What is claimed is:

1. A reflective mask blank comprising:

a substrate; and

a multilayer reflective film provided on the substrate and configured to reflect exposure light, the multilayer reflective film including a periodic layered structure portion including a low refractive index layer and a high refractive index layer, wherein

the low refractive index layer contains ruthenium (Ru), and further contains one or both of carbon (C) and silicon (Si).

2. The reflective mask blank according to claim 1, wherein

the periodic layered structure portion includes an intermediate layer between at least one of the low refractive index layer and the high refractive index layer, the intermediate layer containing at least one selected from carbon (C), nitrogen (N), and oxygen (O).

3. The reflective mask blank according to claim 1 or 2,

wherein the periodic layered structure portion includes an intermediate layer between at least one of the low refractive index layer and the high refractive index layer, the intermediate layer containing at least one selected from molybdenum (Mo), niobium (Nb), and zirconium (Zr).

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

wherein a content of carbon (C) of the low refractive index layer is 4 atom% or more and 40 atom% or less.

5. The reflective mask blank according to any one of claims 1 to 4,

wherein a content of silicon (Si) of the low refractive index layer is 4 atom% or more and 40 atom% or less.

6. The reflective mask blank according to any one of claims 1 to 5, wherein

in an X-ray diffraction pattern by CuKα rays using an out-of-plane measurement method for the multilayer reflective film, a half-value width corresponding to a diffraction angle 2θ of a diffraction peak having the highest intensity observed at a diffraction angle 2θ between 41° and 47° is 4.0° or more.

7. The reflective mask blank according to any one of claims 1 to 6,

wherein an absolute value of film stress of the multilayer reflective film is 500 MPa or less.

8. The reflective mask blank according to any one of claims 1 to 7 comprising a protective film containing ruthenium

(Ru) provided on the multilayer reflective film.

9. The reflective mask blank according to any one of claims 1 to 8 comprising an absorber film provided on the multilayer reflective film.

10. A reflective mask comprising:

the reflective mask blank according to any one of claims 1 to 9; and

a patterned absorber film provided on the multilayer reflective film.

11. A method for manufacturing a reflective mask blank,

wherein the multilayer reflective film of the reflective mask blank according to any one of claims 1 to 9 is formed by a sputtering film formation method using a sputtering apparatus capable of mounting a plurality of targets in a chamber.