

MAGNETIC TRANSFER METHOD FOR MAGNETIC RECORDING MEDIUM

Technical Field of the Invention

The present invention relates to a magnetic transfer method for a magnetic recording medium, and more particularly to a method of writing a positioning servo signal of a writing/reading head of data written on the surface of a magnetic recording medium by using a magnetic transfer technique in a hard disc drive (hereinafter abbreviated to "HDD") using magnetic film as a storage material, which is mainly used as an external storage device of a computer at present.

Prior Art

In HDD, data are recorded/reproduced while a magnetic head is floated from the surface of a rotating magnetic recording medium away from the surface of a disc at a distance of several tens of nm by a floating mechanism called as a slider. Bit information on the magnetic recording medium is stored in data tracks arranged concentrically on the recording medium surface. The data recording/reproducing head is moved and positioned to a target track on the magnetic recording medium surface at a high speed, and data are recorded and reproduced.

A positioning signal (servo signal) for detecting the

relative position between the head and the data tracks is concentrically written on the surface of the magnetic recording medium, and the magnetic head for recording/reproducing data detects the relative position thereof at a fixed time interval. The servo signal is written in a magnetic recording medium by using a dedicated device called as a servo writer after the magnetic recording medium is installed in a hard disc device, and it is used to prevent displacement from the center of a servo signal detected by the head (or the center of the locus of the head).

The recording density of such a magnetic recording medium reaches 100Gbit/in² in the case of magnetic recording media under development, and the storage capacity trends to increase by 60% or more per year. In connection with the increase of the storage capacity, there is a tendency that the density of the servo signal for detecting the relative position between the head and the data track by the head is also increased, and the writing time of the servo signal is increased year by year. The increase of the writing time of the servo signal becomes a fact or causing reduction in productivity of HDD and increase in cost.

Against the backdrop of such a problem has been recently developed such a technique that a servo signal is collectively

written in a magnetic recording medium by magnetic transfer to shorten the writing time of the servo information more dramatically as compared with the system of writing a servo signal by using a signal writing head of the servo writer as described above.

Fig. 8 is a diagram showing a magnetic transfer process of a servo signal. In an initial demagnetizing step, permanent magnet 82 for demagnetization is moved so as to be kept spaced from the surface of a magnetic recording medium 81 at a fixed interval of 1mm or less as shown in Fig. 8(a). A magnetic layer formed on the magnetic recording medium 81 is not kept to be magnetized in a fixed direction before this step, and it is uniformly magnetized in a direction indicated by an arrow in the figure by magnetic field leaking from a gap of the permanent magnet 82.

In a master disc positioning step, a master disc 83 for magnetic transfer is disposed and positioned on the magnetic recording medium 81 as shown in Fig. 8(b). For example, Patent JP-A-11-175973 describes it as a technique to enhance reliability to this positioning that a marker is provided to carry out the positioning between the center of the master disc and the center of the medium.

In a transfer pattern writing step, the master disc 83 is brought into close contact with the surface of the magnetic recording medium 81 as shown in Fig. 8 (c), and the permanent magnet 82 for magnetic transfer is moved along a movement path indicated by an arrow in the figure to perform magnetic transfer.

Fig. 9 is a diagram showing the mutual positional relationship between the permanent magnet and the magnetic recording medium in the initial demagnetizing step and the transfer pattern writing step for magnetic transfer, wherein Fig. 9(a) shows the positional relationship in the initial demagnetizing step, and Fig. 9(b) shows the positional relationship in the transfer pattern writing step.

As shown in Fig. 9(b), in the transfer pattern writing step, the master disc and the magnetic recording medium are disposed so that a soft-magnetic-film-side surface of the master disc having soft magnetic film 95 including a Co type soft magnetic layer embedded in one surface of an Si substrate 94 is brought into close contact with a magnetic-layer-side surface of the magnetic recording medium having a magnetic layer 92 on a substrate 91, and the permanent magnet 93 for magnetic transfer is swept so as to move on the Si substrate 94.

The soft magnetic film 95 having the Co type soft magnetic layer embedded in the form of a pattern is interposed between the permanent magnet 93 and the magnetic layer 92, so that the magnetic field formed in the Si substrate 94 by the permanent magnet 93 can magnetize the magnetic layer 92 at the portions corresponding to the positions of the soft magnetic film 95 at which no Co type soft magnetic layer exists. However, in the magnetic layer 92 at the portions corresponding to the positions at which the Co type soft magnetic layer exists, the magnetic field passed through the soft magnetic film 95 so as to form a magnetic route having small magnetic resistance. Therefore, the magnetic field leaking from the Si substrate 94 is weaker and new signal writing is not carried out. The magnetic transfer of the servo signal is carried out by the mechanism as described above. As shown in Fig. 9(b), the direction of the magnetic field for writing the transfer signal is opposite to the direction of the magnetic field for demagnetization.

Fig. 10 is a diagram showing an embedding process of the soft magnetic layer in the master disc, wherein (a) shows a coating step of a resist, (b) shows a resist pattern forming step, (c) shows an Si substrate etching step, Fig. 10(d) shows a sputtering step to form the Co soft magnetic film, and (e) shows a liftoff step for removing extra Co film.

First, as shown in Fig. 10(a), a resist of $1\mu\text{m}$ in thickness is coated on the surface of an Si substrate 1001 of about $500\mu\text{m}$ in thickness by using a spin coater, and then a resist layer 1002 is formed by patterning based on photolithography method as in the case of the normal method of manufacturing an Si semiconductor as shown in Fig. 10(b). Subsequently, as shown in Fig. 10(b), dry etching is carried out by a reactive plasma etching method using methane trichloride as reactive gas so that the surface of the Si substrate 1001 in areas which are not covered by the resist layer 1002 is removed at a depth of about 500nm by etching. Furthermore, as shown in Fig. 10(d), Co type soft magnetic film 1003a, 1003b of 500nm in thickness is formed by a sputtering method under the state that the resist layer 1002 is left. Finally, as shown in Fig. 10(e), the resultant body containing the Si substrate 1001 immersed in solvent for dissolving the resist (by using ultrasonic wave or the like as occasion demands) to dissolve the resist layer 1002, so that the resist layer 1002 and the Co soft magnetic film 1003b on the resist layer 1002 are removed.

At present, a method of forming magnetic film on both the surfaces and carrying out reading/writing on both the surfaces in order to increase the storage capacity per disc has been mainly used for magnetic recording media of HDD. This manufacturing method for the magnetic recording media is

described in Patent JP-A-2002-319128.

Problem to be solved by the Invention

A servo pattern as described above and a data pattern are provided as a magnetic pattern to be recorded in the magnetic recording medium. Many magnetic disc are loaded in a present HDD device, and each of magnetic heads is individually equipped at each of both the surfaces of each magnetic disc. When a data area is indicated, only HAS (head stack assembly) in which the head corresponding to a cylinder in the data area concerned is mounted is controlled to be moved to a predetermined position under servo control, and the other HSAs are kept not to be controlled.

For example, when a cylinder to be read/written is varied from the front surface to the back surface, if a displacement between the servo patterns on both the surfaces is large, it takes time until the positioning of the HAS on the back surface by the servo control is stabilized, so that the set ring time corresponding to the reading time of data after the cylinder is switched is increased, and thus a high-speed data access of HDD is degraded. Therefore, it is very important that there is no displacement between the magnetic patterns on both the surfaces of the magnetic recording medium.

A conventional target pattern to be magnetically transferred is limited to a servo pattern having a large pattern width because the photo-process technique for forming master discs is based on " μm -rule". However, in consideration of advancement of utility of magnetic transfer and the photo-process technique and application of "sub- μm -rule", a data pattern as well as a conventional servo pattern should be considered as a transfer target, and it is required to carry out the magnetic transfer based on a high-density master disc to a magnetic recording medium.

However, the prior art has a problem that it is impossible to carry out the positioning between a magnetic pattern of a master disc for the front surface of a magnetic recording medium and a magnetic pattern of the master disc for the back surface of the magnetic recording medium.

The present invention has been implemented in view of the foregoing problem, and has an object to provide a magnetic transfer method for a magnetic recording medium that can easily provide magnetic patterns having no displacement between both the surfaces of the magnetic recording medium.

Means for solving the Problem

In order to attain the object, according to the invention

of claim 1, a magnetic transfer method for a magnetic recording medium in which a magnetic pattern is transferred to the magnetic recording medium by using a master disc having soft magnetic material embedded therein, is characterized by comprising: a step of determining an origin of a magnetic recording medium by observing the inner periphery or outer periphery of the magnetic recording medium; a step of providing an alignment mark on a first face of the magnetic recording medium on the basis of the origin thus determined; a step of providing an alignment mark on a second face of the magnetic recording medium on the basis of the alignment mark on the surface; and a step of aligning a corresponding alignment mark provided on a master disc coincident with the alignment mark provided on the first or second face of the magnetic recording medium to transfer a magnetic pattern formed on the soft magnetic material to the magnetic recording medium.

The invention according to claim 2 is characterized in that in the magnetic transfer method for a magnetic recording medium according to claim 1, at least one of the step of providing the alignment mark on the first face and the step of providing the alignment mark on the second face provides the alignment mark out of an area where magnetic information on the magnetic recording medium is written/read.

The invention according to claim 3 is characterized in that in the magnetic transfer method for a magnetic recording medium according to claim 1 or 2, the step of providing the alignment mark on the first face and the step of providing the alignment mark on the second face provide the alignment marks by a photo process.

The invention according to claim 4 is characterized in that in the magnetic transfer method for a magnetic recording medium according to any one of claims 1 to 3, the step of providing the alignment mark on the second face comprises: a step of disposing a photomask at a predetermined position to provide the alignment mark on the second face and recording an image of the photomask; a step of disposing the magnetic recording medium at a predetermined position and picking up an image of the alignment mark provided on the first face; a step of comparing the recorded image with the pickup image; and a step of correcting the position of the magnetic recording medium on the basis of a comparison result.

The invention according to claim 5 is characterized in that in the magnetic transfer method for a magnetic recording medium according to any one of claims 1 to 4, two or more alignment marks are provided on the master disc, and at least one of the step of providing the alignment mark on the first

face and the step of providing the alignment mark on the second face provides two or more alignment marks corresponding to the master disc.

The invention according to claim 6 is characterized in that in the magnetic transfer method for a magnetic recording medium according to any one of claims 1 to 5, each of the alignment marks provided on the respective faces of the magnetic recording medium and the corresponding alignment mark provided on the master disc are designed in such a shape as to be engageable with each other.

The invention according to claim 7 is characterized in that in the magnetic transfer method for a magnetic recording medium according to any one of claims 1 to 6, the alignment mark of the master disc is provided on a face of the master disc in which the soft magnetic material is embedded, and the alignment-mark provided surface on the magnetic recording medium which corresponds to the master disc is a surface located at the opposite side to a surface to which the magnetic pattern is transferred by the master disc.

The invention according to claim 8 is characterized in that in the magnetic transfer method according to any one of claims 1 to 6, the alignment mark of the master disc is provided

at the opposite side to a surface on which the soft magnetic material of the master disc is embedded, and the alignment-mark provided surface on the magnetic recording medium which corresponds to the master disc is a surface to which the magnetic pattern is transferred by the master disc.

The present invention has attained the above object by taking the following means.

(1) Provision of Alignment Mark to Front Surface/Back Surface of Magnetic Recording Medium

The inner periphery or outer periphery of a magnetic recording medium is observed by a TV camera to determine the origin (center) of the magnetic recording medium. The origin of a photomask on which an alignment pattern for the front surface is drawn is aligned with the above center, and the alignment mark drawn on the photomask for the front surface is formed on the front surface of the magnetic recording medium by the photo process. Subsequently, the alignment mark formed on the front surface of the magnetic recording medium is observed, and the position of a photomask for the back surface is adjusted so that an alignment mark drawn on the photomask for the back surface which is used for the positioning to the front surface is aligned with the alignment mark thus observed. Then, the alignment mark for the back surface drawn

on the photomask for the back surface is formed on the back surface of the magnetic recording medium.

The alignment mark on the front surface of the magnetic recording medium is used for the positioning to the alignment mark of the master disc for the back surface, and the alignment mark on the back surface of the magnetic recording medium is used for the positioning to the alignment of the mask disc for the front surface. Accordingly, with respect to the shape and position of the alignment marks, it is unnecessary to make them coincident between the front surface/the back surface of the magnetic recording material, and it is sufficient to make them coincident between respective alignments marks which will be engaged with each other.

The alignment marks are provided to the magnetic recording medium while observing the shape of an inner hole into which the shaft of a spindle motor is inserted when the magnetic recording medium is installed into HDD and setting the center of a circle inscribing the inner hole as the origin.

(2) Provision of Positioning Alignment Mark to Master Disc

A master disc for each of the front and back surfaces on which a magnetic pattern to be magnetically transferred to a magnetic recording medium is embedded is provided with

alignment marks for positioning on a face of the master disc in which the magnetic pattern is embedded. With respect to the master disc for the front surface, the alignment marks thereof are located at the same positions as the alignment marks for the back surface of the magnetic recording medium. With respect to the master disc for the back surface, the alignment marks thereof are located at the same positions as the alignment marks for the front surface of the magnetic recording medium. Furthermore, the shapes of the alignment marks are preferably set so that the corresponding alignment marks are engageable with each other.

(3) Positioning Between Alignment Marks of Magnetic Recording Medium and Master Disc

The positions and shapes of two alignment marks on the magnetic transfer face of the master disc are observed and recorded by a CCD camera having an enlarging function or the like. Subsequently, the magnetic recording medium is inserted into the gap between the master disc and the CCD camera to observe the alignment marks provided on the surface opposite to the magnetic transfer face of the magnetic recording medium, and the differences between the recorded position and orientation of each alignment mark of the master disc and the position and orientation of each alignment mark of the magnetic recording medium thus observed are determined. An

two-directional orthogonal stage and a rotating stage on which the magnetic recording medium is supported are moved to align these alignment marks with each other. Thereafter, the magnetic recording medium and the master disc are brought into close contact with each other, and the permanent magnet is rotationally approached to them and made to go around, thereby completing the magnetic transfer to one surface. Subsequently, the positioning between the master disc and the magnetic recording medium is carried out for the other surface in the same manner.

In this invention, "master disc" means "maser information carrier" for transfer to a magnetic disc medium, and the outer shape thereof is not limited to a disc-shape.

Brief Description of the Drawings

Fig. 1 is a diagram showing each step of a method of setting alignment marks onto a magnetic recording medium according to an embodiment of the present invention.

Fig. 2 is a diagram schematically showing the construction of a drawing device for drawing alignment marks onto a magnetic recording medium according to the embodiment of the present invention.

Fig. 3 is a diagram showing a photomask having alignment marks for a magnetic recording medium according to

the embodiment of the present invention.

Fig. 4 is a diagram showing a procedure of adjusting the alignment marks onto the magnetic recording medium according to the embodiment of the present invention.

Fig. 5 is a diagram showing the magnetic recording medium having the alignment marks according to the embodiment of the present invention.

Fig. 6 is a diagram showing master discs for the front and back surfaces according to the embodiment of the present invention.

Fig. 7 is a diagram showing a positioning step for the magnetic recording medium and the master disc according to the embodiment of the present invention.

Fig. 8 is a diagram showing a process of carrying out magnetic transfer onto a magnetic recording medium in a prior art.

Fig. 9 is a diagram showing the principle of magnetic transfer to a magnetic recording medium in the prior art.

Fig. 10 is a diagram showing a process of manufacturing a master disc according to the embodiment of the present invention.

Embodiment of the Invention

Fig. 1 is a diagram showing the procedure of providing the alignment marks to the magnetic recording medium in this

embodiment. Fig. 2 is a diagram showing a drawing device for exposing alignment marks of a photomask on the front/back surface of the magnetic recording medium, Fig. 3 shows the photomask for providing the alignment marks on the front/back surface of the magnetic recording medium and Fig. 4 is a diagram showing the procedure of aligning the alignment marks of the photomask for the back surface with the alignment marks for the back surface provided on the front surface of the magnetic recording medium in the drawing device. The details of the procedure shown in Fig. 1 will be described with reference to Figs. 2 to 4 in combination with Fig. 1.

(a) Coating of Resist to Surface of Magnetic Recording Medium

First, a photoresist 402 for patterning of alignment marks is coated on the surface of the magnetic recording medium 404.

(b) Patterning of Alignment Marks on Surface of Magnetic Recording Medium

As shown in Fig. 2, the drawing device for drawing the alignment marks on the magnetic recording medium according to this embodiment comprises an X, Y stage 202 for TV camera, a CCD camera 204, a signal processing device 212, an X, Y stage 208 for magnetic recording medium, a rotating stage 216 for

magnetic recording medium and a microscope 210 for aligning the alignment marks. The CCD camera 204 is moved above the X, Y stage 202 for TV camera, and picks up an image of the surface of the magnetic recording medium 404 or photomask 214 to detect the edge of the magnetic recording medium and the alignment marks provided on the medium concerned. A high-resolution CCD camera is preferably used. An image signal thus picked up is transmitted to the signal processing device 212.

The signal processing device 212 processes an image signal received from the CCD camera 204 to determine the edge of the magnetic recording medium 404 and calculate the origin of the magnetic recording medium 404.

The alignment mark aligning microscope 210 is a microscope disposed so that the magnetic recording medium 404 or the photomask 214 can be observed from the lower side of the figure by the microscope 210.

The photomask 214 is disposed so as to be movable in the horizontal direction in the drawing device. The X, Y stage 208 for the magnetic recording medium moves the magnetic recording medium 404 in the horizontal direction. The rotating stage 216 for the magnetic recording medium is designed so as to rotate

the magnetic recording medium 404 disposed on the rotating stage 216.

In this step, the inner hole of the magnetic recording medium 404 is observed by the CCD camera 204 equipped to the drawing device shown in Fig. 2, and the signal processing device 212 processes the image signal from the CCD camera to determine the center position of the magnetic recording medium 404.

The photomask for the front surface of the magnetic recording medium used in this step is equipped with an alignment mark (center mark) 106 for alignment with the center of the magnetic recording medium as shown in Fig. 3(a), and two alignment marks 102 for alignment with the back surface of the magnetic recording medium which are equipped at the right and left sides of the photomask. In this step, the photomask for the front surface is adjusted so that the center mark 106 is aligned with the center position of the magnetic recording medium 404 which is determined through the image processing, and the alignment marks 102 for alignment are exposed and developed, whereby the resist at the sites (exposure portion) 406 corresponding to the alignment marks 102 for alignment is removed. Therefore, the photoresist 402 acts as a mask for etching.

(c) Etching of Alignment Mark onto Surface of Magnetic Recording Medium

When dry-etching is carried out by using the etching mask based on the photoresist 402, the sites corresponding to the alignment marks having no resist are etched to form recesses 408.

(d) Coating of Resist onto Back Surface

A photoresist 402 for patterning of alignment marks is coated on the back surface of the magnetic recording medium 404.

(e) Patterning of Alignment Marks onto Back Surface of Magnetic Recording Medium

This step will be described according to the following procedure as shown in Fig. 4.

- Observation and Recording of Alignment Marks of Photomask for the back surface

As shown in an example of Fig. 3(b), a photomask for the back surface is provided with two alignment marks for alignment with the front surface of the magnetic recording medium 404 at the right and left sides of the photomask. In this step, as shown in Fig. 4(a), the alignment marks 104 for alignment which are provided on the photomask 310 for the back surface are observed by the alignment-mark aligning microscope 210, and the image

thereof is recorded.

As described above, when the alignment marks are provided on the back surface, the photomask is disposed at a predetermined position, and the image of the photomask is recorded.

- Attachment of the magnetic recording medium

As shown in Fig. 4(b), X, Y stage for the magnetic recording medium mounted with the magnetic recording medium and the rotating stage for the magnetic recording medium (hereinafter referred to simply as "stage") are moved in a direction of the arrow a to attach the magnetic recording medium.

- Observation and Minute Adjustment of Alignment Marks of Magnetic Recording Medium

As shown in Fig. 4(c), the alignment marks 304 for the back surface which are equipped on the front surface of the magnetic recording medium 404 are observed by the alignment-mark aligning microscope 210, and compared with the alignment marks recorded. On the basis of the comparison result, the stage 306 is moved in directions indicated by arrows b, c and d to correct the displacement amount.

As described above, when the alignment marks are equipped on the back surface, the magnetic recording medium is disposed at a predetermined position, an image of the alignment marks for the back surface equipped on the front surface is picked up, the recorded image and the pickup image are compared with

each other, and the position of the magnetic recording medium is corrected on the basis of the comparison result.

- Exposure of Alignment Pattern for the back surface

In the pre-stage, light is exposed from the upper side of the photomask under the state that the alignment marks for the back surface are aligned with the recorded alignment marks, and the alignment marks are drawn on the back surface of the magnetic recording medium 404. When they are developed, the photoresist 402 at the sites 410 corresponding to the alignment marks is removed, so that the photoresist 402 acts as a mask for etching.

(f) Etching of Alignment Marks onto Back Surface of Magnetic Recording Medium

When dry-etching is carried out by using the etching mask based on the photoresist 402, the sites 410 corresponding to the alignment marks having no photoresist 402 are etched to form recesses 412.

(g) Lift-off

Unnecessary resist is dissolved by resist exfoliating agent, and the magnetic recording medium 404 recessed at the sites corresponding to the alignment marks is completed.

The magnetic recording medium having the alignment

marks according to this invention is achieved through the above step as shown in the example of Fig. 5. As shown in Figs. 5(a) and (b), the alignment marks 502 for the back surface which are engaged with the alignment marks provided on the master disc to be magnetically transferred to the back surface of the magnetic recording medium are provided at the right and left sides on the front surface of the magnetic recording medium. Likewise, as shown in Figs. 5(b) and (c), the alignment marks 504 for the front surface which are engaged with the alignment marks provided on the master disc to be magnetically transferred to the front surface of the magnetic recording medium are provided at the upper and lower sides on the back surface of the magnetic recording medium. The positions of the alignment marks for the front and back surfaces of the magnetic recording medium are preferably out of the area on which the data writing/reading is carried out.

Figs. 6(a) and (b) show master discs for the front and back surfaces, respectively. As shown in Fig. 6(a), Alignment marks 602 for alignment to carry out the positioning to the magnetic recording medium are provided at the upper and lower sides on the master disc for the front surface. Furthermore, as shown in Fig. 6(B), alignment marks 604 for alignment to carry out the positioning to the magnetic recording medium are provided at the right and left sides on the master disc for the

back surface. A magnetic pattern (soft magnetic material pattern) 606 of the soft magnetic film for magnetic transfer is embedded in the silicon substrate. Provision of the alignment marks to the master disc can be carried out without increasing the number of steps by carrying out the light exposure and etching of the magnetic pattern simultaneously in the process of manufacturing the master disc shown in Fig. 10.

The shape of the master disc shown in Fig. 6 is rectangular, however, there is no problem even when it is a circle having an orientation flat like an Si substrate.

As described above, by using the mechanism shown in Fig. 2, the positioning is carried out on the magnetic recording medium and the master disc which are equipped with the alignment marks.

Subsequently, the procedure of carrying out the magnetic transfer will be described with reference to Fig. 7.

(a) Storage of Alignment Marks of Master Disc

In this case, a magnetic transfer device having an alignment mark positioning mechanism is used. As shown in Fig. 7(a), this mechanism is implemented by disposing two alignment mark aligning CCD cameras 710 and 712 in an existing magnetic

transfer device. Specifically, the alignment mark aligning CCD cameras 710 and 712 are disposed at such positions that alignment marks 704 of a master disc can be observed.

The master disc 702 is set in the magnetic transfer device as described above so that the alignment marks 704 provided on the magnetic transfer surface of the master disc is located within the visual fields of the alignment-mark aligning CCD cameras 710 and 712. Images picked up by the CCD cameras are stored. The images picked up and recorded by the alignment-mark aligning CCD cameras 710 and 712 (recorded images) are represented by A1 and A2, respectively.

(b) Observation of Alignment Marks of Magnetic Recording Medium

The magnetic recording medium 404 is set below the master disc 702. At this time, the magnetic recording medium 404 is set so that the surface on which the front-surface alignment marks 708 corresponding to the master disc for carrying out the magnetic transfer are provided is placed face down and also the front-surface alignment marks 708 are located within the visual fields of the alignment-mark aligning CCD cameras 710 and 712 as shown in Fig. 7(b). Images picked up by the alignment-mark aligning CCD cameras 710 and 712 and the recorded images of the alignment marks 704 of the

master disc are overlapped with each other. Fig. 7(b) shows a state that images (observed images) B1 and B2 newly picked up by the CCD cameras 710 and 712 are superposed on the recorded images A1 and A2.

(c) Positioning of Magnetic Recording Medium

The X-Y stage and rotating stage on which the magnetic recording medium 404 is mounted are adjusted so that the alignment marks of the master disc 702 and the magnetic recording medium 404 are aligned with each other on each image in which the respective alignment marks are overlapped with each other. The recorded images A1, A2 and the observed images B1, B2 when the position of the magnetic recording medium is adjusted are shown in Fig. 7(c).

(d) As shown in Fig. 7(c), under the state that the alignment marks for the magnetic transfer (not shown) to one surface are engaged, the magnetic recording medium and the master disc are brought into close contact with each other, and an external magnetic field is applied as shown in Fig. 9 to perform magnetic transfer. Through the above procedure, the magnetic transfer to one surface is completed.

With respect to the other surface, the master disc 702 is exchanged for the back-surface master disc, the magnetic

recording medium is turned over and then the same process is carried out, whereby the magnetic transfer can be carried out on both the surfaces in Fig. 7. According to the above procedure, there can be provided a magnetic recording medium which is positioned with respect to both the surfaces thereof and embedded with magnetic patterns.

The alignment marks of the master disc is provided at the same position as the embedding surface of the soft magnetic material in this embodiment. However, they may be provided on the opposite surface to the embedding surface of the soft magnetic material. In this case, in the alignment-mark positioning mechanism shown in Fig. 7, the CCD cameras 710 and 712 are disposed above the master disc. The magnetic recording medium 404 is first disposed to store the alignment marks thereof, and then the master disc is mounted and adjusted in position so that the alignment marks are engaged. In this case, however, contamination to the master disc may occur due to movement of the master disc above the magnetic recording medium. Furthermore, the step of embedding the soft magnetic film into the master disc and the step of providing the alignment marks are carried out separately from each other.

Advantageous Effect of the Invention

As described above, according to this invention, the

positioning of a magnetic pattern on the front surface of a magnetic recording medium and a magnetic pattern on the back surface thereof can be performed in a magnetic transfer method using a master disc, and even when a cylinder to be read/written is varied like front surface → back surface or back surface → front surface, the data reading/writing time can be made uniform without greatly varying the time needed until the position of HAS is stabilized.

CLAIMS

1. A magnetic transfer method for a magnetic recording medium in which a magnetic pattern is transferred to the magnetic recording medium by using a master disc having soft magnetic material embedded therein, characterized by comprising:

a step of determining an origin of a magnetic recording medium by observing the inner periphery or outer periphery of the magnetic recording medium;

a step of providing an alignment mark on a first side face of the magnetic recording medium on the basis of the origin thus determined;

a step of providing an alignment mark on a second side of the magnetic recording medium on the basis of the alignment mark on the first face; and

a step of aligning a corresponding alignment mark provided on a master disc coincident with the alignment mark provided on the first or second side of the magnetic recording medium to transfer a magnetic pattern formed on the soft magnetic material to the magnetic recording medium,

wherein the magnetic recording medium is rotationally alignable with the master disc using the alignment mark provided on the first or second side of the magnetic recording medium.

2. The magnetic transfer method for a magnetic recording medium according to claim 1, wherein the alignment mark on the first or second side is placed outside a data area where magnetic information on the magnetic recording medium is written/read.

3. The magnetic transfer method for a magnetic recording medium according to claim 1, wherein the alignment marks on the first and second sides are formed by a photo process.

4. The magnetic transfer method for a magnetic recording medium according to claim 1, wherein said step of providing the alignment mark on the second side comprises:

a step of disposing a photomask at a predetermined position to provide the alignment mark on the second side and recording an image of the photomask;

a step of disposing the magnetic recording medium at a predetermined position and observing an image of the alignment mark provided on the first side;

a step of comparing the recorded image with the observed image; and

a step of correcting the position of the magnetic recording medium on the basis of a comparison result.

5. The magnetic transfer method for a magnetic recording medium according to claim 1, wherein two or more alignment marks are provided on the master disc, and two or more

alignment marks corresponding to the master disc are formed on the first or second side of the recording medium.

6. The magnetic transfer method for a magnetic recording medium according to claim 4, wherein two or more alignment marks are provided on the master disc, and two or more alignment marks corresponding to the master disc are formed on the first or second side of the recording medium.

7. The magnetic transfer method for a magnetic recording medium according to claim 5, wherein each of the alignment marks provided on the respective sides of the magnetic recording medium and the corresponding alignment mark provided on the master disc are configured to be engageable with each other.

8. The magnetic transfer method according to claim 6, wherein each of the alignment marks provided on the respective sides of the magnetic recording medium and the corresponding alignment mark provided on the master disc are configured to be engageable with each other.

9. The method according to claim 1, wherein the alignment mark of the master disc is provided on a side of the master disc where the soft magnetic material is embedded, and the alignment mark provided side of the magnetic recording medium corresponding to the master disc is located opposite to the side to which the magnetic pattern is transferred by the

master disc.

10. The method according to claim 4, wherein the alignment mark of the master disc is provided on a side of the master disc where the soft magnetic material is embedded, and the alignment mark provided side of the magnetic recording medium corresponding to the master disc is located opposite to the side to which the magnetic pattern is transferred by the master disc.

11. The method according to claim 5, wherein the alignment mark of the master disc is provided on a side of the master disc where the soft magnetic material is embedded, and the alignment mark provided side of the magnetic recording medium corresponding to the master disc is located opposite to the side to which the magnetic pattern is transferred by the master disc.

12. The method according to claim 7, wherein the alignment mark of the master disc is provided on a side of the master disc where the soft magnetic material is embedded, and the alignment mark provided side of the magnetic recording medium corresponding to the master disc is located opposite to the side to which the magnetic pattern is transferred by the master disc.

13. The method according to claim 1, wherein the alignment mark of the master disc is provided at the side opposite to the side where the soft magnetic material of the

master disc is embedded, and the alignment-mark provided side on the magnetic recording medium corresponding to the master disc is a side to which the magnetic pattern is transferred by the master disc.

14. The method according to claim 4, wherein the alignment mark of the master disc is provided at the side opposite to the side where the soft magnetic material of the master disc is embedded, and the alignment-mark provided side on the magnetic recording medium corresponding to the master disc is a side to which the magnetic pattern is transferred by the master disc.

15. The method according to claim 5, wherein the alignment mark of the master disc is provided at the side opposite to the side where the soft magnetic material of the master disc is embedded, and the alignment-mark provided side on the magnetic recording medium corresponding to the master disc is a side to which the magnetic pattern is transferred by the master disc.

16. A magnetic transfer device comprising:

a master disc having soft magnetic material embedded on a first side thereof and an alignment mark on the first side or a second side opposite the first side; and

a magnetic recording medium having at least one alignment mark on each of a first side and a second side thereof,

wherein the alignment mark on the master disc is alignable with the alignment mark provided on the first or second side of the magnetic recording medium to transfer a magnetic pattern formed on the soft magnetic material to the magnetic recording medium,

wherein the magnetic recording medium is rotationally alignable with the master disc using the alignment mark provided on the first or second side of the magnetic recording medium.

17. The magnetic transfer device according to claim 16, wherein two or more alignment marks are provided on the master disc, and two or more alignment marks corresponding to the master disc are formed on the first or second side of the recording medium.

18. The magnetic transfer according to claim 17, wherein each of the alignment marks provided on the respective sides of the magnetic recording medium and the corresponding alignment mark provided on the master disc are engageable with each other.

19. The magnetic transfer device according to claim 17, wherein the alignment marks of the master disc is provided at the first side of the master disc where the soft magnetic material is embedded, and the alignment marks of the magnetic recording medium corresponding to the alignment marks of the master disc are located opposite to the side to which the

magnetic pattern is transferred by the master disc.

20. The magnetic transfer method according to claim 17, wherein the alignment mark of the master disc is provided at the second side thereof, and the alignment mark of the magnetic recording medium corresponding to the alignment mark of the master disc is the side to which the magnetic pattern is transferred by the master disc.

21. The magnetic transfer device according to claim 16, wherein each of the alignment marks on the magnetic recording medium extends into the respective surface thereof without extending through the magnetic recording medium.

22. The magnetic transfer device according to claim 16, wherein each of the alignment marks on the magnetic recording medium is positioned off the center thereof.

23. The method according to claim 1, wherein each of the alignment marks on the magnetic recording medium extends into the respective surface thereof without extending through the magnetic recording medium.

24. The method according to claim 1 wherein each of the alignment marks on the magnetic recording medium is positioned off the center thereof.