CLAIMS

1. A mask blank comprising:

a substrate;

an etching stopper film formed on the substrate; and

a pattern-forming thin film formed on the etching stopper film,

wherein a thickness of the etching stopper film is 15 nm or less,

wherein a thickness of the pattern-forming film is 30 nm or more,

wherein the pattern-forming thin film contains one or more elements selected from silicon and tantalum, and

wherein the etching stopper film contains chromium, oxygen, and carbon, and

wherein a total content of chromium, oxygen, and carbon in the etching stopper film is 95 atomic% or more, and

wherein a chromium content of the etching stopper film is 50 atomic% or more, and

wherein a ratio of a carbon content [atomic%] of the etching stopper film divided by the total content [atomic%] of chromium, oxygen, and carbon, in the etching stopper film is 0.1 or more, and

wherein a nitrogen content of the etching stopper film is not higher than a detection lower limit in composition analysis by X-ray photoelectron spectroscopy.

2. The mask blank according to claim 1, wherein the chromium content of the etching stopper film is 80 atomic% or less.

3. The mask blank according to claim 1 or 2, wherein the carbon content of the etching stopper film is 10 atomic% or more and 20 atomic% or less.

4. The mask blank according to any one of claims 1 to 3, wherein an

oxygen content of the etching stopper film is 10 atomic% or more and 35 atomic% or less.

5. The mask blank according to any one of claims 1 to 4, wherein a silicon content of the etching stopper film is 1 atomic% or less.

6. The mask blank according to any one of claims 1 to 5, wherein, for each constituent element of the etching stopper film, a content of the constituent element in the etching stopper film does not change, along a direction that is orthogonal to a surface of the etching stopper film, by more than 10 atomic%.

7. The mask blank according to any one of claims 1 to 6, wherein a thickness of the etching stopper film is 3 nm or more ~~and 20 nm or less~~.

8. The mask blank according to any one of claims 1 to 7, comprising a hard mask film formed on the pattern-forming thin film and containing chromium.

9. The mask blank according to any one of claims 1 to 8, comprising a phase shift film formed between the substrate and the etching stopper film and containing silicon.

10. A method for using the mask blank according to claim 8 to manufacture a transfer mask, the method comprising:

performing a first dry etching to form a transfer pattern on the hard mask film, wherein a mask used for the first dry etching is a resist film formed on the hard mask film and having the transfer pattern and wherein a gas used for the first dry etching is a first mixture of a chlorine-based gas and an oxygen gas;

performing a second dry etching to form the transfer pattern on the pattern-forming thin film, wherein a mask used for the second dry etching is the hard mask film provided with the transfer pattern and wherein a gas used for the second dry etching is a fluorine-based gas; and

performing a third dry etching to form the transfer pattern on the etching

stopper film and to remove the hard mask film, wherein a mask used for the third dry etching is the pattern-forming thin film provided with the transfer pattern and wherein a gas used for the third dry etching is a second mixture of a chlorine-based gas and an oxygen gas.

11. A method for manufacturing a transfer mask using the mask blank according to claim 9, comprising:

performing a first dry etching to form a transfer pattern on the hard mask film, wherein a mask used for the first dry etching is a resist film formed on the hard mask film and having the transfer pattern and wherein a gas used for the first dry etching is a first mixture of a chlorine-based gas and an oxygen gas;

performing a second dry etching to form the transfer pattern on the pattern-forming thin film, wherein a mask used for the second dry etching is the hard mask film provided with the transfer pattern and wherein a gas used for the second dry etching is a first fluorine-based gas;

forming, on the hard mask film, a resist film having a light shielding pattern;

performing a third dry etching using a second mixture of a chlorine-based gas and an oxygen gas, to form the transfer pattern on the etching stopper film by using, as a mask, the pattern-forming thin film provided with the transfer pattern and simultaneously to form the light shielding pattern on the hard mask film by using, as a mask, the resist film having the light shielding pattern;

performing a fourth dry etching using a second fluorine-based gas, to form the transfer pattern on the phase shift film by using, as a mask, the etching stopper film provided with the transfer pattern and simultaneously to form the light shielding pattern on the pattern-forming thin film by using, as a mask, the hard mask film having the light shielding pattern; and

performing a fifth dry etching to form the light shielding pattern on the etching stopper film and to remove the hard mask film, wherein a mask used for the fifth dry etching is the pattern-forming thin film provided with the light shielding pattern and wherein a gas used for the fifth dry etching is a third mixture of a chlorine-based gas and an oxygen gas.

12. A method for manufacturing a semiconductor device, comprising exposure-transferring the transfer pattern onto a resist film on a semiconductor substrate by using a transfer mask manufactured by the method for manufacturing a transfer mask according to claim 10 or 11.