A recording medium, Method of Configuring Control Information Thereof, Method for Recording or reproducing data using the Same, and Apparatus Thereof

Technical Field

The present invention relates to a method of recording control information on a recording medium, such as a recordable optical disc , having at least one recording layer, and more particularly, to a method in which record velocity information and write strategy parameters are included in the control information.

Background Art

A high density optical recording medium, known as HD-DVD, is widely used to record and store high-definition video data and high-quality audio data. The Blu-ray disc represents next-generation HD-DVD technology.

Technological specifications are now being established for the global standardization of the Blu-ray disc, including standards are for the write-once Blu-ray disc (BD-WO).

Meanwhile, a rewritable Blu-ray disc, known as the 1x-speed BD-RE and now being discussed, should be compatible with BD-RE discs expected to have higher recording velocities, i.e., the 2x-speed BD-RE and beyond. BD-WO specifications for high recording velocity are also in progress. Efficient solutions for coping with the high recording velocity of a high-density optical disc are urgently needed, and the specifications established should ensure mutual compatibility.

Disclosure of Invention

Accordingly, the present invention is directed to an optical disc control information recording method that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a method of recording disc control information as specified information corresponding to a plurality of recording velocities, by which recording velocity information is included in the disc control information so that the recording and reproducing of an optical disc can be performed based on prerecorded disc information.

Another object of the present invention is to provide a data structure for configuring disc control information.

Another object of the present invention is to provide a method of recording, in a specific area of an optical disc, disc control information corresponding to a plurality of recording velocities, by which information for specific recording velocities per recording layer is recorded in a specific sequence, to provide mutual compatibility between like-based discs.

Another object of the present invention is to provide a recording and reproducing method and apparatus thereof, by which user data can be recorded on and reproduced from an optical disc using prerecorded disc control information.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, in configuring disc control information within a management area of an optical disc including at least one recording layer, a method of recording the disc control information of the optical disc according to the present invention includes the steps of providing the at least one disc control information within the management area, the disc control information provided per applicable recording velocity to each of the at least one recording layer and recording at least one write strategy information per the applicable recording velocity within the disc control information.

In another aspect of the present invention, a method of recording data on a multilayer recording medium includes the steps of providing at least two control information, the control information including information required to reproduce or record data from on from the multi layer recording medium at least depending on recording layer and/or recording or reproducing speed, the control information arranged in order first according to layer number, second

according to an increasing recording speed within each recording layer, or according to write strategy within each recording layer; and recording the disc control information in sequential order on a specific area of the multi layer recording medium.

In another aspect of the present invention, a data structure for disc control information recorded on a multilayer recording medium or to be recorded/reproduced on/from the multilayer recording medium is characterized in that the multilayer recording medium includes at least a first layer and a second layer, the disc control information is located at a particular area of the first and/or second layer, and the disc control information on the first and/or second layer includes first and second control information for the first and second layers and in that the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by

the recording parameters of the alternate write strategy or the higher recording speed for the second layer.

In another aspect of the present invention, a method of recording data on a multilayer recording medium includes the steps of generating disc control information and recording the disc control information on a specific area of the multilayer recording medium, wherein the multilayer recording medium includes at least a first layer and a second layer, the disc control information is located at a particular area of the first and/or second layer, and the disc control information on the first and/or second layer includes first and second control information for the first and second layers and wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer.

In another aspect of the present invention, a method of recording/reproducing data on/from a multilayer recording medium includes the steps of reading disc control information from a specific area of the multilayer recording medium wherein the multilayer recording medium includes at least a first layer and a second layer, the disc control information is located at a particular area of the first and/or second layer, and the disc control information on the first and/or second layer includes first and second control information for the first and second layers and wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer and recording/reproducing the data on/from a main data area of the first or second layer based on the read disc control information.

In another aspect of the present invention, a recording medium includes a multiplayer, the multilayer recording medium including at least a first layer and a second layer and disc control information located at a particular area of the first and/or second layer, the disc control information on the first and/or second layer including first and second control information for the first and second layers wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer.

In another aspect of the present invention, an optical disc includes at least one recording layer provided with a recordable area and a recording-disabled or prerecorded area, wherein disc control information is separately recorded within the prerecorded area per applicable recording velocity and wherein recording layer information designating a recording layer, recording velocity information directing a recording

velocity, and write strategy information according to the corresponding recording velocity are written within the disc control information.

In another aspect of the present invention, an optical disc recording method includes the steps of if an optical disc having at least one recording layer is loaded, reading disc control information written within a management area of the optical disc per recording velocity and reading to store recording layer information, recording velocity information, and write strategy information fitting the corresponding recording velocity recorded within the disc control information each, deciding the recording velocity of the corresponding recording layer by referring to the stored recording layer information, recording velocity information, and write strategy information, and performing recording at the decided recording velocity.

In another aspect of the present invention, an optical disc record playback apparatus includes a control unit delivering a recording command and a record playback unit receiving the recording command, the record playback unit performing a recording according to the received recording command in a

manner of reading disc control information written within a management area of an optical disc in per recording layer and recording velocity sequence, reading write strategy information recorded within disc control information by inter-working with a recording velocity of a corresponding recording layer, deciding the recording velocity of the corresponding recording layer by referring to recording velocity information and the write strategy information, and performing the recording at the decided recording velocity.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Brief Description of Drawings

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the

description serve to explain the principle of the invention. In the drawings:

FIG. 1 is a diagram of a single-layer disc applicable to the present invention;

FIG. 2 is a diagram of a dual-layer disc applicable to the present invention;

FIG. 3 is a diagram of a management area where disc control information of the present invention is recorded, in which a format of recording the disc information in a corresponding area is schematically shown;

FIGS. 4A to 4C are diagrams of disc information recorded according to a first embodiment of the present invention;

FIGS. 5A to 5C are diagrams of disc information recorded according to a second embodiment of the present invention;

FIGS. 6A to 6E are diagrams of disc information recorded according to a third embodiment of the present invention;

FIGS. 7A and 7B are diagrams of disc information recorded according to a fourth embodiment of the present invention; and

FIG. 8 is a block diagram of an optical disc recording and reproducing apparatus using disc control information according to the present invention.

Best Mode for Carrying Out the Invention

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

A Blu-ray disc is taken as an example of an optical disc according to the present invention. Yet, the concept of the present invention, characterized in an optical disc having its disc control information recorded thereon, is applicable to DVD-RAM, DVD-RW, DVD+RW, DVD-R, DVD+R, and similar such discs. Although the terminology used herein is well known for the most part, some terms have been chosen by the applicant, such that the present invention should be understood with the intended meanings of the terminology as used by the applicant. For example, the "disc control information" of a disc is recorded in a specified area, i.e., a recordable area of the disc or a prerecorded area (sometimes known as an embossed area, in which manufacturer data is recorded and where no further recording is possible), and includes information necessary for the playback of a recorded disc. Disc control

information is called "disc information" or "DI" in relation to Blu-ray disc technology but is typically referred to as "physical format information" for DVD-RAM, DVD-RW, DVD+RW, DVD-R, and DVD+R discs. Hence, it should be apparent that the technical background of the present invention is equally applicable to physical format information.

Moreover, the disc information according to the present invention is recorded as an unspecified unit of information, which may be counted, for example, as a first or second information.

FIGS. 1 and 2 illustrate the structure of optical discs according to the present invention, in which any recordable optical disc may be applicable to the present invention. The recordable disc may be, for example, a rewritable optical disc or a write-once optical disc.

Referring to FIG. 1, illustrating an optical disc having one recording layer, a lead-in area is provided as a management area on an inner circumference area of an optical disc, whereas a lead-out area is provided as a management area on an outer circumference area of the optical disc. In the inner circumference area, a pre-recorded area and a rewritable (or

write-once) area are provided separately. In BD-RE and BD-WO technology, the pre-recorded area is called the PIC area, where permanent information and control data is recorded, and disc information is recorded in the PIC area. A data area is made up of a user data area where user data is recorded and inner and outer spare areas ISA and OSA, which are used in the replacement of the data of a defective area. In the case of a BD-WO disc, a temporary defect management area (TDMA) is provided for recording information of a defect and for general management. The TDMA is unnecessary in the case of BD-RE discs, which have a corresponding area designated as reserved. The present invention intends to provide a method of recording disc information (DI) as disc control information required for record playback of a disc in a pre-recorded or recordable are. It is apparent that a recording method in the pre-record area is differently applied to each kind of disc. In the case of BD-RE and BD-WO discs, the pre-recorded area is the PIC area recorded using a biphased high-frequency modulated signal reproduced according to a specific playback method, to acquire the disc information.

FIG. 2 illustrates an optical disc having dual recording layers, in which an inner circumference area of the disc has a lead-in of a first recording layer (Layer 0) corresponding to a lead-out of a second recording layer (Layer 1). In this case, one PIC area is provided in each of the lead-in and lead-out areas, and the same disc information is recorded in each PIC area.

FIG. 3 illustrates a PIC area formatted according to the present invention. In configuring the disc information of the PIC area of a BD-RE or BD-WO disc, the minimum recording unit is one cluster, 544 clusters constitute one fragment , and five fragments make up the PIC area. Disc information is recorded in a front head cluster of a first fragment IF0. The disc information is plurally recorded per recording layer and recording velocity permitted by the corresponding optical disc. One disc information includes 112 bytes, sometimes referred to as a DI frame. To cope with a loss of disc information, the same contents of the disc information are repeatedly recorded in each front head cluster of the remainder of the fragments. Information representing the corresponding recording layer, information representing recording velocity, and write

strategy information corresponding to the recording velocity are included in each disc information. Such information is utilized in recording and reproducing the optical disc, to provide an optimal condition per recording layer and per recording velocity.

The disc information of the present invention is characterized in providing specific recording velocity information supported by the disc and associated write strategy information, and more specifically, in providing specific recording velocity supported for each recording layer and associated write strategy information via a specified method for discs having a plurality of recording layers.

The specific configuration of the disc information is for a Blu-ray disc, which may differ from the configuration of a DVD-based disc. Specifically, the recording DI volume for a Blu-ray disc is 112 bytes or equivalent. By formulating the disc information of the same recording layer as one information, i.e., without repeating any common information, the write strategy configuration may differ per recording velocity.

FIGS. 4A-4C illustrate the recording of disc information according to a first of four embodiments of the present invention, in which disc information is configured in a specific sequence per recording layer and recording velocity.

Referring to FIG. 4A, each disc information sequence is determined by a sequence number and is recorded using one byte. For instance, the information is recorded in a fifth byte (i.e., the "DI frame sequence number in DI block," which can be represented as 00h, 01h, 02h, 03h, 04h, 05h, 06h, or 07h) of the disc information, where a fifth byte of 00h or 07h indicates a first or eighth disc information, respectively. Moreover, recording layer information and recording velocity information, which will be used by the corresponding disc information, are represented by specific bits and recorded in a specific area (N^{th} byte) within the disc information. For instance, the recording layer information and the recording velocity information are respectively recorded in the upper and lower four bits of the N^{th} byte, where a recording layer information of 0000b, 1000b, or 1001b as the upper four bits indicates a single layer, a dual layer L0 (first layer), or a dual layer L1 (second layer), respectively, and a recording

velocity information of 0000b, 0010b, 0100b, 1000b, or 1111b as the lower four bits indicates a 1x-speed, 2x-speed, 4x-speed, 8x-speed, or 16x-speed recording velocity, respectively. By allocating one byte thusly, the recording layer information and the recording velocity information can be defined according to a system or specification enactment.

The recording layer information and the recording velocity information are recorded in a reserved specific location corresponding to their sequence number, as shown in FIG. 4A, thereby facilitating to confirm the recording layer information and the recording velocity information included in the corresponding disc information. By recording write power or write parameters as write strategy information fitting the corresponding recording layer and recording velocity in detail using the remainder of the bytes within the disc information, namely, the 44^{th}~111^{th} bytes, the recorded information enables efficient recording and reproducing of an optical disc. The information recorded in the 44^{th}~111^{th} bytes is referred to as the write strategy parameters.

FIG. 4B exemplarily shows disc information recorded in a single layer when representing the disc information shown in

FIG. 4A. When an optical disc requires four different recording velocity information, four disc information corresponding to the four recording velocities are needed within a PIC area. In each disc information, its sequence number is recorded in a fifth byte and corresponding recording layer information and recording velocity information are recorded in an N^{th} byte by allocating four bits to each of the corresponding recording layer information and the corresponding recording velocity information. For instance, a representation of recording velocities as 1x-speed, 2x-speed, 4x-speed, and 8x-speed corresponds to the case of the single layer in FIG. 4B. Hence, the upper four bits of the N^{th} byte is 0000b to designate the single layer and the lower four bits indicate each recording velocity information. Specifically, 0000b indicating 1x-speed is written in the first disc information, 0010b indicating 2x-speed is written in the second disc information, 0100b indicating 4x-speed is written in the third disc information, and 1000b indicating 8x-speed is written in the fourth disc information.

FIG. 4C exemplarily shows disc information recorded in a dual layer when representing the disc information shown in FIG. 4A,

in which each disc information corresponding to recording velocity information per recording layer is configured in configuring disc information in case that at least two recording layers exist. Namely, disc information is mainly configured per recording layer and another disc information according to recording velocity of a corresponding recording layer is then configured. In the aspect of a sequence of configuring disc information, disc information is preferentially configured on a recording layer; another disc information, according to a corresponding recording velocity in the corresponding recording layer, is then configured.

Hence, if an optical disc includes two recording layers and each recording layer requires four different recording velocity information, eight disc information are needed to cope with each recording velocity per recording layer within a PIC area. In each of the disc information, a sequence number is written in a fifth byte and recording layer information and recording velocity information are respectively written in four allocated bits of an N^{th} byte.

For instance, if the recording velocities to be represented per recording layer are 1x-speed, 2x-speed, 4x-speed, and 8x-

speed, first through fourth disc information are configured with disc information of a first recording layer (layer 0), the upper four bits of the N^{th} byte are 1000b to designate the first recording layer, and the lower four bits of the N^{th} byte indicate the respective recording velocity information. Specifically, 0000b indicating 1x-speed is written in the first disc information, 0010b indicating 2x-speed is written in the second disc information, 0100b indicating 4x-speed is written in third disc information, and 1000b indicating 8x-speed is written in the fourth disc information.

Moreover, fifth through eighth disc information are configured with disc information of a second recording layer (layer 1) of the dual layer. The upper four bits of the N^{th} byte are 1001b to designate the second recording layer, and the lower four bits of the N^{th} byte indicate the respective recording velocity information. Specifically, 0000b indicating 1x-speed is written in the fifth disc information, 0010b indicating 2x-speed is written in the sixth disc information, 0100b indicating 4x-speed is written in the seventh disc information, and 1000b indicating 8x-speed is written in the eighth disc information.

In the first embodiment, disc information is separated for each recording velocity in each layer. In accordance with another embodiment, disc information is separated for each recording layer, and each recording velocity per recording layer can be included in one DI. In this case, there is one DI per recording layer and the recorded DI volume varies according to the number of supported recording velocities.

FIGS. 5A to 5C illustrate the recording of disc information according to a second of four embodiments of the present invention. In contrast to the first embodiment, the recording layer information and recording velocity information of the second embodiment are recorded in a fifth byte representing a sequence number of disc information.

Instead of simply indicating a sequence of continuous disc information, a sequence number within disc information indicates that the disc information is recorded in a specific sequence by writing recording layer information and recording velocity information of the present invention in the above area.

FIG. 5B illustrates the second embodiment applied to a single layer, in which recording layer information and recording

velocity information are recorded in the same manner as the first embodiment (FIG. 4B) but are written in the fifth byte instead of N^{th}.

For instance, a representation of recording velocities as 1x-speed, 2x-speed, 4x-speed, and 8x-speed corresponds to the case of the single layer in FIG. 5B. Hence, the upper four bits of the fifth byte are 0000b designating the single layer, and the lower four bits of the fifth byte indicate each recording velocity information. Specifically, 0000b indicating 1x-speed is written in the first disc information, 0010b indicating 2x-speed is written in the second disc information, 0100b indicating 4x-speed is written in the third disc information, and 1000b indicating 8x-speed is written in the fourth disc information.

FIG. 5C illustrates the second embodiment applied to a dual layer, in which recording layer information and recording velocity information are recorded in the same manner as the first embodiment (FIG. 4B) but are written in a fifth byte instead of the N^{th}. For instance, if the recording velocities to be represented per recording layer are 1x-speed, 2x-speed, 4x-speed, and 8x-speed, the first through fourth disc

information are configured with disc information of a first recording layer (layer 0) of the dual layer. Hence, the upper four bits of the fifth byte are 1000b to designate the first recording layer, and the lower four bits of the fifth byte means indicate each recording velocity information. Specifically, 0000b indicating 1x-speed is written in the first disc information, 0010b indicating 2x-speed is written in the second disc information, 0100b indicating 4x-speed is written in the third disc information, and 1000b indicating 8x-speed is written in the fourth disc information. Meanwhile, the fifth through eighth disc information are configured with disc information of a second recording layer (layer 1) of the dual layer. The upper four bits of the fifth byte are 1001b to designate the second recording layer, and the lower four bits of the fifth byte indicate each recording velocity information. Specifically, 0000b indicating 1x-speed is written in the fifth disc information, 0010b indicating 2x-speed is written in the sixth disc information, 0100b indicating 4x-speed is written in the seventh disc information, and 1000b indicating 8x-speed is written in the eighth disc information.

FIGS. 6A to 6E illustrate the recording of disc information according to a third of four embodiments of the present invention.

In the third embodiment, a plurality of disc information are recorded in a disc, a record sequence of each disc information is determined by a sequence number, and the record sequence is recorded in one byte. For instance, the corresponding information is recorded in a fifth byte (i.e., the "DI frame sequence number in DI block," which can be represented as 00h, 01h, 02h, 03h, 04h, 05h, 06h, or 07h) of the disc information. Here, for example, a fifth byte of 00h indicates the first disc information as well as disc information of 1x-speed of a first recording layer (Layer 0), a fifth byte of 01h indicates the second disc information as well as disc information of 2x-speed of the first recording layer, and a fifth byte of 07h indicates the eighth disc information as well as disc information of 8x-speed of a second recording layer (Layer 1). Hence, the disc information is preferentially arranged in a recording layer sequence and is configured to follow a per recording velocity information sequence.

Write strategy, interoperating with recording velocity meant by the corresponding disc information, is recorded in a specific area, e.g., a write strategy parameters field (the L^{th}~111^{th} bytes), within the disc information. Identification information for identifying the recorded write strategy type is recorded in another specific area, e.g., a write strategy code field (the N^{th} byte), within the disc information. If there are N kinds of write strategy (WS), the identification information allocates a specific recognition value to each write strategy, setting, for instance, 0000 0001b to indicate a first write strategy (WS-1), 0000 0010b to indicate a second write strategy (WS-2), and XXXX XXXXb to indicate an N^{th} write strategy (WS-N). A WS type of 0000 0000b can be set to indicate that no specific WS type exists as well as WS parameters. Namely, the 'WS code' information of the N byte can be utilized to indicate that there is no WS as well as information designating the WS type.

FIG. 6B shows an example of recording disc information for a specific write strategy, in which a disc manufacturer selects to record WS-1 from various specifications in recording a write strategy for 1x-speed within 1x-speed disc information

of a first recording layer. Namely, a write strategy code field (N^{th} byte) of 0000 0001b indicates a first write strategy, and parameter values corresponding to WS-1 are written in the write strategy parameters field (the L^{th}~111^{th} bytes).

If a disc manufacturer selects to record in WS-2, 0000 0010b is written in the write strategy code field and WS-2 parameters will be written in the L^{th}~111^{th} bytes. These write strategy parameters have different values according to the kind of write strategy. The corresponding write strategy parameters are predetermined, as specified information fitting the characteristics of the disc, and made available to a disc manufacturer or a system designer. As such, the write strategy parameters have arbitrary values with no relevance to the present invention.

FIGS. 6C to 6E show specific embodiments for including the write strategy in the disc information of the present invention, assuming a dual-layer disc in which 1x-speed and 2x-speed are applied to the two recording layers, respectively. Here, FIGS. 6C and 6D show a write strategy optionally selected to be recorded for all recording layers and recording

velocities on manufacturing a disc, and FIG. 6E shows a recorded write strategy predetermined based on a mandatory recording at a specific recording velocity.

FIG. 6C shows a case of optionally recording the write strategy for all recording layers and recording velocities. For instance, 00h is recorded to indicate disc information of 1x-speed for a first recording layer, and WS-1 is selected as the write strategy; 01h is recorded to indicate disc information of 2x-speed for the first recording layer, and WS-2 is selected as the write strategy; 02h is recorded to indicate disc information of 1x-speed for a second recording layer, and WS-1 is selected as the write strategy; and 03h is recorded to indicate disc information of 2x-speed for the second recording layer, and WS-N is selected as the write strategy.

FIG. 6D shows another example of optionally recording the write strategy, in which the same write strategy is applied to the disc information of every recording layer and recording velocity. Since write strategy can be optionally recorded, a disc manufacturer may apply the entire disc information identically for one most reliable write strategy. FIG. 6D

illustrates a case that WS-1 is written for every disc information.

FIG. 6E shows a method of recording a write strategy previously determined in a mandatory manner in case of a specific recording velocity and write strategies optionally for all other recording velocities. The write strategy for 1x-speed is considered primary, where a specific method is predetermined, and a disc manufacturer can optionally record all other recording velocities. For instance, if the write strategy mandatory for the 1x-speed is WS-1, 00h is recorded to indicate disc information of 1x-speed for a first recording layer, and WS-1 is set as the mandatory write strategy. Then, 01h is recorded to indicate disc information of 2x-speed for the first recording layer, and WS-2 is selected as the write strategy that can be optionally recorded; 02h is recorded to indicate disc information of 1x-speed for a second recording layer, and WS-1 is selected as the mandatory write strategy; and 03h is recorded to indicate disc information of 2x-speed for the second recording layer, WS-2 is selected as the write strategy that can be optionally recorded.

In applying the case of FIG. 6E, one of a plurality of specified write strategies is uniformly written as the 1x-speed write strategy in a mandatory manner, thereby enabling to secure recording characteristics of the disc more. A disc manufacturer can optionally record one of a plurality of the specified write strategies uniformly for all recording velocities besides the 1x-speed, whereby a disc manufacturing process time can be shortened. Here, the mandatory write strategy for 1x-speed can be recorded and a disc manufacturer can optionally record another write strategy for 1x-speed separately, in which case the disc information for 1x-speed is made up of one disc information including the specified mandatory write strategy and another disc information including the optional write strategy.

FIGS. 7A and 7B illustrate the recording of disc information according to a fourth of four embodiments of the present invention. First of all, a plurality of disc information are recorded in a disc, a record sequence of each disc information is determined by a sequence number, and the record sequence is written in one byte. For instance, the corresponding information is recorded in a fifth byte (i.e., the "DI frame

sequence number in DI block," which can be represented as 00h, 01h, 02h, 03h, 04h, 05h, 06h, or 07h) of the disc information, where a fifth byte of 00h, 01h, or 07h indicates a first disc information of 2x-speed for a first recording layer, a second disc information of 2x-speed for the first recording layer, or an eighth disc information of 8x-speed for a second recording layer, respectively. Hence, the disc information is preferentially arranged in a recording layer sequence and is configured to follow a per recording velocity information sequence.

In a specific area within the disc information, recording velocity information designated by the corresponding disc information and write strategy coping with the corresponding recording velocity are written in a reserved specific location. For instance, the recording velocity information of the corresponding disc information is written in the N^{th}~$(N+4)^{th}$ bytes, and the write strategy coping with the corresponding recording velocity is written in the M^{th}~111^{th} bytes.

For the fourth embodiment of the present invention to provide disc information coping with high recording velocity, the recording velocity information and write strategy are written

for each of a plurality of recording velocity information, i.e., a nominal recording velocity (Vnom), a maximum recording velocity (Vmax), a minimum recording velocity (Vmin), and an intermediate recording velocity (Vint). Here, the nominal recording velocity is a basic recording velocity of a corresponding disc and is generally written as information associated with 1x-speed; the maximum recording velocity is an applicable maximum recording velocity (e.g., 3x-speed) associated with the optimal recording velocity; the minimum recording velocity ins an applicable minimum recording velocity (e.g., Vmax/2.4) associated with the optimal recording velocity; and the intermediate recording velocity is an applicable intermediate recording velocity (e.g., 1.7×Vmin) associated with the optimal recording velocity. The above relation of recording velocity values has been determined by considering a radius ratio between inner and outer circumferences of a Blu-ray disc applicable to the present invention. It is apparent that such a relation can be variably applied to other kinds of discs and that the recording velocity values can be set to different values according to disc characteristics.

Relating to the optimal recording velocity (1x-speed), the same information is preferably recorded in each disc information. Preferably, the maximum, minimum, and intermediate recording velocities are differently determined according to the maximum recording velocity value as far as the corresponding information is applicable.

Though any number of intermediate recording velocities can be established, the present invention is characterized in having at least one intermediate recording velocity. At least four recording velocity information are included in one disc information, with system operation benefiting from larger numbers of recording velocity information. By utilizing a recordable area within disc information to the maximum, many intermediate recording velocity information can be provided.

FIG. 7B schematically shows disc information recorded in the case of FIG. 7A, and more particularly, in the case of a dual layer. For instance, when an optical disc requires three different recording velocity information per recording layer, six disc information corresponding to the respective recording velocities are needed within a PIC area. Each disc information is allocated to write a sequence number,

corresponding recording velocity information, and corresponding write strategy to a predetermined area.

For instance, if the recording velocities to be represented are 1x-speed, 2x-speed, and 6x-speed, the disc information for a first recording layer includes first, second, and third disc information. Here, the first disc information is 1x-speed disc information of the first recording layer, its sequence number corresponding to 00h, and the corresponding recording velocity and write strategy are written in a reserved location, i.e., the N^{th}~$(N+4)^{th}$ bytes and the M^{th}~111^{th} bytes, respectively; the second disc information is 2x-speed disc information of the first recording layer, its sequence number corresponding to 01h, and the corresponding recording velocity and write strategy are written in similarly reserved locations; and the third disc information is 6x-speed disc information of the first recording layer, its sequence number corresponding to 02h, and the corresponding recording velocity and write strategy are written in similarly reserved locations.

Likewise, fourth, fifth, and sixth disc information are for a second recording layer, where the fourth disc information is 1x-speed disc information of the second recording layer and

its sequence number corresponds to 03h, where the fifth disc information is 2x-speed disc information of the second recording layer and its sequence number corresponds to 04h, and where the sixth disc information is 6x-speed disc information of the second recording layer and its sequence number corresponds to 05h. In this case, corresponding recording velocity and write strategy are written in the same location as in the case of the first recording layer.

In the fourth embodiment of the present invention, a plurality of recording velocity information are all included in one disc information, but one write strategy associated with specific recording velocity information can be written in one disc information with the remainder written in another disc information. For instance, regarding four kinds of recording velocity information, the number of required disc information will be four times more than that of the above-explained embodiment. Yet, the PIC area, in which the disc information of 112 bytes is written, is an area providing for a sufficiently large number of disc information to be written information.

FIG. 8 illustrates an optical disc recording and reproducing apparatus using disc control information according to the present invention. The recording and reproducing apparatus comprises a recorder/reproducer 10 for recording data on and reproducing data from an optical disc and a controller 20 for controlling the recorder/reproducer 10. The controller 20 generates a record or playback command for a specific area, and the recorder/reproducer 10 caries out the record/playback function for the specific area accordingly. The recorder/reproducer 10 includes an interface 12 for communicating with an external device, i.e., the controller (or host); a pickup 11 for performing read and write operations with respect to the optical disc; a data processor 13 for modulating the pickup's input signal for performing a reproduction operation and for demodulating the pickup's output signal for performing a record operation; a servo 14 for controlling the read and write operations of the pickup; a memory 15 for temporarily storing disc control information; and a microcomputer 16 for respectively controlling each element of the recorder/reproducer.

In a recording data on an optical disc according to the present invention, the optical disc recording and reproducing apparatus first reads the entire disc management area of an inserted optical disc, the read information being disc information of the present invention, which is temporarily stored in the memory 15. Thus, the recording layer information, recording velocity information, and write strategy fitting the corresponding recording velocity are read out and temporarily stored.

If intending to perform a writing on a specific area within the optical disc, the controller 20 renders such an intent into a writing command and then delivers it to the recorder/reproducer 10 together with data for writing location information to be recorded. After receiving the writing command, the microcomputer 16 decides the corresponding recording velocity applied to an intended recording layer within the optical disc from the management information stored in the memory 15 and then performs the writing command using the most optimal write strategy by referring to the decided recording velocity.

Industrial Applicability

Accordingly, the present invention provides methods of formatting disc control information for coping with higher recording velocities in a high-density optical disc, enabling standardized disc control information to be used when recording and reproducing.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. A method of recording control information on a recording medium having at least two recording layers , the method comprising steps of:

providing, per applicable recording velocity, control information for at least two recording layers, the control information including information required to reproduce or record data from or on the recording medium; and

recording the control information within a management area of the recording medium and at least one write strategy information per the applicable recording velocity within the disc control information.

2. The method of claim 1, wherein the management area is a prerecorded area.

3. The method of claim 1, wherein the management area having the control information recorded therein is a

recordable area when recording data on the recording medium.

4. The method of claim 2, wherein the control information is disc information configured in a permanent information and control (PIC) data area.

5. The method of claim 2, wherein the disc control information is physical format information.

6. The method of claim 1, wherein the write strategy information includes write strategy parameters or write strategy type required to form a pit in order to record data on the recording medium.

7. The method of claim 6, wherein the at least one write strategy information includes basic write strategy information and optional write strategy information.

8. The method of claim 1, wherein the disc control information includes recording layer information and recording velocity information.

9. A method of recording control information on multi layer recording medium, comprising the steps of:

providing at least two control information, the control information including information required to reproduce or record data from on from the multi layer recording medium at least depending on recording layer and/or recording or reproducing speed, the control information arranged in order first according to layer number, second according to an increasing recording speed within each recording layer, or according to write strategy within each recording layer; and

recording the disc control information in sequential order on a specific area of the multi layer recording medium.

10. The method of claim 9, wherein the write strategy information includes write strategy parameters or write

strategy type required to form a pit in order to record data on the recording medium.

11. The method of claim 10, wherein the at least one write strategy information is divided into basic write strategy information and optional write strategy information.

12. The method of claim 9, wherein recording layer information and recording velocity information are written within the control information.

13. A data structure for recording disc control information on or reproducing control information from a multilayer recording medium having at least a first recording layer and a second recording layer, at least one of the first and second recording layers having a predetermined area for containing the control information and, the disc control information including first control information for the first recording layer and second control information for the second recording layer,

wherein the first control information is followed by the second control information, the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or higher recording speed for the first layer, and the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or higher recording speed for the second layer.

14. The data structure of claim 13, wherein the first control information and the second control information each include identification information for identifying whether the recording parameters for the alternate write strategy exist or a type of the alternate write strategy.

15. The data structure of claim 14, wherein the recording parameters for the alternate write strategy is dependent on a recording speed and/or the type of the alternate write strategy.

16. The data structure of claim 15, wherein each of the first and second control information includes a layer ID.

17. The data structure of claim 13, wherein the first and second control information are arranged in sequential order.

18. A method of recording data on a multilayer recording medium, comprising steps of:

generating control information; and

recording the control information on a specific area of the multilayer recording medium,

wherein the multilayer recording medium includes at least a first layer and a second layer, the control information is located at a particular area of the first and/or second layer, and the control information on the first and/or second layer includes first and second control information for the first and second layers and

wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer.

19. The method of claim 18, wherein each of the first and second control information includes identification information to identify whether the recording parameters of the alternate write strategy exist and a type of the alternate write strategy.

20. The method of claim 19, wherein the parameters for the alternate write strategy are dependent on a recording speed and/or the type of the write strategy.

21. The method of claim 20, wherein each of the first and second control information includes a layer ID.

22. The method of claim 18, wherein in the recording step, the first and second control information are recorded in sequential order.

23. A method of recording/reproducing data on/from a multilayer recording medium, comprising steps of:

reading control information from a specific area of the multilayer recording medium wherein the multilayer recording medium includes at least a first layer and a second layer, the control information is located at a particular area of the first and/or second layer, and the control information on the first and/or second layer includes first and second control information for the first and second layers and wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information

having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer; and recording/reproducing the data on/from a main data area of the first or second layer based on the read control information.

24. The method of claim 23, wherein the first and second control information are recorded on the specific area in sequential order and wherein in the reading step, the first and second control information are read in recorded order.

25. A multilayer recording medium comprising:

at least a first layer and a second layer; and

control information located at a particular area of the first and/or second layer, the control information on the first and/or second layer including first and second control information for the first and second layers wherein the first control information having recording

parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the alternate write strategy or the higher recording speed for the second layer.

26. The recording medium of claim 25, wherein each of the first and second control information includes identification information to identify whether the recording parameters of the alternate write strategy exist and a type of the alternate write strategy.

27. The recording medium of claim 26, wherein the parameters for the alternate write strategy are dependent on a recording speed and/or the type of the write strategy.

28. The recording medium of claim 27, wherein each of the first and second control information includes a layer ID.

29. The recording medium of claim 25, wherein in the recording step, the first and second control information are recorded in sequential order.

30. An optical recording medium comprising at least two recording layers provided with a recordable area and a recording-disabled or prerecorded area respectively,

wherein control information is separately recorded within the prerecorded area per applicable recording velocity and

wherein recording layer information designating a recording layer, recording velocity information directing a recording velocity, and write strategy information according to the corresponding recording velocity are written within the control information.

31. The optical recording medium of claim 30, wherein the recording medium is a recordable Blu-ray disc.

32. The optical recording medium of claim 30, wherein the disc is a recordable DVD.

33. A method for recording data on a multilayer recording medium, comprising steps of:

reading control information written within a management area of the recording medium per recording velocity and storing the control information, the control information including recording layer information, recording velocity information, and write strategy information for the corresponding recording velocity recorded within the control information each;

determining the recording velocity of the corresponding recording layer based on the stored recording layer information, recording velocity information, and write strategy information; and

performing recording at the decided recording velocity.

34. An apparatus for recording data on and reproducing data from an optical recording medium having at least two recording layers, the apparatus comprising:

a reader to read control information from a specific area of the multi-layer recording medium, wherein the multi-layer recording medium includes at least a first layer and a second layer, the control information is located at a particular area of the first and/or second layer, and the control information on the first and/or second layer includes first and second control information for the first and second layers and wherein the first control information having recording parameters for a basic write strategy followed by recording parameters of an alternate write strategy or a higher recording speed for the first layer is followed by the second control information having the recording parameters for the basic write strategy followed by the recording parameters of the

alternate write strategy or the higher recording speed for the second layer; and

a controller to record or reproduce the data on or from a main data area of the first or second layer based on the read control information.