CLAIMS

1. A method of manufacturing a mask blank substrate that is used in lithography, the method comprising:

conducting a surface processing for processing a main surface of a mask blank substrate on the side of which a transfer pattern is formed so as to obtain a prescribed surface morphology, and

carrying out a defect inspection on the main surface of the mask blank substrate using inspection light in the wavelength region of 150 nm to 365 nm or EUV light,

wherein the power spectral density at a spatial frequency of 1×10^{-2} μm^{-1} to 1 μm^{-1}, obtained by measuring a 0.14 mm × 0.1 mm region on the main surface of the mask blank substrate on the side of which the transfer pattern is formed at 640 × 480 pixels with a white-light interferometer, is not more than 4×10^{6} nm^4, and the power spectral density at a spatial frequency of not less than 1 μm^{-1}, obtained by measuring a 1 μm × 1 μm region on the main surface with an atomic force microscope, is not more than 10 nm^4.

2. The method according to claim 1, wherein the root mean square roughness (Rms) obtained by measuring a 1 μm × 1 μm region of the main surface with an atomic force microscope is less than 0.13 nm.

3. The method according to claim 1, wherein the power spectral density at a spatial frequency of 1 μm^{-1} to 10 μm^{-1} obtained by measuring a 1 μm × 1 μm region on the main surface with an atomic force microscope is 1 nm^4 to 10 nm^4, and

the defect inspection is carried out on the main surface of the mask blank substrate using the inspection light in the wavelength region of 150 nm to 365 nm.

4. The method according to claim 1, wherein the power spectral density at a spatial frequency of 10 μm^{-1} to 100 μm^{-1} obtained by measuring a 1 μm × 1 μm region on the main surface with an atomic force microscope is not more than 5 nm^4, and

the defect inspection is carried out on the main surface of the mask blank substrate using the EUV light.

5. The method according to claim 1, wherein the substrate is a mask blank substrate used in EUV lithography.

6. A method of manufacturing a substrate with a multilayer reflective film, comprising: forming a multilayer reflective film, in which a high refractive index layer and a low refractive index layer are alternately laminated, on the main surface of the mask blank substrate manufactured by the method according to claim 1.

7. The method according to claim 6, further comprising: forming a protective film on the multilayer reflective film.

8. A method of manufacturing a substrate with a multilayer reflective film, having a multilayer reflective film, in which a high refractive index layer and a low refractive index layer are alternately laminated, on a main surface of a mask blank substrate used in lithography, the method comprising:

forming the multilayer reflective film on the main surface of the mask blank substrate, and

carrying out a defect inspection on a surface of the substrate with a multilayer reflective film using inspection light in the wavelength region of 150 nm to 365 nm or EUV light,

wherein the power spectral density at a spatial frequency of 1×10^{-2} μm^{-1} to 1 μm^{-1}, obtained by measuring a 0.14 mm × 0.1 mm region on a surface of the substrate with a multilayer reflective film on the side of which the multilayer reflective film is formed at 640 × 480 pixels with a white-light interferometer, is not more than 4×10^{7} nm^4, and the power spectral density at a spatial frequency of 1 μm^{-1} to 100 μm^{-1}, obtained by measuring a 1 μm × 1 μm region on the surface of the substrate with a multilayer reflective film with an atomic force microscope, is not more than 20 nm^4.

9. The method according to claim 8, wherein the root mean square roughness (Rms) obtained by measuring a 1 μm × 1 μm region of the surface of the substrate with a multilayer reflective film with an atomic force microscope is less than 0.13 nm.

10. The substrate with a multilayer reflective film according to claim 8, further comprising: forming a protective film on the multilayer reflective film.

11. The method according to claim 8, wherein the power spectral density at a spatial frequency of 10 μm^{-1} to 100 μm^{-1} obtained by measuring a 1 $\mu m \times 1$ μm region on the surface of the substrate with a multilayer reflective film with an atomic force microscope is not more than 7.5 nm^4, and

the defect inspection is carried out on the surface of the substrate with a multilayer reflective film using EUV light.

12. A method of manufacturing a reflective mask blank, comprising: forming an absorber film to serve as a transfer pattern on the multilayer reflective film or a protective film of the substrate with a multilayer reflective film manufactured by the method according to claim 8.

13. The method according to claim 12, wherein the power spectral density at a spatial frequency of 1 μm^{-1} to 10 μm^{-1} obtained by measuring a 1 $\mu m \times 1$ μm region on a surface of the absorber film with an atomic force microscope is not more than 20 nm^4, and

the defect inspection is carried out on the surface of the absorber film using inspection light in the wavelength region of 150 nm to 365 nm.

14. The method according to claim 12, wherein the power spectral density at a spatial frequency of 10 μm^{-1} to 100 μm^{-1} obtained by measuring a 1 $\mu m \times 1$ μm region on a surface of the absorber film with an atomic force microscope is not more than 5 nm^4, and

the defect inspection is carried out on the surface of the absorber film using EUV light.

15. The method according to claim 12, further comprising: forming a resist film on the absorber film.

16. A method of manufacturing a reflective mask having an absorber pattern, the method comprising: forming the absorber pattern on the multilayer reflective film or protective film by patterning the absorber film in the reflective mask blank manufactured

by the method according to claim 12.

17. A method of manufacturing a semiconductor device, comprising: forming a transfer pattern on a workpiece by carrying out a lithography process that uses an exposure apparatus using the reflective mask manufactured by the method according to claim 16.