CLAIMS

1. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane; and

driving the movable body within the predetermined plane, based on measurement information of an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane, and based on information on flatness of the grating section.

2. The exposure method according to Claim 1, wherein the movable body is driven also based on information on a formation error of the grating section.

3. The exposure method according to Claim 1, wherein the movable body is driven also based on position information of the movable body in a direction different from the first and second directions.

4. The exposure method according to Claim 1, wherein the movable body is driven also based on inclination information of the movable body with respect to the predetermined plane.

5. The exposure method according to Claim 1, wherein the movable body is driven also based on

characteristic information of the head unit that is a factor causing a measurement error of the encoder system.

6. The exposure method according to Claim 1, wherein the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

7. The exposure method according to Claim 1, wherein the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

8. The exposure method according to Claim 1, wherein by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

9. The exposure method according to Claim 8, wherein the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

10. The exposure method according to Claim 8, wherein out of position information of the movable body in directions of six degrees of freedom, position information

in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

11. The exposure method according to Claim 10, wherein a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

12. The exposure method according to Claim 8, wherein in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

13. The exposure method according to Claim 8, wherein the encoder system and a mark detection system that detects a mark on the object are used in a detection operation of the mark.

14. The exposure method according to Claim 1, wherein: in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and second directions is used in an operation different from the exposure operation.

15. The exposure method according to Claim 14, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

16. The exposure method according to Claim 14, wherein at least part of the measurement information of the interferometer system is used in the exposure operation.

17. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is exposed and a pattern is formed on the sensitive object using the exposure method according to Claim 1.

18. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane; and

controlling a position of the movable body within the predetermined plane, based on measurement information of an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane, and based on correction information to compensate a measurement error of the encoder system that occurs due to flatness of the grating section.

19. The exposure method according to Claim 18, wherein

by the correction information, a measurement error of the encoder system that occurs due to a formation

error of the grating section is also compensated.

20. The exposure method according to Claim 18, wherein by the correction information, a measurement error of the encoder system that occurs due to a displacement of the movable body in a different direction from the first and second directions is also compensated.

21. The exposure method according to Claim 20, wherein the different direction includes at least one of a direction orthogonal to the predetermined plane, a rotation direction around an axis orthogonal to the predetermined plane, and a rotation direction around an axis parallel to the predetermined plane.

22. The exposure method according to Claim 21, wherein by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

23. The exposure method according to Claim 18, wherein by the correction information, a measurement error of the encoder system that occurs due to inclination of the movable body with respect to the predetermined plane is also compensated.

24. The exposure method according to Claim 23, wherein by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

25. The exposure method according to Claim 18, wherein by the correction information, a measurement error of the encoder system that occurs due to the head unit is also compensated.

26. The exposure method according to Claim 25, wherein by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

27. The exposure method according to Claim 25, wherein by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

28. The exposure method according to Claim 18, wherein the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

29. The exposure method according to Claim 18, wherein the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

30. The exposure method according to Claim 18, wherein the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

31. The exposure method according to Claim 18, wherein the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface

of the movable body.

32. The exposure method according to Claim 18, wherein by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

33. The exposure method according to Claim 32, wherein the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

34. The exposure method according to Claim 32, wherein out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

35. The exposure method according to Claim 34, wherein a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

36. The exposure method according to Claim 32, wherein

in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

37. The exposure method according to Claim 32, wherein

the encoder system and a mark detection system that detects a mark on the object are used in a detection operation of the mark.

38. The exposure method according to Claim 18, wherein:

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and second directions is used in an operation different from the exposure operation.

39. The exposure method according to Claim 38, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

40. The exposure method according to Claim 38, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

41. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is exposed and a pattern is formed on the sensitive object using the exposure method according to Claim 18.

42. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane; and

a drive unit that drives the movable body within the predetermined plane based on measurement information of the encoder system and information on flatness of the grating section.

43. The exposure apparatus according to Claim 42, wherein

the movable body is driven also based on information on a formation error of the grating section.

44. The exposure apparatus according to Claim 42, wherein

the movable body is driven also based on position information of the movable body in a direction different from the first and second directions.

45. The exposure apparatus according to Claim 42, wherein

the movable body is driven also based on inclination information of the movable body with respect to the predetermined plane.

46. The exposure apparatus according to Claim 42, wherein

the movable body is driven also based on characteristic information of the head unit that is a factor causing a measurement error of the encoder system.

47. The exposure apparatus according to Claim 42, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

48. The exposure apparatus according to Claim 42, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

49. The exposure apparatus according to Claim 42, further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

50. The exposure apparatus according to Claim 49,

wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

51. The exposure apparatus according to Claim 49, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

52. The exposure apparatus according to Claim 51, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

53. The exposure apparatus according to Claim 49, further comprising:

a position measurement unit that measures position information of the object in the third direction, wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

54. The exposure apparatus according to Claim 49, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

55. The exposure apparatus according to Claim 42, further comprising:

an interferometer system that measures position information of the movable body in at least the first and second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

56. The exposure apparatus according to Claim 55, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

57. The exposure apparatus according to Claim 55, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

58. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least first and second directions that are orthogonal within a predetermined

plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane; and

a controller that controls a position of the movable body within the predetermined plane, based on correction information to compensate a measurement error of the encoder system that occurs due to flatness of the grating section and based on measurement information of the encoder system.

59. The exposure apparatus according to Claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to a formation error of the grating section is also compensated.

60. The exposure apparatus according to Claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to a displacement of the movable body in a different direction from the first and second directions is also compensated.

61. The exposure apparatus according to Claim 60, wherein

the different direction includes at least one of a direction orthogonal to the predetermined plane, a rotation direction around an axis orthogonal to the predetermined plane,

and a rotation direction around an axis parallel to the predetermined plane.

62. The exposure apparatus according to Claim 61, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

63. The exposure apparatus according to Claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to inclination of the movable body with respect to the predetermined plane is also compensated.

64. The exposure apparatus according to Claim 63, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

65. The exposure apparatus according to Claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to the head unit is also compensated.

66. The exposure apparatus according to Claim 65, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

67. The exposure apparatus according to Claim 65,

wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

68. The exposure apparatus according to Claim 58, wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

69. The exposure apparatus according to Claim 58, wherein

the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

70. The exposure apparatus according to Claim 58, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

71. The exposure apparatus according to Claim 58, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface

of the movable body.

72. The exposure apparatus according to Claim 58, further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

73. The exposure apparatus according to Claim 72, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

74. The exposure apparatus according to Claim 72, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

75. The exposure apparatus according to Claim 74, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

76. The exposure apparatus according to Claim 72, further comprising:

a position measurement unit that measures position information of the object in the third direction, wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

77. The exposure apparatus according to Claim 72, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

78. The exposure apparatus according to Claim 58, further comprising:

an interferometer system that measures position information of the movable body in at least the first and second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

79. The exposure apparatus according to Claim 78,

wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

80. The exposure apparatus according to Claim 78, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

81. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane; and

controlling a position of the movable body within the predetermined plane so that a measurement error of an encoder system, in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane, is compensated, based on measurement information of the encoder system and correction information in accordance with characteristic information of the grating section and the head unit.

82. The exposure method according to Claim 81, wherein

the correction information is set in accordance with position information of the movable body in a direction different from the first and second directions.

83. The exposure method according to Claim 81, wherein

the correction information is set in accordance with inclination information of the movable body with respect to the predetermined plane.

84. The exposure method according to Claim 81, wherein the characteristic information includes information on flatness and/or on a formation error of the grating section.

85. The exposure method according to Claim 81, wherein the characteristic information includes information on optical characteristics of the head unit.

86. The exposure method according to Claim 81, wherein the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

87. The exposure method according to Claim 81, wherein the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

88. The exposure method according to Claim 81, wherein the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

89. The exposure method according to Claim 81, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

90. The exposure method according to Claim 81, wherein

by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

91. The exposure method according to Claim 90, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

92. The exposure method according to Claim 90, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

93. The exposure method according to Claim 92, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees

of freedom.

94. The exposure method according to Claim 90, wherein

in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

95. The exposure method according to Claim 90, wherein

the encoder system and a mark detection system that detects a mark on the object are used in a detection operation of the mark.

96. The exposure method according to Claim 81, wherein:

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and second directions is used in an operation different from the exposure operation.

97. The exposure method according to Claim 96, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

98. The exposure method according to Claim 96, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

99. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is

exposed and a pattern is formed on the sensitive object using the exposure method according to Claim 81.

100. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane; and

controlling a position of the movable body within the predetermined plane, based on measurement information of an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane, and based on correction information to compensate a measurement error of the encoder system that occurs due to the grating section and the head unit.

101. The exposure method according to Claim 100, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

102. The exposure method according to Claim 100, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

103. The exposure method according to Claim 100,

wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

104. The exposure method according to Claim 100, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

105. The exposure method according to Claim 100, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

106. The exposure method according to Claim 100, wherein

by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

107. The exposure method according to Claim 106, wherein

the measurement system measures position

information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

108. The exposure method according to Claim 106, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

109. The exposure method according to Claim 108, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

110. The exposure method according to Claim 106, wherein

in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

111. The exposure method according to Claim 106, wherein

the encoder system and a mark detection system

that detects a mark on the object are used in a detection operation of the mark.

112. The exposure method according to Claim 100, wherein:

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and second directions is used in an operation different from the exposure operation.

113. The exposure method according to Claim 112, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

114. The exposure method according to Claim 112, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

115. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is exposed and a pattern is formed on the sensitive object using the exposure method according to Claim 100.

116. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane; and

a controller that controls a position of the movable body within the predetermined plane so that a measurement error of the encoder system is compensated, based on measurement information of the encoder system and correction information in accordance with characteristic information of the grating section and the head unit.

117. The exposure apparatus according to Claim 116, wherein

the correction information is set in accordance with position information of the movable body in a direction different from the first and second directions.

118. The exposure apparatus according to Claim 116, wherein

the correction information is set in accordance with inclination information of the movable body with respect to the predetermined plane.

119. The exposure apparatus according to Claim 116, wherein

the characteristic information includes information on flatness and/or on a formation error of the grating section.

120. The exposure apparatus according to Claim 116, wherein

the characteristic information includes information on optical characteristics of the head unit.

121. The exposure apparatus according to Claim 116, wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

122. The exposure apparatus according to Claim 116, wherein

the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

123. The exposure apparatus according to Claim 116, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

124. The exposure apparatus according to Claim 116, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

125. The exposure apparatus according to Claim 116,

further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

126. The exposure apparatus according to Claim 125, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

127. The exposure apparatus according to Claim 125, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

128. The exposure apparatus according to Claim 127, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the

measured position information in directions of six degrees of freedom.

129. The exposure apparatus according to Claim 125, further comprising:

a position measurement unit that measures position information of the object in the third direction, wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

130. The exposure apparatus according to Claim 125, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

131. The exposure apparatus according to Claim 116, further comprising:

an interferometer system that measures position information of the movable body in at least the first and second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

132. The exposure apparatus according to Claim 131, wherein

the measurement information of the encoder system

is used in a detection operation of the mark and/or surface position information of the object.

133. The exposure apparatus according to Claim 131, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

134. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least first and second directions that are orthogonal within a predetermined plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on a surface of the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the surface of the movable body and which measures position information of the movable body within the predetermined plane; and

a controller that controls a position of the movable body within the predetermined plane, based on correction information to compensate a measurement error of the encoder system that occurs due to the grating section and the head unit and based on measurement information of the encoder system.

135. The exposure apparatus according to Claim 134, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

136. The exposure apparatus according to Claim 134,

wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

137. The exposure apparatus according to Claim 134, wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

138. The exposure apparatus according to Claim 134, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

139. The exposure apparatus according to Claim 134, wherein

the grating section is arranged on a surface of movable body, and the head unit is arranged facing the surface of the movable body.

140. The exposure apparatus according to Claim 134, further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

141. The exposure apparatus according to Claim 140, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a plurality of sensors that face the grating section.

142. The exposure apparatus according to Claim 140, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

143. The exposure apparatus according to Claim 142, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

144. The exposure apparatus according to Claim 140, further comprising:

a position measurement unit that measures position information of the object in the third direction,

wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

145. The exposure apparatus according to Claim 140, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

146. The exposure apparatus according to Claim 134, further comprising:

an interferometer system that measures position information of the movable body in at least the first and second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

147. The exposure apparatus according to Claim 146, wherein

the measurement information of the encoder system is used in a detection operation of the mark and/or surface position information of the object.

148. The exposure apparatus according to Claim 146, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

Claims

1. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least a first and a second directions that are orthogonal within a predetermined plane; and

driving the movable body within the predetermined plane, based on measurement information of an encoder system in which one of a grating section and a head unit is arranged on the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the movable body and which measures position information of the movable body within the predetermined plane, and based on information on flatness of the grating section, wherein

the information on flatness of the grating section relates to a measurement error of the encoder system due to a deviation or a displacement of a grating surface of the grating section from a plane that is parallel to the predetermined plane.

2. The exposure method according to claim 1, wherein

the movable body is driven also based on information on a formation error of the grating section.

3. The exposure method according to claim 1, wherein

the movable body is driven also based on position information of the movable body in a direction different from the first and the second directions.

4. The exposure method according to claim 1, wherein

the movable body is driven also based on inclination information of the movable body with respect to the predetermined plane.

5. The exposure method according to claim 1, wherein

the movable body is driven also based on characteristic information of the head unit that is a factor causing a measurement error of the encoder system.

6. The exposure method according to claim 1, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

7. The exposure method according to claim 1, wherein

the grating section is arranged on the movable body, and the head unit is arranged facing the movable body.

8. The exposure method according to claim 1, wherein

by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a first sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

9. The exposure method according to claim 8, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a second plurality of sensors including the first sensor that faces the grating section.

10. The exposure method according to claim 8, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining

three degrees of freedom is measured by the measurement system.

11. The exposure method according to claim 10, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

12. The exposure method according to claim 8, wherein

in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

13. The exposure method according to claim 8, wherein

the encoder system and a mark detection system that detects a mark on the object are used in a detection operation of the mark.

14. The exposure method according to claim 1, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and the second directions is used in an operation different from the exposure operation.

15. The exposure method according to claim 14, wherein

the measurement information of the encoder system is used in a detection operation of a mark and/or surface position information of the object.

16. The exposure method according to claim 14, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

17. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is exposed and a pattern is formed on the sensitive object using the exposure method according to claim 1.

18. An exposure method in which an object is exposed with an energy beam, the method including:

mounting the object on a movable body that can move in at least a first and a second directions that are orthogonal within a predetermined plane; and

controlling a position of the movable body within the predetermined plane, based on measurement information of an encoder system in which one of a grating section and a head unit is arranged on the movable body on which the object is mounted and the other of the grating section and the head unit is arranged facing the movable body and which measures position information of the movable body within the predetermined plane, and based on correction information to compensate a measurement error of the encoder system that occurs due to flatness of the grating section with respect to a plane that is parallel to the predetermined plane.

19. The exposure method according to claim 18, wherein

by the correction information, a measurement error of the encoder system that occurs due to a formation error of the grating section is also compensated.

20. The exposure method according to claim 18, wherein

by the correction information, a measurement error of the encoder system that occurs due to a displacement of the movable body in a different direction from the first and the second directions is also compensated.

21. The exposure method according to claim 20, wherein

the different direction includes at least one of a direction orthogonal to the predetermined plane, a rotation direction around an axis orthogonal to the predetermined plane, and a rotation direction around an axis parallel to the predetermined plane.

22. The exposure method according to claim 21, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

23. The exposure method according to claim 18, wherein

by the correction information, a measurement error of the encoder system that occurs due to inclination of the movable body with respect to the predetermined plane is also compensated.

24. The exposure method according to claim 23, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

25. The exposure method according to claim 18, wherein

by the correction information, a measurement error of the encoder system that occurs due to the head unit is also compensated.

26. The exposure method according to claim 25, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

27. The exposure method according to claim 25, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

28. The exposure method according to claim 18, wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

29. The exposure method according to claim 18, wherein

the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction

information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

30. The exposure method according to claim 18, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

31. The exposure method according to claim 18, wherein

the grating section is arranged on the movable body, and the head unit is arranged facing the movable body.

32. The exposure method according to claim 18, wherein

by further using a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a first sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

33. The exposure method according to claim 32, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a second plurality of sensors including the first sensor that faces the grating section.

34. The exposure method according to claim 32, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining

three degrees of freedom is measured by the measurement system.

35. The exposure method according to claim 34, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

36. The exposure method according to claim 32, wherein

in addition to the encoder system and the measurement system, a position measurement unit that measures position information of the object in the third direction is further used in a measurement operation of surface position information of the object.

37. The exposure method according to claim 32, wherein

the encoder system and a mark detection system that detects a mark on the object are used in a detection operation of the mark.

38. The exposure method according to claim 18, wherein:

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of an interferometer system that measures position information of the movable body in at least the first and the second directions is used in an operation different from the exposure operation.

39. The exposure method according to claim 38, wherein

the measurement information of the encoder system is used in a detection operation of a mark and/or surface position information of the object.

40. The exposure method according to claim 38, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

41. A device manufacturing method including a lithography process, wherein

in the lithography process, a sensitive object is exposed and a pattern is formed on the sensitive object using the exposure method according to claim 18.

42. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least a first and a second directions that are orthogonal within a predetermined plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the movable body and which measures position information of the movable body within the predetermined plane; and

a drive unit that drives the movable body within the predetermined plane based on measurement information of the encoder system and information on flatness of the grating section, wherein

the information on flatness of the grating section relates to a measurement error of the encoder system due to a deviation or a displacement of a grating surface of the grating section from a plane that is parallel to the predetermined plane.

43. The exposure apparatus according to claim 42, wherein

the movable body is driven also based on information on a formation error of the grating section.

44. The exposure apparatus according to claim 42, wherein

the movable body is driven also based on position information of the movable body in a direction different from the first and the second directions.

45. The exposure apparatus according to claim 42, wherein

the movable body is driven also based on inclination information of the movable body with respect to the predetermined plane.

46. The exposure apparatus according to claim 42, wherein

the movable body is driven also based on characteristic information of the head unit that is a factor causing a measurement error of the encoder system.

47. The exposure apparatus according to claim 42, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

48. The exposure apparatus according to claim 42, wherein

the grating section is arranged on the movable body, and the head unit is arranged facing the movable body.

49. The exposure apparatus according to claim 42, further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a first sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

50. The exposure apparatus according to claim 49, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a second plurality of sensors including the first sensor that faces the grating section.

51. The exposure apparatus according to claim 49, wherein

out of position information of the movable body in directions of six degrees of freedom, position information in directions of three degrees of freedom including the

first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

52. The exposure apparatus according to claim 51, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

53. The exposure apparatus according to claim 49, further comprising:

a position measurement unit that measures position information of the object in the third direction, wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

54. The exposure apparatus according to claim 49, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

55. The exposure apparatus according to claim 42, further comprising:

an interferometer system that measures position information of the movable body in at least the first and the second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

56. The exposure apparatus according to claim 55, wherein

the measurement information of the encoder system is used in a detection operation of a mark and/or surface position information of the object.

57. The exposure apparatus according to claim 55, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.

58. An exposure apparatus that exposes an object with an energy beam, the apparatus comprising:

a movable body that can move in at least a first and a second directions that are orthogonal within a predetermined plane, holding the object;

an encoder system in which one of a grating section and a head unit is arranged on the movable body on which the object is held and the other of the grating section and the head unit is arranged facing the movable body and which measures position information of the movable body within the predetermined plane; and

a controller that controls a position of the movable body within the predetermined plane, based on correction information to compensate a measurement error of the encoder system that occurs due to flatness of the grating section with respect to a plane that is parallel to the predetermined plane and based on measurement information of the encoder system.

59. The exposure apparatus according to claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to a formation error of the grating section is also compensated.

60. The exposure apparatus according to claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to a displacement of the movable body in a different direction from the first and the second directions is also compensated.

61. The exposure apparatus according to claim 60, wherein

the different direction includes at least one of a direction orthogonal to the

predetermined plane, a rotation direction around an axis orthogonal to the predetermined plane, and a rotation direction around an axis parallel to the predetermined plane.

62. The exposure apparatus according to claim 61, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

63. The exposure apparatus according to claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to inclination of the movable body with respect to the predetermined plane is also compensated.

64. The exposure apparatus according to claim 63, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

65. The exposure apparatus according to claim 58, wherein

by the correction information, a measurement error of the encoder system that occurs due to the head unit is also compensated.

66. The exposure apparatus according to claim 65, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least optical characteristics of the head unit is compensated.

67. The exposure apparatus according to claim 65, wherein

by the correction information, a measurement error of the encoder system that occurs due to at least a formation error of the grating section is compensated.

68. The exposure apparatus according to claim 58, wherein

the measurement information of the encoder system or a target position at which the movable body is positioned is corrected based on the correction information.

69. The exposure apparatus according to claim 58, wherein

the object is exposed by the energy beam via a mask, and when the exposure is performed, a position of the mask is controlled based on the correction information so that the measurement error is compensated, while driving the movable body based on the measurement information of the encoder system.

70. The exposure apparatus according to claim 58, wherein

the grating section is arranged extending in the first direction as a longitudinal direction, the head unit has a plurality of heads placed at different positions in the second direction, and position information of the movable body is measured by a head that faces the grating section out of the plurality of heads.

71. The exposure apparatus according to claim 58, wherein

the grating section is arranged on the movable body, and the head unit is arranged facing the movable body.

72. The exposure apparatus according to claim 58, further comprising:

a measurement system that measures position information of the movable body in a third direction orthogonal to the predetermined plane by a first sensor that faces the grating section out of a plurality of sensors placed on the same side as the head unit, wherein

a position of the movable body in the third direction is controlled based on measurement information of the measurement system.

73. The exposure apparatus according to claim 72, wherein

the measurement system measures position information in the third direction and inclination information of the movable body by a second plurality of sensors including the first sensor that faces the grating section.

74. The exposure apparatus according to claim 72, wherein

out of position information of the movable body in directions of six degrees

of freedom, position information in directions of three degrees of freedom including the first direction, the second direction and a rotation direction within the predetermined plane is measured by the encoder system, and position information in directions of the remaining three degrees of freedom is measured by the measurement system.

75. The exposure apparatus according to claim 74, wherein

a position of the movable body at least when performing an exposure operation is controlled based on the measured position information in directions of six degrees of freedom.

76. The exposure apparatus according to claim 72, further comprising:

a position measurement unit that measures position information of the object in the third direction, wherein

the encoder system, the measurement system and the position measurement unit are used in a measurement operation of surface position information of the object.

77. The exposure apparatus according to claim 72, further comprising:

a mark detection system that detects a mark on the object, wherein

the encoder system and the mark detection system are used in a detection operation of the mark.

78. The exposure apparatus according to claim 58, further comprising:

an interferometer system that measures position information of the movable body in at least the first and the second directions, wherein

in order to drive the movable body, the measurement information of the encoder system is used in an exposure operation and measurement information of the interferometer system is used in an operation different from the exposure operation.

79. The exposure apparatus according to claim 78, wherein

the measurement information of the encoder system is used in a detection

operation of a mark and/or surface position information of the object.

80. The exposure apparatus according to claim 78, wherein

at least part of the measurement information of the interferometer system is used in the exposure operation.