CLAIMS

1. A reflective mask blank for EUV lithography, comprising:

a substrate,

a multilayer reflective film reflecting EUV light, and

a phase shift film shifting a phase of the EUV light,

wherein the substrate, the multilayer reflective film, and the phase shift film are formed in this order,

the phase shift film comprises a layer 1 comprising ruthenium (Ru) and nitrogen (N), and

the layer 1 has an absolute value of a film stress of 1,000 MPa or less.

2. The reflective mask blank for EUV lithography according to claim 1, wherein a full width at half maximum FWHM of a diffraction peak attributed to an Ruhcp (002) plane among diffraction peaks derived from the layer 1 by an out of plane XRD method is 0.5° or more.

3. The reflective mask blank for EUV lithography according to claim 1, wherein a diffraction angle 2θ of a diffraction peak attributed to an Ruhcp (002) plane among diffraction peaks derived from the layer 1 by an out of plane XRD method is 42° or less.

4. The reflective mask blank for EUV lithography according to any one of claims 1 to 3, wherein a $(^{102}Ru^{+}+^{14}N^{+})/^{102}Ru^{+}$ average intensity ratio of the layer 1 measured by secondary ion mass spectrometry is 0.0030 or more and 0.020 or less.

5. The reflective mask blank for EUV lithography according to any one of claims 1 to 4, wherein the phase shift film further comprises a layer 2 comprising at least one element (X) selected from the group consisting of chromium (Cr), tantalum (Ta), titanium (Ti), rhenium (Re), tungsten (W), bismuth (Bi), manganese (Mn), platinum (Pt), copper (Cu), iridium (Ir), and vanadium (V).

6. The reflective mask blank for EUV lithography according to claim 5, wherein the

layer 2 further comprises at least one element selected from the group consisting of oxygen (O), N, boron (B), and carbon (C).

7. The reflective mask blank for EUV lithography according to claim 5, wherein the layer 2 further comprises Ru and at least one of O and N.

8. The reflective mask blank for EUV lithography according to any one of claims 1 to 7, wherein the phase shift film has a thickness of 20 nm to 60 nm.

9. The reflective mask blank for EUV lithography according to any one of claims 1 to 8, wherein a phase difference between reflected light of the EUV light from the multilayer reflective film and reflected light of the EUV light from the phase shift film is 150 degrees to 250 degrees, and

a relative reflectance between an EUV light reflectance of a surface of the phase shift film and an EUV light reflectance of a surface of the multilayer reflective film ((EUV light reflectance of surface of phase shift film/EUV light reflectance of surface of multilayer reflective film)×100) is 2% to 37%.

10. The reflective mask blank for EUV lithography according to any one of claims 1 to 9, wherein a protective film for the multilayer reflective film is formed between the multilayer reflective film and the phase shift film.

11. The reflective mask blank for EUV lithography according to claim 10, wherein the protective film comprises at least one element selected from the group consisting of Ru, palladium (Pd), Ir, rhodium (Rh), Pt, zirconium (Zr), niobium (Nb), Ta, Ti, and silicon (Si).

12. The reflective mask blank for EUV lithography according to claim 11, wherein the protective film further comprises at least one element selected from the group consisting of O, N, and B.

13. The reflective mask blank for EUV lithography according to any one of claims 1 to 12, further comprising an etching mask film on the phase shift film, the etching mask film

comprising at least one element selected from the group consisting of Nb, Ti, Mo, Ta, and Si.

14. The reflective mask blank for EUV lithography according to claim 13, wherein the etching mask film further comprises at least one element selected from the group consisting of O, N, and B.

15. A reflective mask for EUV lithography, comprising a pattern formed on the phase shift film of the reflective mask blank for EUV lithography according to any one of claims 1 to 14.

16. A method for manufacturing a reflective mask blank for EUV lithography, the method comprising:

forming a multilayer reflective film reflecting EUV light on or above a substrate; and

forming a phase shift film shifting a phase of the EUV light on or above the multilayer reflective film,

wherein the phase shift film comprises a layer 1 comprising Ru and N, and

the layer 1 is formed by performing a reactive sputtering method using a target comprising Ru in an inert gas atmosphere comprising argon (Ar) and N_2 and having a volume ratio of N_2 of 1 vol% to 40 vol%.

17. A method for manufacturing a reflective mask blank for EUV lithography, the method comprising:

forming a multilayer reflective film reflecting EUV light on or above a substrate; and

forming a phase shift film shifting a phase of the EUV light on or above the multilayer reflective film,

wherein the phase shift film comprises a layer 1 comprising Ru and N, and

the layer 1 is formed by performing a reactive sputtering method using a target comprising Ru in an inert gas atmosphere comprising Ar, krypton (Kr), and N_2 and having a volume ratio of N_2 of 1 vol% to 40 vol%.

18. A method for manufacturing a reflective mask for EUV lithography, the method comprising patterning a phase shift film of a reflective mask blank for EUV lithography

manufactured by the method for manufacturing a reflective mask blank for EUV lithography according to claim 16 or 17 to form a pattern.