WHAT IS CLAIMED IS:

1. An apparatus for curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the apparatus comprising:

an irradiator configured to irradiate the material with light for curing the material; and

a controller configured to control the irradiator,

wherein

the controller is configured to acquire information regarding that a piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after irradiation to the piece of the material with light by the irradiator has finished, and

wherein the controller is configured to determine, after acquiring the information, an irradiation time during which another piece of the material is irradiated with light from the irradiator based on square root of an illuminance of the light from the irradiator, and to control the irradiator to irradiate the other piece of the material with the light for the determined irradiation time.

2. An apparatus for curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, comprising:

an irradiator configured to irradiate the material with light for curing the material; and

a controller configured to control the irradiator,

wherein the controller is configured to acquire information regarding that a piece of the material has not been

cured to be within a predetermined range for a target degree of photopolymerization after irradiation to the piece of the material with light by the irradiator has finished, and

wherein the controller is configured to determine, after acquiring the information, an irradiation time during which another piece of the material is irradiated with light from the irradiator based on square root of an illuminance of the light from the irradiator, and to control the irradiator to irradiate the other piece of the material with the light for the determined irradiation time.

3. The apparatus according to claim 1, wherein the controller determines the irradiation time such that the irradiation time is inverse proportional to the square root of the illuminance of the light from the irradiator, with which the material is irradiated.

4. The apparatus according to claim 1, wherein letting I_c be the illuminance of the light from the irradiator, with which the material is irradiated, t_c be the irradiation time during which the material is irradiated with the light, k be a coefficient, and PD be a target degree of photopolymerization of the material subjected to irradiation with the light, the controller determines the irradiation time in accordance with:

$$PD = k \times (\sqrt{I_c}) \times t_c$$

5. The apparatus according to claim 4, further comprising an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein letting I_c be the illuminance detected by the illuminance detector, the controller determines the irradiation time in accordance with:

$$PD = k \times (\sqrt{I_c}) \times t_c$$

6. The apparatus according to claim 1, further comprising:

a driving mechanism configured to change a relative distance between the material and the mold;

a separation force detector configured to detect a separation force required to separate the mold from the material; and

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the irradiator irradiates the material with the light such that the material is cured, in a state in which the relative distance is set by the driving mechanism so as to bring the mold into contact with the material supplied on the substrate, and then the relative distance is changed by the driving mechanism so as to separate the mold from the material, and

wherein the controller is configured to acquire first information regarding that the separation force while the relative distance is changed by the driving mechanism so as to separate the mold from the piece of the material falls outside an allowable range, wherein the separation force falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance detected again by the illuminance detector.

7. The apparatus according to claim 1, further comprising:

a driving mechanism configured to change a relative distance between the material and a mold;

a separation force detector configured to detect a separation force required to separate the mold from the material; and

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the irradiator irradiates the material with the light such that the material is cured, in a state in which the relative distance is set by the driving mechanism so as to bring the mold into contact with the material supplied on the substrate, and then the relative distance is changed by the driving mechanism so as to separate the mold from the material, and

wherein the controller is configured to acquire first information regarding that a product of (a) the separation force while the relative distance is changed by the driving mechanism so as to separate the mold from the piece of the material and (b) a time during which the separation force acts on the mold falls outside an allowable range, wherein the product falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance of detected again by the illuminance detector.

8. The apparatus according to claim 1, further comprising:

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the controller is configured to acquire first information regarding that a defect density in a pattern obtained by curing the piece of the material falls outside an allowable range, wherein the defect density falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance of detected again by the illuminance detector.

9. An apparatus for curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the apparatus comprising:

an irradiator configured to irradiate the material with light for curing the material; and

a controller configured to control the irradiator, wherein the controller determines that whether or not the material is cured such that a degree of polymerization of the material falls within a predetermined range of a target degree of the polymerization of the material, and

the controller determines the irradiation time during which the material is irradiated with the light from the irradiator based on the square root of the illuminance of the light from the irradiator, with which the material is irradiated and a target value associated with polymerization of the material in case that the controller determines that the material is not cured such that the degree of the polymerization

of the imprint material falls outside the predetermined range.

10. The apparatus according to claim 1, wherein the controller determines the irradiation time during which the material is irradiated with the light from the irradiator by dividing a target value associated with polymerization of the material by the square root of the illuminance of the light from the irradiator.

11. An apparatus for curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the apparatus comprising:

an irradiator configured to irradiate the material with light for curing the material,

a controller configured to control the irradiator; andan illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the controller determines a first irradiation time during which the material is irradiated with the light from the irradiator, based on a square root of a first illuminance of the light from the irradiator, with which the material is irradiated, and controls the irradiator so that an irradiation time during which the material is irradiated with the light from the irradiator becomes the first irradiation time, and

wherein the illuminance detector detects a second illuminance of the light with which the irradiator irradiates the material, the second illuminance being different from the first illuminance, and

wherein the controller determines a second irradiation time during which the material is irradiated with the light from

the irradiator, based on a square root of the detected second illuminance of the light from the irradiator, with which the material is irradiated, and controls the irradiator so that an irradiation time during which the material is irradiated with the light from the irradiator becomes the second irradiation time.

12. The apparatus according to claim 1, wherein the material is an imprint material for forming a pattern.

13. The apparatus according to claim 2, wherein the controller determines the irradiation time such that the irradiation time is inverse proportional to the square root of the illuminance of the light from the irradiator, with which the material is irradiated.

14. The apparatus according to claim 2, wherein letting I_c be the illuminance of the light from the irradiator, with which the material is irradiated, t_c be the irradiation time during which the material is irradiated with the light, k be a coefficient, and PD be a target degree of photopolymerization of the material subjected to irradiation with the light, the controller determines the irradiation time in accordance with:

$$PD = k \times (\sqrt{I_c}) \times t_c$$

15. The apparatus according to claim 14, further comprising an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein letting I_c be the illuminance detected by the illuminance detector, the controller determines the irradiation time in accordance with:

$$PD = k \times (\sqrt{I_c}) \times t_c$$

16. The apparatus according to claim 2, further comprising:

a driving mechanism configured to change a relative distance between the material and the mold;

a separation force detector configured to detect a separation force required to separate the mold from the material; and

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the irradiator irradiates the material with the light such that the material is cured, in a state in which the relative distance is set by the driving mechanism so as to bring the mold into contact with the material supplied on the substrate, and then the relative distance is changed by the driving mechanism so as to separate the mold from the material, and

wherein the controller is configured to acquire first information regarding that the separation force while the relative distance is changed by the driving mechanism so as to separate the mold from the piece of the material falls outside an allowable range, wherein the separation force falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance detected again by the illuminance detector.

17. The apparatus according to claim 2, further comprising:

a driving mechanism configured to change a relative distance between the material and a mold;

a separation force detector configured to detect a separation force required to separate the mold from the

material; and

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the irradiator irradiates the material with the light such that the material is cured, in a state in which the relative distance is set by the driving mechanism so as to bring the mold into contact with the material supplied on the substrate, and then the relative distance is changed by the driving mechanism so as to separate the mold from the material, and

wherein the controller is configured to acquire first information regarding that a product of (a) the separation force while the relative distance is changed by the driving mechanism so as to separate the mold from the piece of the material and (b) a time during which the separation force acts on the mold falls outside an allowable range, wherein the product falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance of detected again by the illuminance detector.

18. The apparatus according to claim 2, further comprising:

an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the controller is configured to acquire first information regarding that a defect density in a pattern

obtained by curing the piece of the material falls outside an allowable range, wherein the defect density falling outside the allowable range indicates that the piece of the material has not been cured to be within the predetermined range, and

wherein the controller is configured to cause, after acquiring the first information, the illuminance detector to detect the illuminance again, and to determine the irradiation time based on square root of the illuminance of detected again by the illuminance detector.

19. An apparatus for curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, comprising:

an irradiator configured to irradiate the material with light for curing the material; and

a controller configured to control the irradiator, wherein the controller determines that whether or not the material is cured such that a degree of polymerization of the material falls within a predetermined range of a target degree of the polymerization of the material, and

the controller determines the irradiation time during which the material is irradiated with the light from the irradiator based on the square root of the illuminance of the light from the irradiator, with which the material is irradiated and a target value associated with polymerization of the material in case that the controller determines that the material is not cured such that the degree of the polymerization of the imprint material falls outside the predetermined range.

20. The apparatus according to claim 2, wherein the controller determines the irradiation time during which the material is irradiated with the light from the irradiator by dividing a target value associated with polymerization of the material by

the square root of the illuminance of the light from the irradiator.

21. An apparatus for curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, comprising:

an irradiator configured to irradiate the material with light for curing the material,

a controller configured to control the irradiator; and an illuminance detector configured to detect the illuminance of the light with which the irradiator irradiates the material,

wherein the controller determines a first irradiation time during which the material is irradiated with the light from the irradiator, based on a square root of a first illuminance of the light from the irradiator, with which the material is irradiated, and controls the irradiator so that an irradiation time during which the material is irradiated with the light from the irradiator becomes the first irradiation time, and

wherein the illuminance detector detects a second illuminance of the light with which the irradiator irradiates the material, the second illuminance being different from the first illuminance, and

wherein the controller determines a second irradiation time during which the material is irradiated with the light from the irradiator, based on a square root of the detected second illuminance of the light from the irradiator, with which the material is irradiated, and controls the irradiator so that an irradiation time during which the material is irradiated with the light from the irradiator becomes the second irradiation time.

22. The apparatus according to claim 2, wherein the material is an imprint material for forming a pattern.

23. An apparatus for curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the apparatus comprising:

an irradiator configured to irradiate the material with light,

the irradiator including an adjustor configured to adjust an illuminance of the light with which the material is irradiated,

wherein the controller is configured to acquire information regarding that a piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after irradiation to the piece of the material with light by the irradiator has finished, and

wherein the controller is configured to control, after acquiring the information, the adjuster to adjust an illuminance of the light from the irradiator when the irradiator irradiates another piece of the material with light based on a square of an irradiation time during which the other piece of the material is irradiated by the irradiator.

24. An apparatus for curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, the apparatus comprising:

an irradiator configured to irradiate the material with light,

the irradiator including an adjustor configured to adjust an illuminance of the light with which the material is irradiated,

wherein the controller is configured to acquire information regarding that a piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after irradiation to the piece of the material with light by the irradiator has finished, and

wherein the controller is configured to control, after acquiring the information, the adjuster to adjust an illuminance of the light from the irradiator when the irradiator irradiates another piece of the material with light based on a square of an irradiation time during which the other piece of the material is irradiated by the irradiator.

25. An article manufacturing method comprising:

curing a material on a substrate by irradiating the material with light in a state in which a mold is brought into contact with the material by using an apparatus according to any one of claims 1 to 24; and

processing the substrate on which the cured material is formed.

26. A method of forming a pattern by curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the method comprising:

an irradiation step of irradiating a piece of the material with light for curing the piece of the material;

an acquisition step of acquiring information regarding that the piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after the irradiation step has finished;

a determination step of determining, after the

acquisition step, an irradiation time during which another piece of the material is irradiated with light based on square root of an illuminance of the light; and

an irradiation step of irradiating the other piece of the material with the light for the determined irradaition time.

27. A method of forming a pattern by curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, the method comprising:

an irradiation step of irradiating a piece of the material with light for curing the piece of the material;

an acquisition step of acquiring information regarding that the piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after the irradiation step has finished;

a determination step of determining, after the acquisition step, an irradiation time during which another piece of the material is irradiated with light based on square root of an illuminance of the light; and

an irradiation step of irradiating the other piece of the material with the light for the determined irradiation time.

28. A method of forming a pattern by curing a material by irradiating the material with light in a state in which a mold is brought into contact with the material, photochemical reaction velocity of the material being proportional to square root of an illuminance of the light with which the material is irradiated, the method comprising:

an irradiation step of irradiating a piece of the material with light for curing the piece of the material;

an acquisition step of acquiring information regarding that the piece of the material has not been cured to be within

a predetermined range for a target degree of photopolymerization after the irradiation step has finished;

an adjustment step of adjusting an illuminance of the light for irradiating another piece of the material with light based on a square of an irradiation time during which the other piece of the material is irradiated; and

an irradiation step of irradiating the other piece of the material with the illuminance adjusted in the adjustment step.

29. A method of curing a radical polymerizable material by irradiating the material with light in a state in which a mold is brought into contact with the material, the method:

an irradiation step of irradiating a piece of the material with light for curing the piece of the material;

an acquisition step of acquiring information regarding that the piece of the material has not been cured to be within a predetermined range for a target degree of photopolymerization after the irradiation step has finished;

an adjustment step of adjusting an illuminance of the light for irradiating another piece of the material with light based on a square of an irradiation time during which the other piece of the material is irradiated; and

an irradiation step of irradiating the other piece of the material with the illuminance adjusted in the adjustment step.