claims 1 to 6 wherein the first film comprises chromium or a chromium compound, such as chromium alone, chromium oxide (CrO), chromium nitride (CrN), chromium carbide (CrC), chromium oxynitride (CrON), chromium oxycarbide (CrOC), chromium nitride carbide (CrNC) or chromium oxide nitride carbide (CrONC).

10. A photomask blank of any one of the preceding claims which is for use in said photolithography using ArF excimer laser light as said exposure light.

11. A photomask blank of any one of the preceding claims wherein said second film has said properties of refractive index or extinction coefficient with respect to a said inspection light having a wavelength of up to 600 nm, such as 213 nm, 355 nm, 488 nm or 532 nm.

12. A method of preparing a photomask blank as defined in any one of claims 1 to 10, comprising a step of inspecting the photomask blank for defects at said inspection light wavelength.

13. A method of preparing a photomask from a photomask blank of any one of claims 1 to 11, comprising first forming a mask pattern in the second film and then etching the underlying first film, which may constitute an optical functional film such as a light-shielding film or phase shift film, using the mask pattern of the second film which serves as an etching mask, thereby transferring the mask pattern of the second film to the first film.

14. A method of claim 13 in which the photomask blank is inspected for defects using said inspection light before being used for preparing the photomask.

15. A method of claim 12 or 14 in which the inspection is for penetrating pinhole defects.