

DESCRIPTION

PRODUCTION METHOD AND PRODUCTION APPARATUS OF DISC

TECHNICAL FIELD

5 The present invention relates to a production method and a production apparatus of a disc for forming a coating or a film in a desired thickness on various disc substrates.

BACKGROUND ART

10 In general, a spin-coating method is applied for forming a coating or a film such as a recording layer, protection layer and the like on a disc substrate. In accordance with this spin-coating method, the disc substrate is spun at a certain rate of spin, a coating material is supplied on the disc in a spiral form by discharging liquid of the coating material from a nozzle along with moving or shifting the nozzle from outside
15 to inside on the disc substrate, and the coating layer is generated by spreading the coating material using centrifugal force.

For example, a material of the coating layer applied to form a recording layer is made from a solvent and a coloring material and the coating layer is formed by drying the solvent. In this case, the recording layer is dried from inside to outside of the disc as
20 the recording layer is spread by spinning. In general, such drying is incomplete and there are still approximately a few percent of the solvent in the recording layer, however, the solvent is removed or dried almost completely in a following drying step. It should be noted that "drying" in this document means drying in a spin-coating process.

As described above, the recording layer is formed by spreading the coating
25 material from inside to outside of the disc substrate by spinning. In this process, by

maintaining the rate of spin at a certain level, a tendency is observed that the thickness of the coating or the film becomes larger from the inside toward the outside.

In order to correct or adjust the thickness of the coating and to form the coating on the whole surface of the disc substrate evenly, various spin patterns have been
5 invented or proposed. For example, a spin pattern in which a rate of spin is gradually increased in accordance with a certain slope or pace from a certain slow and initial speed; a spin pattern in which a certain spinning speed is maintained after gradually increasing the rate of spin in accordance with a certain slope or pace from a certain slow and initial speed and after that the rate of spin is increased or decreased in a certain slope or pace
10 (see Japanese Patent Application, First Publication No. H06-004910); or a spin pattern in which a rate of spin is increased with respect to time in accordance with a certain region of a curve of a second order (see Japanese Patent Application, First Publication No. 2000-285533).

It is possible to realize a spin pattern by applying a spin program including a
15 relationship between changes of the thickness of the recording layer and the rate of spin of the disc substrate calculated beforehand from various results of measurements.

However, with respect to a real production apparatus, because of control factors which are greatly difficult to be included in the spin program such as a production environment (temperature and/or humidity), a state of the disc substrate (its temperature and/or water
20 absorption degree), a condition of forming the disc substrate and the like, the thickness of the recording layer of the disc substrate differs. Therefore, the quality of optical discs differs even when the same spin program is applied for forming the recording layer of the disc substrate, and it is difficult to produce optical discs of the same or almost the same quality.

25 In the prior art, when such condition changes are detected, in order to correct or

adjust the differences or unevenness of the thickness of the recording layer, the required time for finishing forming of the recording layer formed in accordance with the steps above is calculated, a speed of drying the recording layer is calculated, and the spin program is changed based on the data of the speed of drying and data of measuring the
5 recording layer.

However, there is a problem such that, in order to correct or adjust the thickness of the recording layer, the conditions of the production environment should be strictly fixed and conditions including the forming state of the disc substrate such as the temperature and the water absorption degree of the disc substrate should be maintained,
10 if not so, a position where the thickness differs moves even after correcting or adjusting the thickness.

Moreover, when the spin program is changed, it takes a long time for changing because of the need to obtain various data again and the like, therefore, there is a problem such that good or poor quality of the spin program depends on the skills of an operator.

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DISCLOSURE OF INVENTION

The present invention has an object such that the rate of spin of the disc substrate is changed based on a measured result of drying of the coating when the coating is formed on the disc substrate in accordance with the spin-coating method, and the
20 coating is maintained in a range of a predetermined thickness even when the conditions of forming the coating are changed.

A disc production method of the present invention includes: a step of forming a coating on a disc substrate by drying the coating after coating a coating material while the disc substrate is spinning; a step of detecting moving of a boundary between a dried
25 area and a wet area on the coating that is spinning; a step of measuring a distribution of a

coating thickness after drying; and a step of controlling a spinning speed of the disc substrate based on a relationship between the moving of the boundary which is detected and the distribution of the coating thickness.

In accordance with the invention above, by controlling the spinning speed of the disc substrate based on the relationship between the moving of the boundary which is detected and the distribution of the coating thickness, it is possible to adjust the coating thickness at positions along the radius of the disc substrate, therefore, the coating thickness that is finally obtained is maintained in a desired range of the coating thickness. It should be noted that the disc in the present invention is not limited to an optical disc, and all discs are included in scope of the present invention if they have the coating formed by coating the coating material on a circular disc substrate and by drying.

It is appropriate that, in the step of detecting the moving of the boundary between the dried area and the wet area on the coating, drying time of the coating be measured at two or more measuring points along a radius on the disc substrate. It is appropriate that, in the step of controlling the spinning speed of the disc substrate, the spinning speed be changed when the drying time of the disc substrate corresponding to the measuring points after starting spinning the disc substrate passes. By applying such a structure, it is easy to control because it requires only the detection of conditions of drying at the predetermined measuring points.

It is appropriate that the step of detecting the moving of the boundary between the dried area and the wet area on the coating include: a step of detecting drying state of the coating at a plurality of points one by one from inside to outside; a step of measuring the coating thickness; and a step of detecting the point along the radius where the coating thickness of the coating is out of a predetermined range. It is appropriate that, in the step of controlling the spinning speed of the disc substrate, the spinning speed of the disc

substrate be changed when the boundary between the dried area and the wet area on the coating reaches the point along the radius where the coating thickness of the coating is out of the predetermined range. It is appropriate that, after changing the spinning speed, the spinning speed be changed again when the coating thickness of the recording layer is out of the predetermined range again.

It is appropriate that a drying detection step of detecting a state in which the recording layer is dried gradually from the inside edge to the outside edge, a coating thickness measuring step in which the coating thickness of the recording layer is measured, and a step of detecting a position where the coating thickness of the recording layer is out of the predetermined range and calculating drying time of the recording layer at the position, be performed. In this case, it is possible to change the spinning speed when the coating thickness reaches the upper or lower limit by controlling so as to maintain the coating thickness within the predetermined range, therefore, it is possible to maintain the coating thickness in the predetermined range of the coating thickness even if there are condition changes or the like upon producing the disc substrate.

It is appropriate that the controlling of the spinning speed be operated by changing a spin program. In this case, it is possible to select a most preferable spin pattern from many spin patterns in which slopes of the spinning speed of the disc substrate are set beforehand, therefore, it is possible to realize a predetermined slope of the spinning speed easily.

It is appropriate that, in the step of detecting the moving of the boundary between the dried area and the wet area on the coating, the boundary be detected by using at least one of reflectance and transmittance of the coating against the light. It should be noted that the scope of the present invention is not limited by this constitution and it is possible that drying be detected by detecting other physical characteristics (for example,

changes of the weight, changes of electrostatic capacitance, changes of electrical conductivity, changes of transmittance or reflectance of energy rays other than light, or the like).

It is appropriate that, both in the step of detecting the moving of the boundary between the dried area and the wet area on the coating and in the step of measuring the distribution of the coating thickness after drying be operated on a n -th (n is an integer and is 1 or more) disc substrate; and the step of controlling the spinning speed of the disc substrate be operated on a $n+a$ -th (n is a fixed integer and is 1 or more) disc substrate. In this case, by using data based on the disc substrate on which the operation is finished, spinning of the a -th disc substrate after that disc substrate is operated, therefore, the structure of the apparatus is simplified. It is appropriate to adjust the value of " a " based on time lag between the step of forming the coating and the step of measuring the distribution of the coating thickness.

It is appropriate that an average be calculated from stored results of distributions of the coating thickness of a certain number (for example, n , $n+1$, $n+2$, ... $n+m$ (m is a fixed number and is equal to or larger than 1)) of continuing disc substrates, and a structure be designed so as to control spinning of the disc substrate after a certain number (for example, $n+r$ (r is a integer and is larger than m)) by using the average data. By applying such a structure, in a case of having trouble with the coating with respect to only a certain disc substrate, it is possible to minimize the influence on the control.

It is appropriate that the step of detecting moving of the boundary between the dried area and the wet area on the coating, the step of measuring the distribution of the coating thickness after drying and the step of controlling the spinning speed of the disc substrate be operated on the same disc substrate. In this case, measuring and controlling of spinning are operated on the same disc substrate, therefore, it is possible to react or

respond to a quick changes of situations.

A disc production apparatus of the present invention includes: a spinning mechanism which spins a disc substrate; a coating mechanism which coats a coating material on the disc substrate; a drying detection mechanism which detects moving of a boundary between a dried area and a wet area on the coating during spinning; a coating thickness measuring mechanism which measures a distribution of a coating thickness after drying; and a control mechanism which controls a spinning speed of the disc substrate based on a relationship between the moving of the boundary which is detected and the distribution of the coating thickness.

In accordance with the apparatus, by controlling the spinning speed of the disc substrate based on the relationship between the moving of the boundary which is detected and the distribution of the coating thickness, it is possible to adjust the coating thickness at positions along the radius of the disc substrate, therefore, the coating thickness that is finally obtained is maintained in a desired range of the coating thickness.

It is appropriate that, in the disc production apparatus above, the control mechanism include a spin programming mechanism including a spin program which includes a plurality of spin patterns that show characteristics between spinning time and spinning speed of the disc substrate; and the spin programming mechanism, when the spinning speed needs to be changed during forming the coating, changes the spin pattern after a position where the spinning speed needs to be changed.

It is appropriate that the spin mechanism include a mounting table for mounting the disc substrate and a spin driving mechanism for pinning the mounting table at a desired pinning speed.

It is appropriate that the coating thickness measuring mechanism include a detection mechanism which compares obtained coating thickness data with a

predetermined coating thickness range and which outputs a check signal that indicates whether the coating thickness is inside the predetermined coating thickness range along a radius of the disc substrate or outside. It is appropriate that the disc production apparatus include (i) a drying detection mechanism which calculates drying time of the coating for changing the spin pattern when a drying signal and the check signal are received; (ii) a coating thickness measuring mechanism which measures the coating thickness and outputs coating thickness data; (iii) a coating thickness detection mechanism which compares obtained coating thickness data with a predetermined coating thickness range and which outputs the check signal that indicates whether the coating thickness is inside the predetermined coating thickness range along a radius of the disc substrate or outside; and (iv) a spin programming mechanism including a spin program which includes a plurality of spin patterns that show characteristics between spinning time and spinning speed of the disc substrate.

It is appropriate that the drying detection mechanism be an image processing apparatus. In this case, it is possible to detect states of drying easily at any desired points.

It is appropriate that the drying detection mechanism include a coating drying sensor including: both a light radiation mechanism which radiates light on the coating while the light is irradiated; and a light receiving mechanism which receives light reflected from the coating or light transmitted through the coating; and a drying judgment mechanism which outputs a drying signal when the amount of light received by the light receiving mechanism reaches a predetermined level. Thus, it is possible to reduce the cost of the apparatus.

It is appropriate that the light radiation mechanism be a laser generation mechanism which generates a laser beam, or a light emission diode. In this case, it is

possible to measure drying of the coating thickness accurately by using the transmission or reflection of light.

It is appropriate that the light receiving mechanism be an image processing apparatus including a CCD camera or a CCD sensor in a strip shape set between an
5 inside edge and an outside edge of the disc substrate. In this case, it is possible to measure drying states of the coating accurately by using the image processing.

It is appropriate that the light receiving mechanism be one or a plurality of photo diodes arranged along a radius of the disc substrate.

By applying the production method and the production apparatus of the disc,
10 even when various conditions are changed, it is possible to maintain the thickness of the coating in a predetermined range.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a figure for explaining, in the production method of the disc of the
15 present invention, the progress of drying of a coating while operating spin-coating.

FIG. 1B is a figure for explaining, in the production method of the disc of the present invention, the progress of drying of a coating while operating spin-coating.

FIG. 1C is a figure for explaining, in the production method of the disc of the present invention, the progress of drying of a coating while operating spin-coating.

20 FIG. 1D is a figure for explaining, in the production method of the disc of the present invention, the progress of drying of a coating while operating spin-coating.

FIG. 1E is a figure for explaining, in the production method of the disc of the present invention, the progress of drying of a coating while operating spin-coating.

FIG. 2 is a block diagram of a production apparatus of a disc, which is one
25 embodiment of the present invention.

FIG. 3A is a plane figure showing a boundary detection mechanism in said embodiment.

FIG. 3B is a cross section of FIG. 3A along a line IIIB-IIIB.

FIG. 3C is a cross section of FIG. 3A along a line IIIC-IIIC.

5 FIG. 4 is a graph showing changes of the thickness of the coating layer along a radius of the disc.

FIG. 5 is a graph showing changes of a rate of spin of the disc substrate with time.

10 FIG. 6 is a graph showing changes of the thickness of the coating layer at positions along a radius of the disc in another embodiment.

FIG. 7 is a graph showing changes of the thickness of the coating layer along a radius of the disc.

FIG. 8 is a graph showing changes of a rate of spin of the disc substrate with time.

15 FIG. 9 is a block diagram of a production apparatus of a disc, which is another embodiment.

FIG. 10 is a cross-section showing an example of a drying detection mechanism.

20 FIG. 11 is a cross-section showing another example of a drying detection mechanism.

FIG. 12 is a cross-section showing another example of a drying detection mechanism.

FIG. 13 is a block diagram of a production apparatus of a disc in another embodiment.

25 FIG. 14 is a cross-section showing another example of a drying detection

mechanism in other embodiment.

FIG. 15 is a cross-section showing another example of a drying detection mechanism in other embodiment.

5 BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, a best mode for carrying out the present invention is explained. It should be noted that the present invention is not limited by each embodiment below, and any embodiments are only limited by the descriptions in the claims. For example, it is acceptable to combine embodiments below in accordance with requirements or needs,
10 and it is acceptable to combine each embodiment with other structures which are already publicly disclosed.

A first embodiment

The present invention uses the knowledge such that a coating formed in accordance with the spin-coating method is dried from inside to outside while spinning
15 and the knowledge that the coating dried in a spinning step is not moved even by a centrifugal force of spinning and the thickness of the coating is not changed.

An example in which a coating (a recording layer in this example) 2 is formed on a disc substrate D in accordance with the spin-coating method is explained in reference to FIG. 1A-1E. As shown in FIG. 1A, on the disc substrate D spinning at a
20 certain speed, a nozzle N which is set above the disc substrate D and which moves in a direction from outside to inside of the disc substrate D supplies liquid of a coating material, therefore, a coating material w is supplied from outside to inside in a spiral state. The liquid of a recording material is generally used and is made from a solvent, an organic coloring matter dissolved in the solvent and the like.

25 When the nozzle N reaches the inside edge of the disc substrate D after moving

in a direction of an arrow, the nozzle N stops supplying the coating material w and returns to a position where the nozzle N was originally set. On the other hand, the disc substrate D is spun at a high speed in a rate of spin which is gradually increased in accordance with a certain slope or pace. Therefore, the coating material is spread on the disc substrate and the redundant coating material w is spun off (FIG. 1B).

While the coating material w is being spread on the disc substrate D, the coating material w inside starts to be dried and forms a coating W. This is because, as described above, the coating material w included in the solvent is moved toward an outside direction because of a centrifugal force caused by spinning the disc substrate D (FIG. 1C-1E). When the coating W formed on whole surface of the disc substrate D is dried, spinning of the disc substrate D is stopped and the disc substrate D is taken out by a transfer mechanism (not shown in figures) from a spinner apparatus (not shown in figures).

Referring to FIG. 2-5, one embodiment of the present invention is explained. FIG. 2 is a block diagram of a coating formation apparatus 100 for an optical disc that shows one embodiment of the present invention, and FIG. 3A-3C are figures for explaining a detection method and a detection apparatus of drying of the coating while spinning the disc substrate D. FIG. 4 is a figure for explaining changes of thickness of the coating along a radius of the disc, and FIG. 5 is a figure which shows a relationship between required time for drying the coating and a rate of spin of the disc substrate.

It is possible to apply a generally used apparatus for a spinner apparatus 1 which has: a coater house 3 for preventing a coating material spun off while spinning at a high speed from scattering; a nozzle mechanism 5 for supplying the coating material on the disc substrate D; a mounting table 7 for mounting the disc substrate D; a spin driving apparatus 9 for spinning the mounting table 7; a spin shaft 11 for connecting the

mounting table 7 and the spin driving apparatus 9; and a spin control apparatus 13.

The spin control apparatus 13, in order to spread the coating material supplied on the disc substrate D, gives an initial control command P to the spin driving apparatus 9, and first of all, the mounting table 7 is spun at a certain slow speed. After that the spin control apparatus 13 spins the mounting table 7 in accordance with spin patterns such as a certain rate of spin, a rate of spin increased at a certain rate along with time or a rate of spin increased in accordance with a predetermined curve of a second order along with time. The spin control apparatus 13 has a function which is not provided by a control apparatus of the prior art and is described below.

Above the disc substrate D, a coating drying sensor 19 constituted from a radiation mechanism 15 and a light acceptance mechanism 17 is provided. The inventors recognized that the coating changes its color when it is dried and has different reflectance and transmittance of light between before and after drying of the coating. As a result of experiments on various coating materials sold in public, there are differences among the coating materials, however, with respect to a specific range of wavelength, it is observed that the amount of reflection and transmission of light are increased over 10%.

In this embodiment, in order to detect drying of the coating mainly by using the reflection rate of light while spinning the disc substrate D, the irradiation mechanism 15 for irradiating light on the coating W and the light acceptance mechanism 17 for receiving the light reflected by the coating are provided.

It is considered that a portion of the light irradiated from the light irradiation mechanism 15, as shown in FIG. 10, is reflected directly by the coating W, otherwise, another portion of the light passes through the coating W and moreover, passes through a substrate material (for example, polycarbonate), and a portion of it is reflected by the

mounting table 7 and reaches the light acceptance mechanism 17 again through the coating W and the disc substrate D.

In this case, it is appropriate that a surface of the mounting table 7 be a mirror surface or be in a state such that a reflectance is decreased as low as a certain value.

5 Moreover, it is possible that the surface of the mounting table 7 is dull-finished or lusterless and the reflectance is reduced to almost zero. In this case, only the reflectance of the coating W is detected. It is appropriate that a color of the surface of the mounting table 7 be adjusted or changed in order to obtain a preferable reflectance in accordance with a wavelength of light.

10 In accordance with experiments by the inventors, it is observed that it is easy to detect a boundary of drying when the surface of the mounting table has a reflectance of 0-30% with respect to a wavelength of light applied for detection. It is preferable that the reflectance of the surface of the mounting table 7 be 0-15%. In order to detect the light reflected by the coating W effectively, as shown in FIG. 11, it is appropriate that a
15 mask 28 be provided in front of the light receiving mechanism 17 and light from other side be blocked out. It is appropriate that a lens or the like instead of the mask 28 be provided and a similar effect of selecting light be obtained.

Referring to FIG. 3A-3C, a method and an apparatus for detecting drying of the coating while spinning the disc substrate D are explained. The coating drying sensor 19
20 in this embodiment is provided above the disc substrate D, for example, at a position of approximately 3-10 mm. It should be noted that such a height is not limited. The coating drying sensor 19 has both a light emitting mechanism 15 which generates light of a certain level and irradiates it on the coating W of the disc substrate D and a light acceptance mechanism 17 which receives the reflected light and converts it to an electric
25 signal. The light emitting mechanism 15 is constituted from multiple light emitting

diodes or laser elements set in a line along the radius of the disc substrate as shown in FIG. 3B and 3C, or from a single or multiple lamps or the like. In this embodiment, the light acceptance mechanism 17 is a CCD line camera providing a narrow width CCD array or a photodiode array, and the CCD receives light reflected from a predetermined
 5 small unit area on the disc substrate D.

The CCD line camera, as the light acceptance mechanism 17, receives light reflected from a certain narrow area or region from inside to outside of the coating W on the disc substrate D and an image processing mechanism 21 operates image processing on the light from the narrow area or region. In accordance with images from the CCD
 10 line camera, the color of the coating W is strong gray before drying, however, after drying, the color of the coating W changes to a lighter gray that is closer to white. The image processing mechanism 21 operates image processing on such color changes and outputs a signal zero (0) when the coating W is strong gray and outputs a signal one (1) when the color changes to lighter gray that is a color close to white.

15 In FIG. 3C, when the whole surface of the coating W is not dried, by the CCD array (or each light accepting device), as the light acceptance mechanism 17, from a position (a) that is a left edge of the figure to a position (r) that is a right edge of the figure, the signal zero (0) is output everywhere. On the other hand, when drying is improved and the coating W is dried from inside to a point X, the CCD array which is the
 20 light acceptance mechanism 17 outputs the signal one (1) from portions (a), (b), and (c) and outputs the signal zero (0) from portions (d)-(r). That is, when the reflected light from the coating before being dried is received, the signal zero (0) is output, and when the reflected light from the coating after being dried is received, the signal one (1) is output.

25 The image processing mechanism 21 operates image processing in order to

obtain such binary signals, therefore, it is possible to calculate the time for reaching a dried position on the coating W of the disc substrate D from the start time of spinning. That is, it is possible to easily calculate the required time for drying to a certain position.

In a detailed explanation, the coating material is spread and the coating layer W is formed and dried by spinning the disc substrate D at a rate of n times per minute (rpm). As described above, while the coating layer is dried, the image processing is conducted on the state of drying obtained by the CCD line camera. For example, by measuring the required time for drying at positions on the disc substrate at which r_1 , r_2 , r_3 and r_4 (mm) are apart from the inside edge in a radial and/or outside direction, it is possible to calculate the drying time t_1 , t_2 , t_3 and t_4 at these positions easily. At t_1 - t_4 , the image processing mechanism 21 outputs a drying signal S1 showing the drying state of the coating layer. Therefore, the image processing mechanism 21 has both functions of detecting drying of the coating layer and of obtaining the required time for drying at the positions along the radial direction on the coating layer by measuring or calculating.

After forming the coating layer, the disc substrate D is taken off from the spinner apparatus 1 and the thickness of the coating layer is measured by a coating thickness measuring mechanism 23 of an inspection apparatus, which is not shown in figures, in a state of approximately room temperature. Such measuring of the thickness of the coating layer is conducted by an inspection apparatus of the prior art, therefore, details are not described, however, such measuring of the thickness of the coating layer is operated at multiple predetermined points or sequentially and continuously along the radius, that is, from the inside edge to the outside edge of the coating layer. Measured coating thickness data obtained by this operation is transmitted as a coating thickness signal S2 shown in FIG. 2 to a coating thickness detection mechanism 25. The coating thickness detection mechanism 25 checks whether or not the coating thickness data of the

coating layer transmitted from the coating thickness measuring mechanism 23 is in a predetermined range of coating thickness.

A check signal S3 is output when the thickness of the coating layer reaches an upper limit or a lower limit of the predetermined range of coating thickness, or when one or a predetermined number of disc substrates D are inspected. In a case in which the check signal S3 is generated when one or multiple discs are inspected, the check signal S3 is a binary signal indicated by 0 and/or 1, and the signal is 0 when the thickness of the coating is in the predetermined coating thickness range and is 1 when out of the range.

Generally, in many cases, the predetermined coating thickness range is set to be a range of 1-2% around a desired coating thickness. It should be noted that it is possible to set in accordance with needs or requirements regardless of a limitation of this range. When a spin programming mechanism 27 receives the check signal S3 from the coating thickness detection mechanism 25, the spin programming mechanism 27 changes to a spin program which increases the rate of spin and which is selected from multiple spin programs stored inside.

A concrete example of the spin program is explained with reference to FIG. 4 and 5. As shown in FIG. 4, a division at regular intervals is conducted from the inside edge to the outside edge of the coating layer, for example, a division into 4 portions (it is not limited to a division into 4 portions, and it is appropriate to be divided into 2 or more portions in accordance with needs or requirements). From the inside edge, points are expressed as r1, r2, r3 and r4, and regions from the inside edge to the outside edge are expressed as I, II, III and IV. Drying times t1, t2, t3 and t4 of the coating layer on a horizontal axis of FIG. 5 respectively indicate the required time for drying at positions (points) on the coating layer r1, r2, r3 and r4 of FIG. 4, respectively.

The spin programming mechanism 27, as described above, receives the drying

signal S1 from the image processing mechanism 21 at a time expressed as drying times t_1, t_2, t_3 and t_4 . The spin programming mechanism 27 has a program by which, when the spinning time is t and if $0 \leq t \leq t_1$, a slope of spinning speed v_1 which shows an increasing or decreasing rate of spinning is selected, if $t_1 < t \leq t_2$, a slope of spinning speed v_2 is selected, if $t_2 < t \leq t_3$, a slope of spinning speed v_3 is selected, and if $t_3 < t \leq t_4$, a slope of spinning speed v_4 is selected. Therefore, the spin programming mechanism 27: gives the spin control apparatus 13 a signal S4 requesting to work in accordance with the slope of spinning speed v_1 initially; gives the spin control apparatus 13 the signal S4 requesting to work in accordance with the slope of spinning speed v_2 when the drying signal S1 is received from the image processing mechanism 21 at t_1 ; gives the spin control apparatus 13 the signal S4 requesting to work in accordance with the slope of spinning speed v_3 when the drying signal S1 is received from the image processing mechanism 21 at t_2 ; and gives the spin control apparatus 13 the signal S4 requesting to work in accordance with the slope of spinning speed v_4 when the drying signal S1 is received from the image processing mechanism 21 at t_3 . The spin control apparatus 13, in accordance with the check signal S4 described above, outputs a control command Q in order to drive the spin drive apparatus 9 along the slopes of spinning speeds v_1 - v_4 .

A concrete example of the spin program is as shown above and in accordance with a spin pattern (A) shown in FIG. 5, in region I from the inside edge to the position (point) r_1 , spinning is operated at the slope of spinning speed v_1 that increases at a minimum increasing rate, spinning is operated at the slope of spinning speed v_2 that is larger than the slope of spinning speed v_1 in region II, spinning is operated at the slope of spinning speed v_3' that is larger than the slope of spinning speed v_2 in region III, and

spinning is operated at the slope of spinning speed v_4' that is larger than the slope of spinning speed v_3' in region IV ($V_1 \leq V_2 \leq V_3' \leq V_4'$). That is, in accordance with the spin pattern (A), first, after spinning at the slope of spinning speed v_1 , the slope of spinning speed v_1 is maintained until the drying time t_1 is reached at the position (point) r_1 , and just after passing t_1 , the slope of the spinning speed is changed to the slope of spinning speed v_2 . The slope of spinning speed v_2 is maintained until the drying time t_2 is reached at the position (point) r_2 , and just after passing t_2 , the slope of spinning speed is changed to the slope of spinning speed v_3' .

A curve (X) of FIG. 4 shows a change of the thickness of the coating layer while the coating layer is formed by spinning the disc substrate in accordance with the spin pattern (A) in which the slope of the spinning speed is changed in such manner, and it is assumed that the coating thickness of the coating layer exceeds an upper limit at a position r_2' between the positions r_2 and r_3 on the coating layer. Here, as described above, the coating thickness detection mechanism 25 gives the check signal S3 that indicates exceeding of the coating thickness from the predetermined range at the position (point) r_2' on the coating layer shown in FIG. 4 at the required time for drying t_3' .

When the check signal S3 above is received, with respect to the disc substrates on which the coating layer is formed hereafter, the spin programming mechanism 27, for example, in order to change from the spin pattern (A) shown in FIG. 5 to a spin pattern (B), gives the spin control apparatus 13 the signal S4 which specifies the spin pattern (B). Therefore, the spin control apparatus 13, with respect to the disc substrates on which the coating layer is formed, operates spinning in accordance with the spin pattern (B). The spin pattern (B), as with the spin pattern (A), has the slope of spinning speed v_1 at region I and the slope of spinning speed v_2 at the region II, however, spinning is operated at region III with a slope of spinning speed v_3 which has a larger increasing rate than the

slope of spinning speed $v3'$ and at region IV with a slope of spinning speed $v4$ which has a larger increasing rate than the slope of spinning speed $v4'$ ($V1 \leq V2 \leq V3 \leq V4$).

As described above, when the spin programming mechanism 27 receives the check signal S3 which notifies that the coating thickness is out of the predetermined region from the coating thickness detection mechanism 25, the spin driving apparatus 9 spins the following disc substrates in accordance with spin pattern (B), therefore, the coating thickness does not exceed the upper limit. Generally, in order to prevent quick changes of the coating thickness, the spin pattern is determined in a manner in which the rate of spin is not changed quickly and greatly at a certain point on the coating layer.

10 However, even when spinning is operated in accordance with the spin pattern (B), because of characteristics of the coating materials and/or the like, there may be a case such that the coating thickness exceeds the upper limit at a point between the positions (points) $r3$ and $r4$ on the coating layer. In such a case, the spin pattern (B) is changed to a spin pattern (C) not shown in figures and has a quicker slope of spinning speed. For

15 example, the spin pattern (C) not shown in figures is set to have the same slopes of spinning speed $v1-v3$ and to have a quicker slope of spinning speed between the positions (points) $r3$ and $r4$ on the coating layer than the slope of spinning speed $v4$.

In the embodiment above, the slope of spinning speed at the region IV between the positions $r3-r4$ on the disc substrate D is determined to be $v4$ and the operation is

20 controlled. However, when the slope of spinning speed at an inside position is changed, the coating thickness of the coating layer at a position outside the inside position is affected. Therefore, the operation is controlled in accordance with a spin pattern in which the slope of the spinning speed at region IV is the same as the slope of the spinning speed $v3$ at region III, and the operation is controlled by maintaining the slope

25 of spinning speed $v3$ until the end if the coating thickness does not exceed the

predetermined range of the coating thickness. However, when the coating thickness of the coating layer exceeds the predetermined range of the coating thickness at region IV, with respect to the following disc substrates on which the coating layer is formed later, it is naturally appropriate that the operation be controlled by applying the slope of the spinning speed v_4 from the beginning of region IV. It is not necessary that the slopes of the spinning speed be gradually increased such as ($v_1 \leq v_2 \leq v_3 \leq v_4$), and it is appropriate that all the slopes of the spinning speed be the same.

By changing once to the spin pattern in which a combination of a slope of spinning speed has a large increasing rate, in most cases, it is possible to maintain the coating thickness in a predetermined range. Even when the coating material has a special or unusual characteristic, by changing again to the spin pattern in which a combination of a slope of spinning speed has larger increasing rate, it is possible to maintain the coating thickness of the disc substrates on which the coating layer is formed hereafter in a predetermined range. It should be noted that, in the present invention, it is not needed to set the predetermined thickness of the coating uniform from the inside to the outside of the disc, and it is possible to form in a manner such as setting the thickness increasing or decreasing from the inside to outside. Moreover, it is possible to control in a manner such as setting the thickness thick or thin only at a certain position along the radius.

In this embodiment, the spin pattern that determines the slope of the spinning speed from start to end of spinning is changed as a whole, however, it is appropriate that the slope of spinning speed of only a certain region be changed.

In the embodiment above, the spin program is changed along with measuring drying of the coating by the image processing mechanism 21 and the slope of spinning speed is changed by changing the spin pattern automatically. However, it is not

necessary to change the spin program automatically, and in order to reduce the cost, upon being used in actual situations, it is not needed for an apparatus to measure drying states. In such a case, upon being used in actual situations, it is not needed for the coating forming apparatus to provide the image processing mechanism, and it is appropriate that the spin program be created based on the drying time data, the coating thickness data and/or the like corresponding to the various slopes of spinning speed obtained in above-described manner beforehand, the real coating forming apparatus be operated by inputting the spin program, and the spin pattern, that is the slope of spinning speed of the mounting table 7, be changed as described above when it is detected that the coating thickness reaches an upper limit (a predetermined value).

In the embodiment above, with respect to n -th (n is an integer equal to or larger than 1) disc substrate, both a step of detecting moving of a boundary between a dried area and a not-dried or wet area and a step of measuring a coating-thickness distribution of the coating are operated, and with respect to $n+a$ -th (a is a fixed integer equal to or larger than 1) disc substrate, a step of controlling the spinning speed of the disc substrate is operated. In this case, by applying data obtained based on the operated disc substrate, rotation of the a -th disc substrate after the operated disc substrate is controlled, therefore, the structure of the apparatus is simplified. It is appropriate that the value of “ a ” be adjusted in accordance with a time lag between the step of forming the coating and the step of measuring the coating-thickness distribution.

It is appropriate that, with respect to a certain number of discs (for example, n , $n+1$, $n+2$, ..., $n+m$ (m is a fixed integer equal to or larger than 1)), measured results of the distribution of the coating thickness be stored and an average be calculated, and by applying the average data, spinning of the disc substrate after a certain number (for example, $n+r$ (r is an integer larger than m)) be controlled.

A second embodiment

The second embodiment of the present invention is explained with reference to FIG. 6. In this embodiment, as described above, the coating material is spread by spinning the disc substrate D at the slope of spinning speed v_1 that increases at a minimum increasing rate in region I from the inside edge to the position (point) r_1 , at the slope of spinning speed v_2 that is larger than the slope of spinning speed v_1 in region II, and at the slope of spinning speed v_3 that is larger than the slope of spinning speed v_2 in regions III and IV.

As shown in FIG. 6, when the coating thickness exceeds the upper limit of the predetermined range at a position (point) r_2' from the inside edge of the disc substrate D, sizes of areas Y_1 and Y_2 between the measured coating thickness and the upper limit of the predetermined region of the coating thickness, corresponding to each of regions III and IV, are calculated. The sizes of the regions are digitized by dividing into predetermined ranks, for example, ranks 1-5 as an excess of the coating thickness. In other words, the coating thickness exceeding the upper limit of the predetermined region of the coating thickness is time-integrated as the excess at each region.

After measuring the coating thickness at regions I-IV, the check signal S_3 indicating the excess at each region is output. When the check signal S_3 indicates a value of 0 at region I, 0 at region II, 1 at region III and 5 at region IV, the slope of the spinning speed at region III is set in accordance with the value of 1 which is the excess of the coating thickness and the slope of the spinning speed at region IV is set to be a steep slope in accordance with the value of 5 which is the excess of the coating thickness. Therefore, with respect to the following disc substrates on which the coating is formed, the slope of the spinning speed is not changed at regions I and II, the slope of the spinning speed at region III is set in accordance with the value of 1 which is the excess of

the coating thickness and the slope of the spinning speed at region IV is set in accordance with the value of 5 which is the excess of the coating thickness. By setting the slope of the spinning speed in such a manner, it is possible to control the coating thickness more accurately in a short time.

5 The coating thickness at region IV is changed because, at region III, the disc substrate D is spun at the slope of spinning speed corresponding to the value of 1 which is the excess of the coating thickness, therefore, it is appropriate that the slope of the spinning speed at region III be set to be the slope of the spinning speed in consideration of the value of 5 which is the excess of the coating thickness of region IV beforehand and
10 spinning be operated at the same slope of the spinning speed at region IV as region III. As a result of spinning the disc substrate at the changed slope of the spinning speed and forming the coating, if the coating thickness exceeds the predetermined range of the coating thickness in the middle of region IV, it is appropriate to change the slope of the spinning speed at the region IV as described above.

15 A third embodiment

Another embodiment of the present invention is explained with reference to FIG. 13. In the apparatus of FIG. 2 described above, after forming the coating, the coating thickness is measured at a later step. This embodiment is characterized by operating a formation of the coating and measurement the coating thickness in the same
20 apparatus.

The coating thickness measuring mechanism 24 measures a coating thickness W on the disc substrate D sequentially or at multiple points intermittently along the radius of the disc substrate D while the disc substrate D is mounted and set on the mounting table 7. There are the following two timings for measuring by the coating
25 thickness measuring mechanism 24.

(1) After drying the coating W as a whole, along with rotating the mounting table 7 continuously, measuring the coating thickness of the coating W is operated.

(2) Along with coating and drying of the coating W, inside a drying boundary of the coating W, the coating thickness of the coating W is measured in a manner which is just like chasing the drying boundary. In a case of (2) above, it is appropriate that a measured result be applied to a disc substrate to be coated next, and it is appropriate that a measured result be applied to a feedback operation of a disc substrate currently being coated.

In accordance with the constitution of FIG. 13, it is possible to build the coating thickness measuring mechanism 24 in the spin-coating apparatus, therefore, it is not needed to provide the coating thickness measuring mechanism 24 independently from the spin-coating apparatus, and there is an advantage to make the apparatus smaller.

In a case of feeding back the measured result of the coating thickness measuring mechanism 24 to a rotation operation of a currently coating disc substrate, the coating thickness is measured without contacting while forming the coating on the disc substrate. When the coating thickness is out of a predetermined range, the slope of spinning speed of the disc substrate D is adjusted in real time. In this case, based on measured results of the coating thickness, it is possible to operate feedback control with respect to the coating thickness of the same one disc substrate, therefore, there is an advantage in which it is possible to flexibly manage against sudden changes. A control method of this case is explained below.

FIG. 7 is a figure showing changes of coating thickness along a radius of the coating, and FIG. 8 is a figure showing a relationship between drying time of the coating and spinning speed. The coating thickness measuring mechanism 24 measures the coating thickness of the coating W just after drying and outputs a signal indicating data

of the coating thickness to the coating thickness detection mechanism 25. As shown in FIG. 7, when the coating thickness of the coating W exceeds an upper limit of the predetermined range of the coating thickness at a position L1 on a radius of the disc substrate D, the coating thickness detection mechanism 25 outputs the check signal S3, which indicates that the coating thickness exceeds the upper limit of the predetermined range. When the spin programming mechanism 27 receives this check signal S3, as shown in FIG. 8, the slope of spinning speed is changed to v_2 at drying time t_1 of the coating at position L1 of the disc substrate. Therefore, the disc substrate is spun at the slope of the spinning speed v_1 until position L1, and the slope of the spinning speed is changed to v_2 at position L1. It should be noted that a generally used mechanism which uses reflection of light or the like is appropriate for the coating thickness measuring mechanism in this case, and the coating thickness measuring mechanism measures the coating thickness along the radius continuously or at multiple predetermined points during steps of forming the coating on the disc substrate D.

When the disc substrate is spun at the slope of spinning speed v_2 , if the coating thickness does not exceed the upper limit of the predetermined range, the coating is formed along with maintaining the slope of the spinning speed v_2 . However, as shown in FIG. 7, when the coating thickness exceeds the upper limit at position L2, the slope of the spinning speed is changed to v_3 at drying time t_3 of the coating at position L2 of the disc substrate. As described above, in this embodiment, during steps of forming the coating and while forming the coating, the coating thickness is measured, and if the coating thickness exceeds the predetermined range, the slope of the spinning speed of the disc substrate is changed in real time even though the coating is formed.

In this embodiment, there is a time lag between a detection of irregularities or errors of the coating thickness and a feedback to the coating thickness control, therefore,

it is preferable to obtain a margin by setting the predetermined range of the coating thickness smaller than a real allowable range of the coating thickness and by controlling spinning before reaching the upper or lower limit of the real allowable range of the coating thickness.

5 A fourth embodiment

FIG. 9 is a figure showing a constitution of a coating forming apparatus 200 used in this embodiment of the present invention. Constitution elements referred to with the same numerals as in FIG. 2 are the same constitution elements as in FIG. 2.

In this embodiment, a coating drying sensor 19 made from both a radiation mechanism
10 15, which is made from multiple light emitting devices such as light emitting diodes arranged in a line, and a light receiving element 17, which receives light generated by the light emitting devices and reflected by a certain small area of the coating and which generates an electrical signal corresponding to amount of received light, is used. A mechanism for detecting drying of the coating is the same as described in the first
15 embodiment, therefore, a description is omitted.

In the embodiment of FIG. 2, the array of light receiving elements, in which multiple (for example, 100-2000) light receiving elements are arranged along the radius of the disc substrate, is used, however, in this invention, it is appropriate to apply a structure in which, for example, as shown in FIG. 15, a number (3 in an example of the
20 figure) of drying detection mechanisms that correspond to a number of steps of spinning control are provided. Positions where the drying detection mechanism detects drying along the radius of the disc are not limited, however, generally, it is preferable to apply 3 or more positions. When the drying detection mechanisms are set at 3 positions or more, with respect to generally used discs, it is possible to control the coating thickness with
25 enough accuracy. It should be noted that, in this embodiment, it is possible to apply the

light emitting diode or the like to the light emitting device and to apply the photo diode or the like to the light receiving element.

The signals generated by the light receiving element 17, which receives reflected light from the predetermined position (point), have different values between the coating before and after drying. The signal before drying has a larger value than the signal after drying, for example, 10% or more. A drying judgment mechanism 31 compares the values of the signals from the light receiving element 17 to a predetermined value, and when the value of the signal exceeds the predetermined value, the drying judgment mechanism 31 generates the drying signal S1 which is input to the programming mechanism 27.

In this embodiment, the coating thickness measuring mechanism 23 and the coating thickness detection mechanism 25, which have the same functions as in the first embodiment, are used too, and the functions and the operations of these elements are already described, therefore, their descriptions are omitted. It is possible to form the coating in accordance with the same method described above by applying the drying judgment mechanism 31 and the coating drying sensor 19 which is constituted from both the light radiation mechanism 15 and the light receiving element 17.

It should be noted that, in this embodiment, it is appropriate that the light radiating devices and the light receiving elements be arranged with a certain gap or interval, and it is appropriate that they be arranged without a gap or interval. It is appropriate that the light radiation device is a single lamp which has the same length as a length from the inside edge to the outside edge of the disc substrate. The light receiving element receives only the reflected light from the predetermined small area on the coating of the disc substrate.

In the embodiment above, an example in which the light receiving element

receives the reflected light from the coating is explained, however, as shown in FIG 14, it is appropriate that the light transmitted through the disc substrate D and the coating W be received. Generally, many of the disc substrates D are made from polycarbonate resin, and almost all visible rays of normal wavelength are transmitted through the disc substrate. Moreover, the coating W has a thin thickness that is generally 0.1 μ m, therefore, a portion of visible rays of the normal wavelength is transmitted through the coating W. The inventors have recognized that the amount of light transmitted through the coating W is different between the coatings before being dried and after being dried, and light is transmitted more after being dried than the coating before being dried.

Therefore, it is possible to detect drying of the coating similarly to the first to third embodiments even in a case of detecting the light transmitted through the coating.

Upon using the transmitted light through the coating, with respect to the apparatus in FIG. 2 or FIG. 9, it is appropriate that the mounting table 7 be formed from a transparent material (for example, glass, ceramics, plastics or the like) shown in FIG. 14, and the light radiating mechanism 15 (or the light receiving mechanism 17) be set on the upper side of the mounting table 7 along with setting the light receiving mechanism 17 (or the light radiating mechanism 15) under the lower side of the mounting table 7. Or, it is appropriate that the light radiating mechanism 15 (or the light receiving mechanism 17) be set inside the mounting table 7.

In this case, when the amount of light received by the light receiving mechanism is equal to a predetermined value or more, it is possible for drying to be confirmed or determined. Or, it is naturally appropriate that one of the light emitting mechanism or the light receiving mechanism is set so as to face a horizontal direction or is set in parallel with the surface of the disc substrate and the light is refracted by a mirror or a prism.

It is possible to realize a case in which the light radiating mechanism is set inside the mounting table 7 as described above, by constituting the upper side on which the disc substrate D is mounted from a transparent glass substrate, by setting the light radiation mechanism or light receiving mechanism inside the mounting table, and by
5 setting the light receiving mechanism or the light radiation mechanism on the upper side of the mounting table. In this case, for a structure in order to supply the electrical power from outside to the light radiating mechanism or the light receiving mechanism inside the mounting table, it is possible to apply various structures which have already been proposed or suggested. For example, it is appropriate that a rotating and sliding
10 mechanism which is not shown in figures be attached to the end of the spin shaft 11 in FIG. 2 or 9, a power supply line (not shown in figures) lead from outside through inside of the spin shaft 11 be connected to a fixed portion of the rotating and sliding mechanism, and a power supply line (not shown in figures) connected to the light radiation mechanism 15 or the light receiving mechanism be connected to a spinning portion (not
15 shown in figures) of the rotating and sliding mechanism.

It is appropriate that drying be improved by blowing hot gas on the coating of the disc substrate or irradiating infrared along with detecting drying.

With respect to a means for detecting drying of the coating material coated on the disc substrate, it is not limited to only a means of detecting changes of transmittance
20 or reflectance described above, and it is appropriate that a means which detects other physical characteristics, for example, changes of electrostatic capacitance of the coating, changes of the weight, changes of electrical conductivity, changes of transmittance or reflectance of energy rays other than light, or the like, be used. For example, in a case of detecting the electrostatic capacitance, it is appropriate that one or more electrostatic
25 capacitance sensors be provided close to the coating and a position of a boundary of

dried area be detected based on changes of the electrostatic capacitance caused by drying. In a case of measuring weight, it is appropriate that detection be operated by using a load cell set at the mounting table or by using a skew sensor or the like in order to detect changes of rotation moment.

- 5 In the embodiments above, the coating material which includes solvent or liquid is coated and is dried by volatilizing the solvent or liquid. In the present invention, drying includes a phase transformation in which, for example, a hardening resin changes from liquid to a solid. Therefore, it is possible to apply the present invention to a case in which a heat-hardening resin or an energy ray hardening resin is
- 10 cured from the inside edge to the outside edge after spin-coating.

CLAIMS

1. A disc production method comprising:

a step of forming a coating on a disc substrate by drying the coating after

5 coating a coating material while the disc substrate is spinning;

a step of detecting moving of a boundary between a dried area and a wet area
on the coating that is spinning;

a step of measuring a distribution of a coating thickness after drying; and

a step of controlling a spinning speed of the disc substrate based on a
10 relationship between the moving of the boundary which is detected and the distribution
of the coating thickness.

2. A disc production method according to claim 1, wherein:

in the step of detecting the moving of the boundary between the dried area and
15 the wet area on the coating that is spinning, a drying time of the coating is measured at
two or more measuring points along a radius on the disc substrate; and

in the step of controlling the spinning speed of the disc substrate, the spinning
speed is changed when the drying time of the disc substrate corresponding to the
measuring points passes after starting spinning the disc substrate.

20

3. A disc production method according to claim 1, wherein:

the step of detecting the moving of the boundary between the dried area and the
wet area on the coating that is spinning comprises:

a step of detecting a drying state of the coating at a plurality of points
25 one by one from inside to outside;

a step of measuring the coating thickness; and

a step of detecting a point along the radius where the coating thickness of the coating is out of a predetermined range, wherein

in the step of controlling the spinning speed of the disc substrate, the spinning speed of the disc substrate is changed when the boundary between the dried area and the wet area on the coating reaches the point along the radius where the coating thickness of the coating is out of the predetermined range.

4. A disc production method according to claim 1, wherein the controlling of the spinning speed is operated by changing a spin program which controls a motor for spinning the disc substrate.

5. A disc production method according to claim 1, wherein in the step of detecting the moving of the boundary between the dried area and the wet area on the coating, the boundary is detected by using at least one of reflectance and transmittance of the coating against light.

6. A disc production method according to claim 1, wherein in the step of controlling the spinning speed of the disc substrate, the spinning speed is controlled in order to maintain the coating thickness in a predetermined range.

7. A disc production method according to claim 1, wherein: both the step of detecting the moving of the boundary between the dried area and the wet area on the coating and the step of measuring the distribution of the coating thickness after drying are operated on a n-th (n is an integer and is 1 or more) disc

substrate; and

the step of controlling the spinning speed of the disc substrate is operated on a n -th (n is a fixed integer and is 1 or more) disc substrate.

5 8. A disc production method according to claim 1, wherein:

the step of detecting moving of the boundary between the dried area and the wet area on the coating, the step of measuring the distribution of the coating thickness after drying and the step of controlling the spinning speed of the disc substrate are operated on a same disc substrate.

10

9. A disc production apparatus comprising:

a spinning mechanism which spins a disc substrate;

a coating mechanism which coats a coating material on the disc substrate;

a drying detection mechanism which detects moving of a boundary between a

15 dried area and a wet area on the coating during spinning;

a coating thickness measuring mechanism which measures a distribution of a coating thickness after drying; and

a control mechanism which controls a spinning speed of the disc substrate based on a relationship between the moving of the boundary which is detected and the
20 distribution of the coating thickness.

10. A disc production apparatus according to claim 9, wherein:

the control mechanism comprises a spin programming mechanism comprising a spin program which includes a plurality of spin patterns that show characteristics

25 between spinning time and spinning speed of the disc substrate; and

the spin programming mechanism, when the spinning speed needs to be changed during forming the coating, changes the spin pattern after a position where the spinning speed needs to be changed.

5 11. A disc production apparatus according to claim 10, wherein:

the coating thickness measuring mechanism comprises a detection mechanism which compares obtained coating thickness data with a predetermined coating thickness range and which outputs a check signal that indicates whether the coating thickness is inside the predetermined coating thickness range along a radius of the disc substrate or

10 outside; and

the spin programming mechanism changes the spin pattern when both the check signal and a drying signal from the drying detection mechanism are received.

12. A disc production apparatus according to claim 9, wherein the drying detection
15 mechanism is an image processing apparatus.

13. A disc production apparatus according to claim 9, wherein the drying detection mechanism comprises:

a coating drying sensor comprising:

20 a light radiation mechanism which radiates light on the coating; and
a light receiving mechanism which receives light reflected from the coating or light transmitted through the coating; and

a drying judgment mechanism which outputs a drying signal when an amount of light received by the light receiving mechanism reaches a predetermined level.

14. A disc production apparatus according to claim 13, wherein the light radiation mechanism is a laser generation mechanism which generates a laser beam, or a light emission diode.
- 5 15. A disc production apparatus according to claim 13, wherein the light receiving mechanism is an image processing apparatus comprising a CCD camera, a CCD sensor in a strip shape set between an inside edge and an outside edge of the disc substrate, or a plurality of photo diodes arranged along a radius of the disc substrate.