CLAIMS

1. An exposure apparatus that exposes an object with an energy beam via an optical member and forms a pattern on the object, the apparatus comprising:

a movable body that moves along a predetermined plane, while holding the object;

a holding member that holds the optical member; and

a first encoder that measures a distance between a predetermined reference position and the holding member in a first axis direction parallel to the plane.

2. The exposure apparatus according to Claim 1, further comprising:

a second encoder that measures a distance between the reference position and the holding member in a second axis direction that is parallel to the plane and different from the first axis direction.

3. The exposure apparatus according to Claim 2, wherein the second encoder has a second detection device that emits an illumination light, and measures a position in the second axis direction of the holding member with respect to the reference position by receiving a reflected light or a transmitted light from a second scale that moves relative to the illumination light.

4. The exposure apparatus according to Claim 3, wherein the first encoder has a first detection device that emits

an illumination light, and measures a position in the first axis direction of the holding member with respect to the reference position by receiving a reflected light or a transmitted light from a first scale that moves relative to the illumination light.

5. The exposure apparatus according to Claim 4, wherein the first scale and the second scale are arranged on the holding member.

6. The exposure apparatus according to any one of Claims 2 to 5, further comprising:

a measurement device that measures a displacement of the movable body with respect to the reference position; and

a controller that controls movement of the movable body, based on a measurement result of the measurement device and at least one of a measurement result of the first encoder and a measurement result of the second encoder.

7. The exposure apparatus according to any one of Claims 2 to 6, wherein

the first axis direction and the second axis direction are orthogonal to each other.

8. An exposure apparatus that exposes an object with an energy beam via an optical member, the apparatus comprising:

a movable body that can move within a predetermined plane, while holding the object;

a holding member that holds the optical member; and

an encoder device that has a scale arranged on one of the optical member and the holding member and a head arranged on the other, and measures positional information of the optical member in a direction parallel to the predetermined plane.

9. The exposure apparatus according to Claim 8, wherein

the encoder device has two scales having different measurement directions arranged on one of the optical member and the holding member, and measures positional information of the optical member in a first direction and a second direction that are orthogonal to each other within the predetermined plane.

10. The exposure apparatus according to one of Claims 8 and 9, further comprising:

an encoder system that has a scale arranged on one of the movable body and the holding member and a head arranged on the other, and measures positional information of the movable body in a first direction and a second direction that are orthogonal to each other within the predetermined plane, wherein

movement of the movable body is controlled by using measurement information of the encoder device and the encoder system.

11. A device manufacturing method, comprising:

a process of forming a pattern on an object by using the exposure apparatus according to any one of Claims 1 to 10;

and

a process of developing the object on which the pattern has been formed.

12. An exposure method of exposing an object with an energy beam via an optical member and forming a pattern on the object, the method comprising:

a first measurement process of measuring a positional relation between the optical member and a predetermined reference position within a movement plane of a movable body that moves holding the object, by using an encoder system.

13. The exposure method according to Claim 12, wherein

in the first measurement process, a distance between the reference position and the optical member in at least one direction of two orthogonal axis directions within the movement plane, by using the encoder system.

14. The exposure method according to one of Claims 12 and 13, further comprising:

a second measurement process of measuring a displacement of the movable body with respect to the reference position, by using the encoder system; and

a control process of controlling movement of the movable body based on measurement results of the first and second measurement processes.

15. An exposure method of exposing an object held by a movable body that can move within a predetermined plane,

with an energy beam via an optical member, the method comprising:

a process of, by using an encoder device that has a scale arranged on one of the optical member and a holding member that holds the optical member and a head arranged on the other, measuring positional information of the optical member in a direction parallel to the predetermined plane.

16. The exposure method according to Claim 15, wherein the encoder device has two scales having different measurement directions arranged on one of the optical member and the holding member, and measures positional information of the optical member in a first direction and a second direction that are orthogonal to each other within the predetermined plane.

17. The exposure method according to one of Claims 15 and 16, further comprising:

a measurement process of measuring positional information of the movable body in a first direction and a second direction that are orthogonal to each other within the predetermined plane, by using an encoder system that has a scale arranged on one of the movable body and the holding member and a head arranged on the other, wherein

movement of the movable body is controlled by using measurement information of the encoder device and the encoder system.

18. A device manufacturing method, comprising:

a process of forming a pattern on an object using the exposure method according to any one of Claims 12 to 17; and

a process of developing the object on which the pattern has been formed.

CLAIMS

1. An exposure apparatus that exposes a substrate via a projection optical system, the apparatus comprising:

a frame member that supports the projection optical system;

a substrate stage that is disposed below the projection optical system supported by the frame member, and holds the substrate;

a drive device that drives the substrate stage;

an encoder device that measures positional information of the projection optical system supported by the frame member;

an encoder system that measures positional information of the substrate stage; and

a controller that controls driving of the substrate stage by the drive device, based on the positional information measured with the encoder system, wherein

the encoder device has a head section that is placed facing a first grating member in which a reflective grating is formed, and the encoder device irradiates the first grating member with a first measurement beam via the head section, one of the first grating member and the head section being provided at a part of a lower end surface of the projection optical system, the other of the first grating member and the head section being provided at a holding member, and the holding member being supported, in a suspended manner from the frame member, at a position lower than the one of the first grating member and the head section,

the encoder system has a plurality of heads that each irradiate a second grating member with a second measurement beam, the second grating member being different from the first grating member, in the second grating member a reflective grating being formed, one

of the second grating member and the plurality of heads being provided at the substrate stage, and the other of the second grating member and the plurality of heads being supported by the frame member, independently from the encoder device, and

the first grating member is provided without protruding outward from the lower end surface in a direction parallel to a predetermined plane, the predetermined plane being orthogonal to an optical axis of the projection optical system.

2. The exposure apparatus according to Claim 1, wherein

the other of the second grating member and the plurality of heads is provided at another member that is different from the holding member.

3. The exposure apparatus according to Claim 1 or 2, wherein

the holding member is supported in a suspended manner from the frame member, by a plurality of support members that each have a flexure section.

4. An exposure apparatus that exposes a substrate via a projection optical system, the apparatus comprising:

a frame member that supports the projection optical system;

a substrate stage that is disposed below the projection optical system supported by the frame member, and holds the substrate;

a drive device that drives the substrate stage;

a holding member that is supported in a suspended manner from the frame member;

an encoder device that measures positional information of the projection

optical system supported by the frame member;

an encoder system that measures positional information of the substrate stage; and

a controller that controls driving of the substrate stage by the drive device, based on the positional information measured with the encoder system, wherein

the encoder device has a head section that is placed facing a first grating member in which a reflective grating is formed, and the encoder device irradiates the first grating member with a first measurement beam via the head section, one of the first grating member and the head section being provided at the projection optical system, and the other of the first grating member and the head section being provided at the holding member, and

the encoder system has a plurality of heads that each irradiate a second grating member with a second measurement beam, the second grating member being different from the first grating member, in the second grating member a reflective grating being formed, one of the second grating member and the plurality of heads being provided at the substrate stage, and the other of the second grating member and the plurality of heads being provided at the holding member.

5. The exposure apparatus according to Claim 4, wherein

the holding member is supported in a suspended manner from the frame member, by a plurality of support members that each have a flexure section.

6. The exposure apparatus according to any one of Claims 1 to 5, wherein

in the encoder device, both of the first grating member and the head section are disposed higher than a lower surface of the projection optical system, in a direction that is

substantially parallel to an optical axis of the projection optical system.

7. The exposure apparatus according to any one of Claims 1 to 6, wherein

the projection optical system has a flange section, and is supported by the frame member via the flange section, and

one of the first grating member and the head section is provided lower than the flange section of the projection optical system.

8. The exposure apparatus according to any one of Claims 1 to 7, wherein

one of the first grating member and the head section is provided at a part of a lower end surface of the projection optical system, and the other of the first grating member and the head section is provided lower than the one of the first grating member and the head section.

9. The exposure apparatus according to Claim 8, wherein

the first grating member is provided at the projection optical system without protruding outward from the lower end surface in a direction parallel to a predetermined plane, the predetermined plane being orthogonal to an optical axis of the projection optical system.

10. The exposure apparatus according to any one of Claims 1 to 9, wherein

the first grating member has a plurality of first scales in each of which a grating is formed, and

the encoder device has a plurality of heads sections that are placed facing the plurality of first scales, respectively.

11. The exposure apparatus according to any one of Claims 1 to 10, wherein

the encoder device has a light source and a detector, and at least one of the light source and the detector is connected to the head section via an optical fiber, the light source generating the first measurement beam, and the detector receiving the first measurement beam reflected off the first grating member.

12. The exposure apparatus according to any one of Claims 1 to 11, wherein

the second grating member is disposed substantially parallel to a predetermined plane that is orthogonal to an optical axis of the projection optical system, and

the encoder system measures positional information of the substrate stage in a direction parallel to the predetermined plane and a direction orthogonal to the predetermined plane.

13. The exposure apparatus according to Claim 12, wherein

in the encoder system, the second grating member is provided at the holding member and the plurality of heads are provided at the substrate stage, and the encoder system irradiates the second grating member from below with the second measurement beam.

14. The exposure apparatus according to Claim 12 or 13, wherein

the second grating member has a plurality of second scales in each of which a grating is formed, and

the encoder system irradiates each of the plurality of second scales with the second measurement beam via the plurality of heads.

15. A device manufacturing method, including:

exposing a substrate using the exposure apparatus according to any one of Claims 1 to 14; and

developing the substrate that has been exposed.