CLAIMS

1. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

an adjuster for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjuster has a plurality of adjustment surfaces each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated, and

wherein each of the adjustment surfaces outputs light with a light intensity distribution different from a light intensity distribution of incident light.

2. An illumination optical apparatus according to claim 1, wherein, where a first light beam is defined as a light beam arriving at a first point on the surface to be illuminated and where a second light beam is defined as a light beam arriving at a second point different from the first point on the surface to be illuminated, a change of light intensity distribution imposed by passage of the first light beam through the plurality of adjustment surfaces is different from a change of light intensity distribution imposed by passage of the second light beam through the plurality of adjustment surfaces.

3. An illumination optical apparatus according to claim 1 or 2, wherein the plurality of adjustment surfaces are located at respective

positions different from each other along an optical-axis direction of the illumination optical apparatus.

4. An illumination optical apparatus according to any one of claims 1 to 3, wherein each of the adjustment surfaces has a predetermined transmittance distribution or reflectance distribution.

5. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

an adjuster for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjuster has a plurality of adjustment surfaces each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated and has a predetermined transmittance distribution or reflectance distribution, and

wherein the plurality of adjustment surfaces are located at respective positions different from each other along an optical-axis direction of the illumination optical apparatus.

6. An illumination optical apparatus according to claim 4 or 5, wherein the adjuster comprises a first adjustment surface having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment surface having a second transmittance distribution or second reflectance distribution substantially

complementary to the first transmittance distribution or the first reflectance distribution.

7. An illumination optical apparatus according to claim 6, wherein the first adjustment surface is located on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and wherein the second adjustment surface is located on the surface-to-be-illuminated side with respect to the conjugate plane.

8. An illumination optical apparatus according to claim 7, wherein a distance between the first adjustment surface and the conjugate plane is substantially equal to a distance between the second adjustment surface and the conjugate plane.

9. An illumination optical apparatus according to claim 7, wherein a first distance between the first adjustment surface and the conjugate plane is substantially different from a second distance between the second adjustment surface and the conjugate plane.

10. An illumination optical apparatus according to claim 4 or 5, wherein the adjuster comprises a first adjustment surface having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment surface having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution.

11. An illumination optical apparatus according to claim 10, wherein the first adjustment surface is located on the light source side

with respect to a conjugate plane optically conjugate with the surface to be illuminated, and wherein the second adjustment surface is located on the surface-to-be-illuminated side with respect to the conjugate plane.

12. An illumination optical apparatus according to claim 10 or 11, wherein the adjuster adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

13. An illumination optical apparatus according to claim 4 or 5, wherein the adjuster comprises a first adjustment surface having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment surface having a second transmittance distribution or second reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

14. An illumination optical apparatus according to claim 13, wherein the first adjustment surface is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment surface is located on the surface-to-be-illuminated side with respect to the conjugate plane.

15. An illumination optical apparatus according to claim 14, wherein a distance between the first adjustment surface and the conjugate plane is substantially equal to a distance between the second

adjustment surface and the conjugate plane.

16. An illumination optical apparatus according to claim 14, wherein a first distance between the first adjustment surface and the conjugate plane is substantially different from a second distance between the second adjustment surface and the conjugate plane.

17. An illumination optical apparatus according to claim 4 or 5, wherein the adjuster comprises a first adjustment surface having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment surface having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution.

18. An illumination optical apparatus according to claim 17, wherein the first adjustment surface is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment surface is located on the surface-to-be-illuminated side with respect to the conjugate plane.

19. An illumination optical apparatus according to claim 17 or 18, wherein the adjuster adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

20. An illumination optical apparatus according to any one of claims 4 to 19, wherein the transmittance distribution or reflectance distribution of each of the adjustment surfaces is an even-order distribution.

21. An illumination optical apparatus according to any one of claims 1 to 7, 9 to 14, and 16 to 19, wherein the plurality of adjustment surfaces include a first adjustment surface and a second adjustment surface, and

wherein a light beam size at a location where a light beam to arrive at a predetermined point on the surface to be illuminated passes through the first adjustment surface is different from a light beam size at a location where the light beam to arrive at the predetermined point on the surface to be illuminated passes through the second adjustment surface.

22. An illumination optical apparatus according to claim 4 or 5, wherein the adjuster comprises a first adjustment surface having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment surface having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence angles.

23. An illumination optical apparatus according to any one of claims 1 to 22, wherein each of the adjustment surfaces is formed on a plane of an optical member having said plane.

24. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment surface disposed in an optical path between an illumination pupil plane of the illumination optical apparatus and the surface to be illuminated and in an optical path on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and

a second adjustment surface disposed in the optical path between the illumination pupil plane and the surface to be illuminated and in an optical path on the surface-to-be-illuminated side with respect to the conjugate plane optically conjugate with the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence positions.

25. An illumination optical apparatus according to claim 24, wherein the second transmittance distribution or the second reflectance distribution is substantially complementary to the first transmittance distribution or the first reflectance distribution.

26. An illumination optical apparatus according to claim 24, wherein the second transmittance distribution or the second reflectance distribution is substantially different from a transmittance distribution or reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

27. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment surface disposed in an optical path between an illumination pupil plane of the illumination optical apparatus and the surface to be illuminated and in an optical path on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and

a second adjustment surface disposed in the optical path between the illumination pupil plane and the surface to be illuminated and in an optical path on the surface-to-be-illuminated side with respect to the conjugate plane optically conjugate with the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence angles.

28. An illumination optical apparatus according to claim 27, wherein the second transmittance distribution or the second reflectance distribution is substantially complementary to the first transmittance distribution or the first reflectance distribution.

29. An illumination optical apparatus according to claim 27, wherein the second transmittance distribution or the second reflectance distribution is substantially different from a transmittance distribution or reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

30. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment surface disposed in an optical path between an illumination pupil plane of the illumination optical apparatus and the surface to be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and

a second adjustment surface disposed in the optical path between the illumination pupil plane and the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence positions;

wherein a light beam size at a location where a light beam to arrive at a predetermined point on the surface to be illuminated passes through the first adjustment surface is different from a light beam size at a location where the light beam to arrive at the predetermined point on the surface to be illuminated passes through the second adjustment surface.

31. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution calculating step of calculating pupil luminance distributions about a plurality of points on the surface to be illuminated, based on design data of the illumination optical apparatus;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the

respective adjustment surfaces, in order to independently adjust each of the pupil luminance distributions about the plurality of points; and

an adjustment step of forming and placing each of the plurality of adjustment surfaces with the respective required transmittance distributions or reflectance distributions.

32. An adjustment method according to claim 31, further comprising an illuminance distribution calculating step of calculating an illuminance distribution on the surface to be illuminated, based on the design data,

wherein the distribution determining step comprises calculating the required transmittance distributions or reflectance distributions to be given to the respective adjustment surfaces, in order to adjust the illuminance distribution.

33. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution measuring step of measuring pupil luminance distributions about a plurality of points on the surface to be illuminated;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the respective adjustment surfaces, in order to independently adjust each of the pupil luminance distributions about the plurality of points; and

an adjustment step of forming and placing each of the plurality of adjustment surfaces with the respective required transmittance distributions or reflectance distributions.

34. An adjustment method according to claim 33, further comprising an illuminance distribution measuring step of measuring an illuminance distribution on the surface to be illuminated,

wherein the distribution determining step comprises calculating the required transmittance distributions or reflectance distributions to be given to the respective adjustment surfaces, in order to adjust the illuminance distribution.

35. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution acquiring step of acquiring pupil luminance distributions about a plurality of points on the surface to be illuminated;

an approximation step of approximating each of the pupil luminance distributions about the plurality of points acquired in the pupil luminance distribution acquiring step, by a predetermined polynomial as a function of pupil coordinates on the illumination pupil plane;

an evaluation step of evaluating the pupil luminance distributions about the plurality of points by a pupil luminance distribution polynomial as a function of image-plane coordinates and the pupil coordinates on the surface to be illuminated, based on coefficients of respective terms in said predetermined polynomial;

a step of obtaining a correlation between the transmittance distributions or reflectance distributions given to the respective adjustment surfaces and changes of the pupil luminance distributions

about the plurality of points;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the respective adjustment surfaces, in order to independently adjust each of the pupil luminance distributions about the plurality of points, based on a result of the evaluation in the evaluation step and the correlation; and

an adjustment step of forming and placing each of the plurality of adjustment surfaces with the respective required transmittance distributions or reflectance distributions.

36. An adjustment method according to claim 35, further comprising an illuminance distribution acquiring step of acquiring an illuminance distribution on the surface to be illuminated; and a step of obtaining a second correlation between the transmittance distributions or reflectance distributions given to the respective adjustment surfaces and changes of the illuminance distribution on the surface to be illuminated,

wherein the distribution determining step comprises determining the required transmittance distributions or reflectance distributions to be given to the respective adjustment surfaces, in order to adjust the illuminance distribution, based on the second correlation.

37. An adjustment method according to claim 35 or 36, wherein the pupil luminance distribution acquiring step comprises calculating the pupil luminance distributions about the plurality of points on the surface to be illuminated, based on design data of the illumination optical apparatus.

38. An adjustment method according to claim 35 or 36, wherein the pupil luminance distribution acquiring step comprises measuring the pupil luminance distributions about the plurality of points on the surface to be illuminated.

39. An adjustment method according to any one of claims 36 to 38, wherein the illuminance distribution acquiring step comprises calculating the illuminance distribution on the surface to be illuminated, based on the design data of the illumination optical apparatus.

40. An adjustment method according to any one of claims 36 to 38, wherein the illuminance distribution acquiring step comprises measuring the illuminance distribution on the surface to be illuminated.

41. A method of adjusting an illumination optical apparatus for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane on the basis of a light beam from a light source and for illuminating a surface to be illuminated, with a light beam from the pupil luminance distribution,

the adjustment method comprising:

a pupil luminance distribution acquiring step of acquiring pupil luminance distributions about a plurality of points on the surface to be illuminated;

a distribution determining step of determining required transmittance distributions or reflectance distributions at a plurality of positions in an optical path of the illumination optical apparatus, in order to independently adjust each of the pupil luminance distributions about the plurality of points; and

an adjustment step of forming each of a plurality of adjustment

surfaces with the respective required transmittance distributions or reflectance distributions and placing the adjustment surfaces at the plurality of positions.

42. An adjustment method according to claim 41, further comprising an illuminance distribution acquiring step of acquiring an illuminance distribution on the surface to be illuminated,

wherein the distribution determining step comprises calculating the required transmittance distributions or reflectance distributions at the plurality of positions in the optical path of the illumination optical apparatus, in order to adjust the illuminance distribution.

43. An adjustment method according to claim 42, wherein the illuminance distribution acquiring step comprises calculating the illuminance distribution on the surface to be illuminated, based on design data of the illumination optical apparatus.

44. An adjustment method according to claim 42, wherein the illuminance distribution acquiring step comprises measuring the illuminance distribution on the surface to be illuminated.

45. An adjustment method according to any one of claims 41 to 44, wherein the pupil distribution acquiring step comprises calculating the pupil luminance distributions about the plurality of points on the surface to be illuminated, based on design data of the illumination optical apparatus.

46. An adjustment method according to any one of claims 41 to 44, wherein the pupil distribution acquiring step comprises measuring the pupil luminance distributions about the plurality of points on the surface to be illuminated.

47. An exposure apparatus comprising the illumination optical apparatus according to any one of claims 1 to 30, or an illumination optical apparatus adjusted by the adjustment method according to any one of claims 31 to 46, the exposure apparatus being adapted for projecting a predetermined pattern illuminated by the illumination optical apparatus, onto a photosensitive substrate to effect exposure thereof.

48. An exposure apparatus according to claim 47, further comprising a projection optical system for forming an image of the predetermined pattern on the photosensitive substrate,

wherein the surface to be illuminated is an image plane of the projection optical system.

49. An exposure apparatus according to claim 47, wherein a surface of the predetermined pattern is located on the surface to be illuminated.

50. An exposure method comprising: an illumination step of illuminating a predetermined pattern with the illumination optical apparatus according to any one of claims 1 to 30, or with an illumination optical apparatus adjusted by the adjustment method according to any one of claims 31 to 46; and an exposure step of projecting the predetermined pattern onto a photosensitive substrate to effect exposure thereof.

51. An exposure method according to claim 50, wherein the exposure step further comprises a projection step of forming an image of the predetermined pattern on the photosensitive substrate, and

wherein the surface to be illuminated is a surface on which the pattern image is formed.

52. A device manufacture method comprising: an exposure step of using the exposure apparatus according to any one of claims 47 to 49, to effect the exposure of the predetermined pattern on the photosensitive substrate; and a development step of developing the photosensitive substrate.

CLAIMS

1. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

adjusting means for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjusting means has a plurality of adjustment films each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated and has a predetermined transmittance distribution or reflectance distribution,

wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution, and

wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

2. An illumination optical apparatus according to claim 1, wherein a distance between the first adjustment film and the conjugate plane is substantially equal to a distance between the second adjustment film and the conjugate plane.

3. An illumination optical apparatus according to claim 1, wherein a first distance between the first adjustment film and the conjugate plane is substantially different from a second distance between the second adjustment film and the conjugate plane.

4. An illumination optical apparatus according to claim 1, wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution.

5. An illumination optical apparatus according to claim 4, wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

6. An illumination optical apparatus according to claim 4 or 5, wherein the adjusting means adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

7. An illumination optical apparatus according to claim 1, wherein the adjuster comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

8. An illumination optical apparatus according to claim 7, wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

9. An illumination optical apparatus according to claim 8, wherein a distance between the first adjustment film and the conjugate plane is substantially equal to a distance between the second adjustment film and the conjugate plane.

10. An illumination optical apparatus according to claim 8, wherein a first distance between the first adjustment film and the conjugate plane is substantially different from a second distance between the second adjustment film and the conjugate plane.

11. An illumination optical apparatus according to claim 1, wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution.

12. An illumination optical apparatus according to claim 11, wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

13. An illumination optical apparatus according to claim 11 or 12, wherein the adjusting means adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

14. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

adjusting means for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjusting means has a plurality of adjustment films each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated and has a predetermined transmittance distribution or reflectance distribution

wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution, and

wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the

conjugate plane.

15. An illumination optical apparatus according to claim 14, wherein the adjusting means adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

16. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

adjusting means for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjusting means has a plurality of adjustment films each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated and has a predetermined transmittance distribution or reflectance distribution,

wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially complementary to the

first transmittance distribution or the first reflectance distribution, and

wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

17. An illumination optical apparatus according to claim 16, wherein a distance between the first adjustment film and the conjugate plane is substantially equal to a distance between the second adjustment film and the conjugate plane.

18. An illumination optical apparatus according to claim 16, wherein a first distance between the first adjustment film and the conjugate plane is substantially different from a second distance between the second adjustment film and the conjugate plane.

19. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

pupil distribution forming means for forming a pupil luminance distribution with a predetermined luminance distribution on an illumination pupil plane; and

adjusting means for independently adjusting each of pupil luminance distributions about respective points on the surface to be illuminated;

wherein the adjusting means has a plurality of adjustment films each of which is disposed in an optical path between the pupil distribution forming means and the surface to be illuminated and has a predetermined transmittance distribution or reflectance distribution,

wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and a second adjustment film having a second transmittance distribution or second reflectance distribution substantially different from a transmittance distribution or reflectance distribution complementary to the first transmittance distribution or the first reflectance distribution, and

wherein the first adjustment film is located on the light source side with respect to a conjugate plane optically conjugate with the illumination pupil plane, and wherein the second adjustment film is located on the surface-to-be-illuminated side with respect to the conjugate plane.

20. An illumination optical apparatus according to claim 19, wherein the adjusting means adjusts an illuminance distribution on the surface to be illuminated, according to a difference between the complementary transmittance distribution or reflectance distribution and the second transmittance distribution or the second reflectance distribution.

21. An illumination optical apparatus according to any one of claims 1, 3 to 8, 10 to 16, and 18 to 20, wherein the plurality of adjustment

films include a first adjustment film and a second adjustment film, and

wherein a light beam size at a location where a light beam to arrive at a predetermined point on the surface to be illuminated passes through the first adjustment film is different from a light beam size at a location where the light beam to arrive at the predetermined point on the surface to be illuminated passes through the second adjustment film.

22. An illumination optical apparatus according to claim1, 14, 16 or 19, wherein the adjusting means comprises a first adjustment film having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and a second adjustment film having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence angles.

23. An illumination optical apparatus according to any one of claims 1 to 22, wherein each of the adjustment films is formed on a plane of an optical member having said plane.

24. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment film disposed in an optical path between an illumination pupil plane of the illumination optical apparatus and the surface to be illuminated and in an optical path on the light source side with respect to a conjugate plane optically conjugate with the surface to

be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions; and

a second adjustment film disposed in the optical path between the illumination pupil plane and the surface to be illuminated and in an optical path on the surface-to-be-illuminated side with respect to the conjugate plane optically conjugate with the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence positions.

25. An illumination optical apparatus according to claim 24, wherein the second transmittance distribution or the second reflectance distribution is substantially complementary to the first transmittance distribution or the first reflectance distribution.

26. An illumination optical apparatus according to claim 24, wherein the second transmittance distribution or the second reflectance distribution is substantially different from a transmittance distribution or reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

27. An illumination optical apparatus for illuminating a surface to be illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment film disposed in an optical path between an

illumination pupil plane of the illumination optical apparatus and the surface to be illuminated and in an optical path on the light source side with respect to a conjugate plane optically conjugate with the surface to be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence angles; and

a second adjustment film disposed in the optical path between the illumination pupil plane and the surface to be illuminated and in an optical path on the surface-to-be-illuminated side with respect to the conjugate plane optically conjugate with the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence angles.

28. An illumination optical apparatus according to claim 27, wherein the second transmittance distribution or the second reflectance distribution is substantially complementary to the first transmittance distribution or the first reflectance distribution.

29. An illumination optical apparatus according to claim 27, wherein the second transmittance distribution or the second reflectance distribution is substantially different from a transmittance distribution or reflectance distribution substantially complementary to the first transmittance distribution or the first reflectance distribution.

30. An illumination optical apparatus for illuminating a surface to be

illuminated, with a light beam from a light source,

the illumination optical apparatus comprising:

a first adjustment film disposed in an optical path between an illumination pupil plane of the illumination optical apparatus and the surface to be illuminated, and having a first transmittance distribution or first reflectance distribution of transmittances or reflectances different according to incidence positions;

a second adjustment film disposed in the optical path between the illumination pupil plane and the surface to be illuminated, and having a second transmittance distribution or second reflectance distribution of transmittances or reflectances different according to incidence positions; and

optical system disposed in an optical path between the first adjustment film and the second adjustment film,

wherein a light beam size at a location where a light beam to arrive at a predetermined point on the surface to be illuminated passes through the first adjustment film is different from a light beam size at a location where the light beam to arrive at the predetermined point on the surface to be illuminated passes through the second adjustment film.

31. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution calculating step of calculating pupil luminance distributions about a plurality of points on the surface to be illuminated, based on design data of the illumination optical

apparatus;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the respective adjustment films, in order to independently adjust each of the pupil luminance distributions about the plurality of points; and

an adjustment step of forming and placing each of the plurality of adjustment films with the respective required transmittance distributions or reflectance distributions.

32. An adjustment method according to claim 31, further comprising an illuminance distribution calculating step of calculating an illuminance distribution on the surface to be illuminated, based on the design data,

wherein the distribution determining step comprises calculating the required transmittance distributions or reflectance distributions to be given to the respective adjustment films, in order to adjust the illuminance distribution.

33. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution measuring step of measuring pupil luminance distributions about a plurality of points on the surface to be illuminated;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the

respective adjustment films, in order to independently adjust each of the pupil luminance distributions about the plurality of points; and

an adjustment step of forming and placing each of the plurality of adjustment films with the respective required transmittance distributions or reflectance distributions.

34. An adjustment method according to claim 33, further comprising an illuminance distribution measuring step of measuring an illuminance distribution on the surface to be illuminated,

wherein the distribution determining step comprises calculating the required transmittance distributions or reflectance distributions to be given to the respective adjustment films, in order to adjust the illuminance distribution.

35. A method of adjusting the illumination optical apparatus according to any one of claims 1 to 30,

the adjustment method comprising:

a pupil luminance distribution acquiring step of acquiring pupil luminance distributions about a plurality of points on the surface to be illuminated;

an approximation step of approximating each of the pupil luminance distributions about the plurality of points acquired in the pupil luminance distribution acquiring step, by a predetermined polynomial as a function of pupil coordinates on the illumination pupil plane;

an evaluation step of evaluating the pupil luminance

distributions about the plurality of points by a pupil luminance distribution polynomial as a function of image-plane coordinates and the pupil coordinates on the surface to be illuminated, based on coefficients of respective terms in said predetermined polynomial;

a step of obtaining a correlation between the transmittance distributions or reflectance distributions given to the respective adjustment films and changes of the pupil luminance distributions about the plurality of points;

a distribution determining step of determining required transmittance distributions or reflectance distributions to be given to the respective adjustment films, in order to independently adjust each of the pupil luminance distributions about the plurality of points, based on a result of the evaluation in the evaluation step and the correlation; and

an adjustment step of forming and placing each of the plurality of adjustment films with the respective required transmittance distributions or reflectance distributions.

36. An adjustment method according to claim 35, further comprising an illuminance distribution acquiring step of acquiring an illuminance distribution on the surface to be illuminated; and a step of obtaining a second correlation between the transmittance distributions or reflectance distributions given to the respective adjustment films and changes of the illuminance distribution on the surface to be illuminated,

wherein the distribution determining step comprises determining the required transmittance distributions or reflectance distributions to be given to the respective adjustment films, in order to adjust the

illuminance distribution, based on the second correlation.

37. An adjustment method according to claim 35 or 36, wherein the pupil luminance distribution acquiring step comprises calculating the pupil luminance distributions about the plurality of points on the surface to be illuminated, based on design data of the illumination optical apparatus.

38. An adjustment method according to claim 35 or 36, wherein the pupil luminance distribution acquiring step comprises measuring the pupil luminance distributions about the plurality of points on the surface to be illuminated.

39. An adjustment method according to any one of claims 36 to 38, wherein the illuminance distribution acquiring step comprises calculating the illuminance distribution on the surface to be illuminated, based on the design data of the illumination optical apparatus.

40. An adjustment method according to any one of claims 36 to 38, wherein the illuminance distribution acquiring step comprises measuring the illuminance distribution on the surface to be illuminated.

41. An exposure apparatus comprising the illumination optical apparatus according to any one of claims 1 to 30, or an illumination optical apparatus adjusted by the adjustment method according to any one of claims 31 to 40, the exposure apparatus being adapted for

projecting a pattern of a mask illuminated by the illumination optical apparatus, onto a photosensitive substrate to effect exposure thereof.

42. An exposure apparatus according to claim 41, further comprising a projection optical system for forming an image of the pattern of the mask on the photosensitive substrate,

wherein the surface to be illuminated is an image plane of the projection optical system.

43. An exposure apparatus according to claim 41, wherein a surface of the pattern of the mask is located on the surface to be illuminated.

44. An exposure method comprising: an illumination step of illuminating a mask with the illumination optical apparatus according to any one of claims 1 to 30, or with an illumination optical apparatus adjusted by the adjustment method according to any one of claims 31 to 40; and an exposure step of projecting a pattern of the mask onto a photosensitive substrate to effect exposure thereof.

45. An exposure method according to claim 44, wherein the exposure step further comprises a projection step of forming an image of the pattern of the mask on the photosensitive substrate, and

wherein the surface to be illuminated is a surface on which the pattern image is formed.