CLAIMS

1. A pattern forming apparatus that forms a pattern on an object via an optical system, the apparatus comprising:

a movable body on which the object is mounted and which moves within a plane that includes a first axis and a second axis intersecting the first axis, holding the object, and on a surface of which a first grating having a grating whose periodic direction is a direction parallel to the first axis and a second grating having a grating whose periodic direction is a direction parallel to the second axis are placed;

an encoder system that includes a first encoder that has a plurality of first heads whose positions are different in a direction orthogonal to the first axis and measures position information of the movable body in a direction parallel to the first axis by the head facing the first grating, and a second encoder that has a plurality of second heads whose positions are different in a direction orthogonal to the second axis and measures position information of the movable body in the second axis direction by the head facing the second grating;

a surface position measuring system that includes a plurality of surface position sensors that, by irradiating a light to the movable body from a direction orthogonal to the plane and receiving the reflected light, measure position information of a surface of the movable body in a direction orthogonal to the plane at an irradiation point of the light, and measures position information of the movable body in a direction orthogonal to the plane and in a tilt direction with

respect to the plane;

a surface position detecting unit that has a plurality of detection points that are set at a predetermined distance parallel to an array of the plurality of first heads along a straight line in a direction orthogonal to the first axis, and detects surface position information of a surface of a target object at the plurality of detection points by irradiating a detection beam to each of the plurality of detection points set on the target object and individually receiving a reflected light of the detection beam from the target object; and

an adjusting unit that measures surface position information of a surface of the object, using a detection value of the surface position detecting unit and taking , as a datum, surface position information at end portions on one side and the other side of the movable body in a direction orthogonal to the first axis that is detected by the surface position sensor at least one each of which is placed in the vicinity of each of two detection points located near both end portions among of the plurality of detection points of the surface position detecting unit, and when pattern formation is performed, adjusts a position of the object in an optical axis direction of the optical system and in a tilt direction with respect to a plane orthogonal to the optical axis based on the surface position information that has been measured, taking, as a datum, surface position information that is measured by the two surface position sensors that measure surface position information at end portions on one side and the other side of the movable body in a direction orthogonal

to the first axis.

2. The pattern forming apparatus of Claim 1, wherein

on one side and the other side in a direction parallel to the first axis with each of the two detection points in between, one each of the surface position sensors is placed.

3. The pattern forming apparatus in one of Claims 1 and 2, wherein

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

4. The pattern forming apparatus in any one of Claims 1 to 3, wherein

the plurality of surface position sensors include a plurality of specific surface position sensors at least in part, and

the plurality of specific surface position sensors and the plurality of first heads are placed on the same straight line in a direction orthogonal to the first axis.

5. The pattern forming apparatus of Claim 4, wherein

the plurality of specific surface position sensors and the plurality of first heads are alternately placed on the straight line.

6. The pattern forming apparatus in any one of Claims 1 to 3, wherein

the plurality of specific surface position sensors are

placed at a predetermined distance so as to correspond to each other on two straight lines that are located on one side and the other side with a straight line in a direction orthogonal to the first axis connecting the plurality of first heads in between and are parallel to the straight line.

7. The pattern forming apparatus of Claim 6, wherein

the plurality of specific surface position sensors are symmetrically placed with respect to the straight line in a direction orthogonal to the first axis connecting the plurality of first heads.

8. The pattern forming apparatus in one of Claims 6 and 7, wherein

the plurality of specific surface position sensors and the plurality of first heads are alternately placed in a direction orthogonal to the first axis.

9. The pattern forming apparatus in one of Claims 6 and 7, wherein

on one side and the other side of a direction parallel to the first axis with each of the plurality of first heads in between, one each of the specific surface position sensors is placed.

10. The pattern forming apparatus in any one of Claims 1 to 9, further comprising:

an aerial image measuring unit at least a partial constituent of which is arranged at the movable body and which

measures an aerial image of a mark formed by the optical system, the partial constituent including a pattern plate on which a measurement pattern is formed; and

an arithmetic processing unit that measures surface position information of a surface of the pattern plate, using the surface position detecting unit and taking, as a datum, surface position information at end portions on one side and the other side of the movable body in a direction orthogonal to the first axis that is detected by each of the surface position sensors located in the vicinity of each of the two detection points, and measures a best focus position of the optical system using the aerial image measuring unit while controlling a position of the pattern plate in the optical axis direction of the optical system, taking, as a datum, surface position information measured by two specific surface position sensors that measure surface position information at end portions on one side and the other side of the movable body in a direction orthogonal to the first axis.

11. The pattern forming apparatus in any one of Claims 1 to 10, wherein

the plurality of first heads and the plurality of second heads are placed on the first axis and the second axis that pass through the optical axis of the optical system.

12. The pattern forming apparatus of Claim 11, wherein

the plurality of first heads are symmetrically placed with respect to the optical system as a datum, and the plurality of second heads are symmetrically placed with respect to the

optical system as a datum.

13. The pattern forming apparatus in any one of Claims 1 to 12, wherein

the surface position measuring system performs transfer of measurement values between the plurality of surface position sensors according to movement of the movable body.

14. The pattern forming apparatus in any one of Claims 1 to 13, wherein

the surface position sensor is a sensor by a CD pickup method.

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

a movable body that has a surface, which faces the optical system and on part of which a mounting area of the object is arranged, and that is movable in first and second directions within a predetermined plane; and

a measuring unit that has a plurality of sensors having detection points whose positions are each different in at least one of the first and second directions, and can measure position information of the surface of the movable body in a third direction orthogonal to the plane at the plurality of detection points.

16. The exposure apparatus of Claim 15, wherein

the measuring unit measures position information of the surface of the movable body in the third direction by at least

one of the plurality of sensors whose detection points are maintained within a different area from the mounting area on the surface of the movable body.

17. The exposure apparatus of Claim 16, wherein

in a moving range of the movable body in a predetermined operation accompanied by movement of the movable body, at least one of the plurality of detection points is maintained within the different area.

18. The exposure apparatus of Claim 17, wherein

at least two of the plurality of detection points are maintained within the different area during the predetermined operation, and the measuring unit measures position information in the third direction and tilt information of the movable body.

19. The exposure apparatus of Claim 17, wherein

at least three detection points that are not on the same straight line among the plurality of detection points are maintained within the different area during the predetermined operation, and the measuring unit measures position information in the third direction and tilt information in different two directions of the movable body.

20. The exposure apparatus in any one of Claims 17 to 19, wherein

the position and/or the number of the sensors whose detection points are maintained within the different area

during the predetermined operation change(s).

21. The exposure apparatus in any one of Claims 17 to 20, wherein

the predetermined operation includes at least an exposure operation of the object by the energy beam.

22. The exposure apparatus in any one of Claims 15 to 21, further comprising:

an adjusting unit that adjusts a positional relation between a pattern image formed via the optical system and the object, based on position information of the movable body that is measured by the measuring unit at the time of the exposure operation of the object by the energy beam.

23. The exposure apparatus in any one of Claims 15 to 22, wherein

the measuring unit measures position information of the surface of the movable body in the third direction by each of a plurality of the sensors at least one of which differs in accordance with a position of the movable body within the plane.

24. The exposure apparatus in any one of Claims 15 to 23, wherein

the measuring unit switches the sensor used for measurement of the position information among the plurality of sensors, in accordance with a position of the movable body within the plane.

25. The exposure apparatus in any one of Claims 15 to 24, wherein

the plurality of sensors have the detection points that are set at a predetermined distance in at least one of the first and second directions over a range that is substantially equal to or larger than a size of the object.

26. The exposure apparatus of Claim 25, wherein

the range in which the plurality of detection points are set is substantially equal to or larger than a size of the movable body.

27. The exposure apparatus in one of Claims 25 and 26, wherein

the range in which the plurality of detection points are set is set along one of the first and second directions.

28. The exposure apparatus in any one of Claims 15 to 27, wherein

the plurality of sensors have the detection points that are set at a predetermined distance on each of both sides of the optical system in at least one of the first and second directions.

29. The exposure apparatus in any one of Claims 15 to 28, wherein

a distance between the plurality of sensors and the surface of the movable body in the third direction is

substantially equal to or shorter than a distance between the optical system and the surface of the movable body.

30. The exposure apparatus in any one of Claims 15 to 29, wherein

the plurality of sensors have the detection points that are set at a predetermined distance in at least one of the first and second directions over a range that is substantially equal to or larger than a size of the object.

31. The exposure apparatus in any one of Claims 15 to 30, wherein

the movable body has a surface that substantially conforms to a surface of the object mounted on the movable body in the third direction.

32. The exposure apparatus in any one of Claims 15 to 31, wherein

the measuring unit includes a second detecting system that is different from a first detecting system having the plurality of sensors and measures position information in the third direction of the object mounted on the movable body.

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

a movable body that is movable in first and second directions within a predetermined plane, holding the object; and

a measuring unit that includes a first detecting system

that has a plurality of sensors having detection points whose positions are different in at least one of the first and second directions and can measure position information of a surface of the movable body in a third direction orthogonal to the plane at each of the detection points, and a second detecting system that is different from the first detecting system and measures position information of the object held by the movable body in the third direction.

34. The exposure apparatus in one of Claims 32 and 33, wherein

the second detecting system has a detection area that extends along one direction of the first and second directions, and measures position information in the third direction of the object at a plurality of points within the detection area.

35. The exposure apparatus of Claim 34, wherein

the measuring unit can measure position information in the third direction on a substantially entire surface of the object that is relatively moved with the detection area in a direction intersecting the one direction by the second detecting system.

36. The exposure apparatus of Claim 35, wherein

the detection area is formed over a range that is substantially equal to a size of the object in the one direction.

37. The exposure apparatus in any one of Claims 32 to

36, further comprising:

an adjusting unit that adjusts a positional relation between a pattern image formed via the optical system and the object based on surface position information of the object that has been measured by the second detecting system, while measuring position information of the movable body by the first detecting system, at the time of an exposure operation of the object by the energy beam.

38. The exposure apparatus of Claim 37, wherein

the adjusting unit performs adjustment of a position and a tilt of the object with respect to the pattern image by moving the object.

39. The exposure apparatus in any one of Claims 32 to 38, wherein

the first detecting system has the plurality of detection points that are placed along one of the first and second directions, and also the second detecting system has the detection area that is placed apart from the plurality of detection points in the other of the first and second directions, and

the first detecting system includes at least two detection points that are separate from the plurality of detection points and are placed in the vicinity of the detection area.

40. The exposure apparatus of Claim 39, wherein

the measuring unit measures position information of a

surface of the movable body at the at least two detection points by the first detecting system at the time of measuring position information of the object by the second detecting system.

41. The exposure apparatus in any one of Claims 32 to 40, further comprising:

a controller that makes position information measured by the first detecting system and position information measured by the second detecting system correspond to each other.

42. The exposure apparatus in any one of Claims 15 to 41, wherein

the plurality of sensors are installed at a measurement frame that is supported in a suspended state by a frame member.

43. The exposure apparatus of Claim 42, wherein

the measurement frame is supported in a suspended state by the frame member independently from the optical system that is supported in a suspended state by the frame member.

44. The exposure apparatus in any one of Claims 15 to 43, further comprising:

a measuring system that measures position information of the movable body within the plane, wherein

the measuring system includes an encoder system that is placed in a predetermined positional relation with the optical system and also has a head unit with which the movable body having a surface on which a grating section is arranged is

relatively moved.

45. The exposure apparatus of Claim 44, wherein

the head unit is installed at the measurement frame that is supported in a suspended state by the frame member.

46. The exposure apparatus of Claim 45, wherein

the measurement frame is supported in a suspended state by the frame member independently from the optical system that is supported in a suspended state by the frame member.

47. The exposure apparatus in any one of Claims 44 to 46, wherein

the plurality of sensors are installed at the same member as a member where the head unit is installed.

48. The exposure apparatus in any one of Claims 44 to 47, wherein

position information of a surface of the movable body in the third direction is measured by at least one of the plurality of sensors whose detection points are maintained in a different area from the mounting area on the surface of the movable body, and

the different area includes at least part of an area where the grating section is placed.

49. The exposure apparatus in any one of Claims 44 to 48, wherein

the grating section includes a first grating section

that is arranged extending in the first direction, and

the encoder system measures position information of the movable body in the first direction by a first head unit having a detection range that is wider than a width of the first grating section in the second direction.

50. The exposure apparatus of Claim 49, wherein

the first grating section is arranged in pairs with the object in between in the second direction, and

the first head unit has the detection range on each of both sides in the second direction of an exposure area where a pattern image is generated via the optical system.

51. The exposure apparatus of Claim 50, wherein

the two detection ranges are set spaced apart at a distance that is substantially equal to or wider than a width of the first grating section in the second direction.

52. The exposure apparatus in any one of Claims 49 to 51, wherein

the first head unit has a plurality of first heads whose positions are different in the second direction, and

the encoder system measures position information of the first movable body in the first direction by the first head that faces the first grating section within the detection range.

53. The exposure apparatus of Claim 52, wherein

the plurality of first heads are placed at a distance

that is narrower than a width of the first grating section in the second direction.

54. The exposure apparatus in any one of Claims 49 to 53, wherein

the grating section includes a second grating section that is arranged extending in the second direction, and

the encoder system measures position information of the first movable body in the second direction by a second head unit having a detection range that is wider than a width of the second grating section in the first direction.

55. The exposure apparatus of Claim 54, wherein

the second grating section is arranged in pairs with the object in between in the first direction, and

the second head unit has the detection range on each of both sides in the first direction of an exposure area where a pattern image is generated via the optical system.

56. The exposure apparatus in one of Claims 54 and 55, wherein

the second head unit has a plurality of second heads whose positions are different in the first direction, and

the encoder system measures position information of the first movable body in the second direction by the second head that faces the second grating section within the detection range.

57. The exposure apparatus of Claim 56, wherein

the plurality of second heads are placed at a distance that is narrower than a width of the second grating section in the first direction.

58. The exposure apparatus in any one of Claims 44 to 57, wherein

the grating section includes a pair of first grating sections that are each arranged extending in the first direction with the object in between in the second direction and a pair of second grating sections that are each arranged extending in the second direction with the object in between in the first direction, and

in an exposure operation of the object by the energy beam, at least three of the pair of first grating sections and the pair of second grating sections face the corresponding head units.

59. The exposure apparatus of Claim 58, wherein

each of the grating sections has a grating periodically arrayed in the direction in which each of the grating sections is arranged extending.

60. The exposure apparatus in one of Claims 58 and 59, wherein

each of the head units has a plurality of heads that are placed at a predetermined distance in a direction intersecting the corresponding grating section.

61. The exposure apparatus in any one of Claims 44 to

60, wherein

a distance between the head unit and a surface of the movable body in the third direction is substantially equal to or shorter than a distance between the optical system and the surface of the movable body.

62. The exposure apparatus in any one of Claims 44 to 61, wherein

position information measured by the encoder system is used in at least an exposure operation of the object by the energy beam.

63. The exposure apparatus in any one of Claims 44 to 62, wherein

position information measured by the encoder system is used in at least a detection operation of a mark of the object.

64. The exposure apparatus in any one of Claims 44 to 63, wherein

the measuring system includes an interferometer system that measures position information of the movable body, and

a measurement direction of position information of the movable body by the interferometer system includes a direction that is different from a measurement direction of position information of the movable body by the encoders system.

65. The exposure apparatus of Claim 64, wherein

the interferometer system measures position information of the movable body in a direction that is

different from directions within the plane.

66. The exposure apparatus in one of Claims 64 and 65, wherein

the interferometer system measures position information of the movable body in at least one measurement direction of position information of the movable body by the encoder system.

67. The exposure apparatus in any one of Claims 44 to 66, wherein

the measuring system includes an interferometer system that measures position information of the movable body, and

in position control of the movable body based on measurement information of the encoder system, measurement information of the interferometer system is also used.

68. The exposure apparatus of Claim 67, wherein

the measurement information of the interferometer system used in the position control includes position information of the movable body in a direction that is different from a measurement direction of position information of the movable body by the encoder system.

69. The exposure apparatus in any one of Claims 44 to 68, further comprising:

a correcting unit that corrects a measurement error of the encoder system that occurs due to the grating section.

70. The exposure apparatus in any one of Claims 15 to 69, further comprising:

a liquid immersion system that forms a liquid immersion area by filling a space between the optical system and the object with liquid, wherein

the object is exposed with the energy beam via the optical system and liquid in the liquid immersion area.

71. A device manufacturing method, comprising:

exposing an object using the exposure apparatus in any one of Claims 15 to 70; and

developing the exposed object.

72. An exposure method in which an object is exposed with an energy beam via an optical system, the method comprising:

a process of mounting the object on a movable body that has a surface, which faces the optical system and on part of which a mounting area of the object is arranged, and that is movable in first and second directions within a predetermined plane; and

a process of measuring position information of the surface of the movable body in a third direction orthogonal to the plane by a measuring unit that has a plurality of sensors having detection points whose positions are each different in at least one of the first and second directions.

73. The exposure method of Claim 72, wherein

the measuring unit measures position information of the surface of the movable body in the third direction by at least

one of the plurality of sensors whose detection points are maintained within a different area from the mounting area on the surface of the movable body.

74. The exposure method of Claim 73, wherein

in a moving range of the movable body in a predetermined operation accompanied by movement of the movable body, at least one of the plurality of detection points is maintained within the different area.

75. The exposure method of Claim 74, wherein

at least two of the plurality of detection points are maintained within the different area during the predetermined operation, and the measuring unit measures position information in the third direction and tilt information of the movable body.

76. The exposure method of Claim 74, wherein

at least three detection points that are not on the same straight line among the plurality of detection points are maintained within the different area during the predetermined operation, and the measuring unit measures position information in the third direction and tilt information in different two directions of the movable body.

77. The exposure method in any one of Claims 74 to 76, wherein

the position and/or the number of the sensors whose detection points are maintained within the different area

during the predetermined operation change(s).

78. The exposure method in any one of Claims 74 to 77, wherein

the predetermined operation includes at least an exposure operation of the object by the energy beam.

79. The exposure method in any one of Claims 72 to 78, further comprising:

a process of adjusting a positional relation between a pattern image formed via the optical system and the object, based on position information of the movable body that is measured by the measuring unit at the time of the exposure operation of the object by the energy beam.

80. The exposure method in any one of Claims 72 to 79, wherein

the measuring unit measures position information in the third direction of the surface of the movable body by each of a plurality of the sensors at least one of which differs in accordance with a position of the movable body within the plane.

81. The exposure method in any one of Claims 72 to 80, wherein

the measuring unit switches the sensor used for measurement of the position information among the plurality of sensors, in accordance with a position of the movable body within the plane.

82. The exposure method in any one of Claims 72 to 81, wherein

the plurality of sensors have the detection points that are set at a predetermined distance in at least one of the first and second directions over a range that is substantially equal to or larger than a size of the object.

83. The exposure method of Claim 82, wherein

the range in which the plurality of detection points are set is substantially equal to or larger than a size of the movable body.

84. The exposure method in one of Claims 82 and 83, wherein

the range in which the plurality of detection points are set is set along one of the first and second directions.

85. The exposure method in any one of Claims 72 to 84, wherein

the plurality of sensors have the detection points that are set at a predetermined distance on each of both sides of the optical system in at least one of the first and second directions.

86. The exposure method in any one of Claims 72 to 85, wherein

a distance between the plurality of sensors and the surface of the movable body in the third direction is

substantially equal to or shorter than a distance between the optical system and the surface of the movable body in the third direction.

87. The exposure method in any one of Claims 72 to 86, wherein

the plurality of sensors have the detection points that are set at a predetermined distance in at least one of the first and second directions over a range that is substantially equal to or larger than a size of the object.

88. The exposure method in any one of Claims 72 to 87, wherein

the movable body has a surface that substantially conforms to a surface of the object mounted on the movable body in the third direction.

89. An exposure method in which an object is exposed with an energy beam via an optical system, the method comprising:

a process of mounting the object on a movable body that is movable in first and second directions within a predetermined plane; and

a process of measuring position information of a surface of the movable body and the object in a third direction orthogonal to the plane, using a measuring unit that includes a first detecting system that has a plurality of sensors having detection points whose positions are different in at least one of the first and second directions and can measure position information of a surface of the movable body in the third

direction at each of the detection points, and a second detecting system that is different from the first detecting system and measures position information of the object held by the movable body in the third direction.

90. The exposure method in one of Claims 88 and 89, wherein

the second detecting system has a detection area that extends along one direction of the first and second directions, and measures position information of the object in the third direction at a plurality of points within the detection area.

91. The exposure method of Claim 90, wherein

the measuring unit can measure position information in the third direction on a substantially entire surface of the object that is relatively moved with the detection area in a direction intersecting the one direction by the second detecting system.

92. The exposure method of Claim 91, wherein

the detection area is formed over a range that is substantially equal to a size of the object in the one direction.

93. The exposure method in any one of Claims 88 to 92, further comprising:

a process of adjusting a positional relation between a pattern image formed via the optical system and the object based on surface position information of the object that has

been measured by the second detecting system, while measuring position information of the movable body by the first detecting system, at the time of an exposure operation of the object by the energy beam.

94. The exposure method of Claim 93, wherein

in the process of adjusting, adjustment of a position and a tilt of the object with respect to the pattern image is performed by moving the object.

95. The exposure method in any one of Claims 88 to 94, wherein

the first detecting system has the plurality of detection points that are placed along one of the first and second directions, and also the second detecting system has the detection area that is placed apart from the plurality of detection points in the other of the first and second directions, and

the first detecting system includes at least two detection points that are separate from the plurality of detections points and are placed in the vicinity of the detection area.

96. The exposure method of Claim 95 wherein

the measuring unit measures position information of a surface of the movable body at the at least two detection points by the first detecting system at the time of measuring position information of the object by the second detecting system.

97. The exposure method in any one of Claims 72 to 96, further comprising:

a process of making position information measured by the first detecting system and position information measured by the second detecting system correspond to each other.

98. The exposure method in any one of Claims 72 to 97, further comprising:

a measuring system that measures position information of the movable body within the plane, wherein

the measuring system includes an encoder system that is placed in a predetermined positional relation with the optical system and also has a head unit with which the movable body having a surface on which a grating section is arranged is relatively moved.

99. The exposure method of Claim 98, wherein

position information of a surface of the movable body in the third direction is measured by at least one of the plurality of sensors whose detection points are maintained in a different area from the mounting area on the surface of the movable body, and

the different area includes at least part of an area where the grating section is placed.

100. The exposure method in one of Claims 98 and 99, wherein

the grating section includes a first grating section that is arranged extending in the first direction, and

the encoder system measures position information of the movable body in the first direction by a first head unit having a detection range that is wider than a width of the first grating section in the second direction.

101. The exposure method of Claim 100, wherein

the first grating section is arranged in pairs with the object in between in the second direction, and

the first head unit has the detection range on each of both sides in the second direction of an exposure area where a pattern image is generated via the optical system.

102. The exposure method of Claim 101, wherein

the two detection ranges are set spaced apart at a distance that is substantially equal to or wider than a width of the first grating section in the second direction.

103. The exposure method in any one of Claims 100 to 102, wherein

the first head unit has a plurality of first heads whose positions are different in the second direction, and

the encoder system measures position information of the first movable body in the first direction by the first head that faces the first grating section within the detection range.

104. The exposure method of Claim 103, wherein

the plurality of first heads are placed at a distance that is narrower than a width of the first grating section

in the second direction.

105. The exposure method in any one of Claims 100 to 104, wherein

the grating section includes a second grating section that is arranged extending in the second direction, and

the encoder system measures position information of the first movable body in the second direction by a second head unit having a detection range that is wider than a width of the second grating section in the first direction.

106. The exposure method of Claim 105, wherein

the second grating section is arranged in pairs with the object in between in the first direction, and

the second head unit has the detection range on each of both sides in the first direction of an exposure area where a pattern image is generated via the optical system.

107. The exposure method in one of Claims 105 and 106, wherein

the second head unit has a plurality of second heads whose positions are different in the first direction, and

the encoder system measures position information of the first movable body in the second direction by the second head that faces the second grating section within the detection range.

108. The exposure method of Claim 107, wherein

the plurality of second heads are placed at a distance

that is narrower than a width of the second grating section in the first direction.

109. The exposure method in any one of Claims 98 to 108, wherein

the grating section includes a pair of first grating sections that are each arranged extending in the first direction with the object in between in the second direction and a pair of second grating sections that are each arranged extending in the second direction with the object in between in the first direction, and

in an exposure operation of the object by the energy beam, at least three of the pair of first grating sections and the pair of second grating sections face the corresponding head units.

110. The exposure method of Claim 109, wherein

each of the grating sections has a grating periodically arrayed in the direction in which each of the grating sections is arranged extending.

111. The exposure method in one of Claims 109 and 110, wherein

each of the head units has a plurality of heads that are placed at a predetermined distance in a direction intersecting the corresponding grating section.

112. The exposure method in any one of Claims 98 to 111, wherein

a distance between the head unit and a surface of the movable body in the third direction is substantially equal to or shorter than a distance between the optical system and the surface of the movable body in the third direction.

113. The exposure method in any one of Claims 98 to 112, wherein

position information measured by the encoder system is used in at least an exposure operation of the object by the energy beam.

114. The exposure method in any one of Claims 98 to 113, wherein

position information measured by the encoder system is used in at least a detection operation of a mark of the object.

115. The exposure method in any one of Claims 98 to 114, wherein

the measuring system includes an interferometer system that measures position information of the movable body, and

a measurement direction of position information of the movable body by the interferometer system includes a direction that is different from a measurement direction of position information of the movable body by the encoders system.

116. The exposure method of Claim 115, wherein

the interferometer system measures position information of the movable body in a direction that is different from directions within the plane.

117. The exposure method in one of Claims 115 and 116, wherein

the interferometer system measures position information of the movable body in at least one measurement direction of position information of the movable body by the encoder system.

118. The exposure method in any one of Claims 98 to 117, wherein

the measuring system includes an interferometer system that measures position information of the movable body, and

in position control of the movable body based on measurement information of the encoder system, measurement information of the interferometer system is also used.

119. The exposure method of Claim 118, wherein

the measurement information of the interferometer system used in the position control includes position information of the movable body in a direction that is different from a measurement direction of position information of the movable body by the encoder system.

120. The exposure method in any one of Claims 98 to 119, further comprising:

a process of correcting a measurement error of the encoder system that occurs due to the grating section.

121. A device manufacturing method, comprising:

exposing an object using the exposure method in any one of Claims 72 to 120; and

developing the exposed object.

CLAIMS

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

a movable body that is provided with a mounting area for the object on a part of a surface, that faces the optical system, of the movable body, and is movable in directions of six degrees of freedom including a first direction and a second direction orthogonal to each other within a predetermined plane perpendicular to an optical axis of the optical system;

a first detection system that has a plurality of sensors each irradiating a measurement beam to a scale member, where a reflective grating used in measurement of position information of the movable body in a direction parallel to the plane is formed, and having detection points whose positions are different in at least one of the first and the second directions, and that is capable of measuring position information of the movable body in a third direction orthogonal to the plane by a sensor whose detection point is located within a plane where the grating of the scale member is formed, of the plurality of sensors, at a time of movement of the movable body;

a second detection system that is arranged at a position away from the optical system within the predetermined plane, and that measures position information of the object mounted on the movable body in the third direction; and

a controller that prior to exposure of the object, measures position information of the object using the second detection system while measuring position information of the movable body using the first detection system, and at a time

of an exposure operation of the object, measures position information of the movable body using the first detection system.

2. The exposure apparatus according to claim 1, wherein

the controller adjusts a positional relation between a pattern image formed via the optical system and the object using position information of the object measured using the second detection system, based on position information of the movable body measured by the first detection system at a time of an exposure operation of the object.

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

in a movement range of the movable body in a predetermined operation accompanying movement of the movable body that includes an exposure operation of the object, at least one of the plurality of detection points is located within a plane where the grating of the scale member is formed.

4. The exposure apparatus according to claim 3, wherein

during the predetermined operation, at least two detection points, of the plurality of detection points, are located within a plane where the grating of the scale member is formed, and the first detection system measures position information of the movable body in the third direction and tilt information of the movable body.

5. The exposure apparatus according to claim 3, wherein

during the predetermined operation, at least three detection points, of the plurality of detection points, that are not on a same straight line are located within a plane where the grating of the scale member is formed, and the first detection system measures position information of the movable body in the third direction and tilt information of the movable body in two different directions.

6. The exposure apparatus according to any one of claims 3 to 5, wherein

during the predetermined operation, at least one of a position and the number of a sensor changes, of the plurality of sensors, the detection point of the sensor being located within a plane where the grating of the scale member is formed.

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

the first detection system measures position information of the movable body in the third direction by each of a plurality of the sensors, at least one of the plurality of the sensors being different according to a position of the movable body within the plane.

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

the first detection system switches a sensor used in measurement of the position information, of the plurality of sensors, according to a position of the movable body within the plane.

9. The exposure apparatus according to any one of claims 1 to 8, wherein

the plurality of sensors have the detection points that are set at a predetermined distance on each of both sides of the optical system in at least one of the first and the second directions.

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

the movable body has a surface that substantially coincides in the third direction with a surface of the object mounted on the movable body.

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

a movable body that holds the object and is movable in directions of six degrees of freedom including a first direction and a second direction orthogonal to each other within a predetermined plane perpendicular to an optical axis of the optical system;

a measurement device that includes a first detection system and a second detection system, the first detection system having a plurality of sensors whose detection points are different in position in at least one of the first and the second directions and being capable of measuring position information of the movable body in a third direction orthogonal to the plane at each of the detection points, and the second detection system being different from the first detection system and measuring position information of the object held by the movable body in

the third direction; and

a controller that measures position information of the object using the second detection system while measuring position information of the movable body using the first detection system, and makes the position information of the movable body measured using the first detection system and the position information of the object measured using the second detection system correspond to each other.

12. The exposure apparatus according to claim 11, wherein

the first detection system irradiates a measurement beam by each of the plurality of sensors, to a scale member where a reflective grating used in measurement of position information of the movable body within the plane is formed.

13. The exposure apparatus according to claim 11 or 12, wherein

the second detection system has a detection area extending along one direction of the first and the second directions, and measures position information of the object in the third direction at a plurality of points within the detection area.

14. The exposure apparatus according to claim 13, wherein

the measurement device is capable of measuring position information in the third direction on a substantially entire surface of the object that is moved relative to the detection area in a direction intersecting the one direction, by the second detection system.

15. The exposure apparatus according to claim 14, wherein

the detection area is formed across a range comparable to the object in the one direction.

16. The exposure apparatus according to any one of claims 11 to 15, wherein

at a time of an exposure operation of the object with the energy beam, while measuring position information of the movable body by the first detection system, the controller adjusts a positional relation between a pattern image formed via the optical system and the object based on a result of the measurement and information obtained by the correspondence that has been made prior to staring the exposure operation.

17. The exposure apparatus according to claim 16, wherein

the controller performs adjustment of a position and a tilt of the object with respect to the pattern image, by moving the object.

18. The exposure apparatus according to any one of claims 11 to 17, wherein

the first detection system has the plurality of detection points placed along one of the first and the second directions, and the second detection system has a detection area placed away from the plurality of detection points in the other of the first and the second directions, and

the first detection system includes at least two detection points that are different from the plurality of

detection points and placed in the vicinity of the detection area.

19. The exposure apparatus according to claim 18, wherein

the measurement device measures position information of the movable body at the at least two detection points by the first detection system, at a time of measurement of position information of the object by the second detection system.

20. The exposure apparatus according to any one of claims 1 to 19, further comprising:

a frame member that supports the optical system, wherein

the plurality of sensors are supported in a suspended state by the frame member.

21. The exposure apparatus according to any one of claims 1 to 20, further comprising:

a correction device that corrects a measurement error of the first detection system that occurs due to a plane where the grating of the scale member is formed.

22. The exposure apparatus according to any one of claims 1 to 21, further comprising:

a liquid immersion system that forms a liquid immersion area by filling between the optical system and the object with a liquid, wherein

the object is exposed with the energy beam via the optical system and the liquid of the liquid immersion area.

23. A device manufacturing method, comprising:

exposing an object using the exposure apparatus according to any one of claims 1 to 22; and

developing the object that has been exposed.

24. An exposure method of exposing an object with an energy beam via an optical system, the method comprising:

moving the object in a first direction and a second direction orthogonal to each other within a predetermined plane perpendicular to an optical axis of the optical system, by a movable body that is provided with a mounting area for the object on a part of a surface, that faces the optical system, of the movable body;

prior to exposure of the object, while measuring position information in a third direction of the movable body that is in an area away from the optical system within the predetermined plane by a sensor out of a plurality of sensors of a first detection system, measuring position information in the third direction of the object mounted on the movable body by a second detection system different from the first detection system, the first detection system having the plurality of sensors that each irradiate a measurement beam to a scale member, where a reflective grating used in measurement of position information of the movable body in a direction parallel to the plane is formed, and that have detection points whose positions are different in at least one of the first and the second directions, the detection point of the sensor being located within a plane where the grating of the scale member is formed,

and the third direction being orthogonal to the predetermined plane; and

at a time of an exposure operation of the object, measuring position information of the movable body that is below the optical system using the first detection system.

25. The exposure method according to claim 24, wherein

a positional relation between a pattern image formed via the optical system and the object is adjusted using position information of the object measured using the second detection system, based on position information of the movable body measured by the first detection system at a time of an exposure operation of the object.

26. The exposure method according to claim 24 or 25, wherein

in a movement range of the movable body in a predetermined operation accompanying movement of the movable body, at least one of the plurality of detection points is located within a plane where the grating of the scale member is formed.

27. The exposure method according to claim 26, wherein

during the predetermined operation, at least two detection points, of the plurality of detection points, are located within a plane where the grating of the scale member is formed, and the measurement device measures position information of the movable body in the third direction and tilt information of the movable body.

28. The exposure method according to claim 26, wherein

during the predetermined operation, at least three detection points, of the plurality of detection points, that are not on a same straight line are located within a plane where the grating of the scale member is formed, and the measurement device measures position information of the movable body in the third direction and tilt information of the movable body in two different directions.

29. The exposure method according to any one of claims 25 to 28, wherein

during the predetermined operation, at least one of a position and the number of a sensor changes, of the plurality of sensors, the detection point of the sensor being located within a plane where the grating of the scale member is formed.

30. The exposure method according to any one of claims 24 to 29, wherein

the first detection system measures position information of the movable body in the third direction by each of a plurality of the sensors, at least one of the plurality of the sensors being different according to a position of the movable body within the plane.

31. The exposure method according to any one of claims 24 to 30, wherein

the first detection system switches a sensor used in measurement of the position information, of the plurality of sensors, according to a position of the movable body within the

plane.

32. The exposure method according to any one of claims 24 to 31, wherein

the plurality of sensors have the detection points that are set at a predetermined distance on each of both sides of the optical system in at least one of the first and the second directions.

33. The exposure method according to any one of claims 24 to 32, wherein

the movable body has a surface that substantially coincides in the third direction with a surface of the object mounted on the movable body.

34. An exposure method of exposing an object with an energy beam via an optical system, the method comprising:

mounting the object onto a movable body that is movable in a first direction and a second direction orthogonal to each other within a predetermined plane perpendicular to an optical axis of the optical system;

measuring position information of the movable body and the object in a third direction orthogonal to the plane, by using a measurement device that includes a first detection system and a second detection system different from the first detection system, the first detection system having a plurality of sensors whose detection points are different in position in at least one of the first and the second directions and being capable of measuring position information of the movable body

in the third direction at each of the detection points, and the second detection system measuring position information of the object held by the movable body in the third direction; and

making the position information of the movable body measured using the first detection system and the position information of the object measured using the second detection system correspond to each other.

35. The exposure method according to claim 34, wherein

the first detection system irradiates a measurement beam by each of the plurality of sensors, to a scale member where a reflective grating used in measurement of position information of the movable body within the plane is formed.

36. The exposure method according to claim 34 or 35, wherein

the second detection system has a detection area extending along one direction of the first and the second directions, and measures position information of the object in the third direction at a plurality of points within the detection area.

37. The exposure method according to claim 36, wherein

the measurement device is capable of measuring position information in the third direction on a substantially entire surface of the object that is moved relative to the detection area in a direction intersecting the one direction, by the second detection system.

38. The exposure method according to claim 37, wherein

the detection area is formed across a range comparable to the object in the one direction.

39. The exposure method according to any one of claims 34 to 38, further comprising:

at a time of an exposure operation of the object with the energy beam, while measuring position information of the movable body by the first detection system, adjusting a positional relation between a pattern image formed via the optical system and the object based on a result of the measurement and information obtained by the correspondence that has been made prior to staring the exposure operation.

40. The exposure method according to claim 39, wherein

in the adjustment, adjustment of a position and a tilt of the object with respect to the pattern image is performed, by moving the object.

41. The exposure method according to any one of claims 34 to 40, wherein

the first detection system has the plurality of detection points placed along one of the first and the second directions, and the second detection system has a detection area placed away from the plurality of detection points in the other of the first and the second directions, and

the first detection system includes at least two detection points that are different from the plurality of detection points and placed in the vicinity of the detection

area.

42. The exposure method according to claim 41, wherein

the measurement device measures position information of the movable body at the at least two detection points by the first detection system, at a time of measurement of position information of the object by the second detection system.

43. The exposure method according to any one of claims 24 to 42, wherein

the plurality of sensors are supported in a suspended state by a frame member that supports the optical system.

44. The exposure method according to any one of claims 24 to 43, further comprising:

correcting a measurement error of the first detection system that occurs due to a plane where the grating of the scale member is formed.

45. The exposure method according to any one of claims 24 to 44, wherein

in order to expose the object with the energy beam via the optical system and a liquid, a liquid immersion area is formed under the optical system with the liquid.

46. A device manufacturing method, comprising:

exposing an object using the exposure method according to any one of claims 24 to 45; and

developing the object that has been exposed.