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RECORDING MEDIUM FOR STORING LINKING TYPE INFORMATION AND METHOD OF PROCESSING DEFECTIVE AREA USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of optical recording media having continuous basic recording units, and more particularly, to a recording medium for storing linking type information which indicates whether a linking scheme applies to an area immediately after a defective area and a method of processing a defective area using the same.

2. Description of the Related Art

Since basic recording units of a digital versatile disc-rewritable (DVD-RW) and a digital versatile-recordable (DVD-R) are positioned continuously, contrary to those of a DVD-Random Access Memory (DVD-RAM) which are divided by physical identifier (PID) areas or buffer fields (extra areas allocated to correspond to a requirement for controlling a spindle motor accurately), it is required that a recording-start point of each basic unit in a DVD-RW is precisely located. The basic recording unit of the DVD-RAM can be a sector and the basic recording unit of the DVD-RW can be an error correction code (ECC) block.

Since the basic recording units of the DVD-R and the DVD-RW, which have the same physical formats, are positioned continuously as described above, for an incremental recording mode, that is, the mode in which data transmission is momentarily discontinued or new data is recorded following the previous data, the DVD-R and the DVD-RW use a linking scheme in which a predetermined number of bytes (for example, 3 bytes) of a next recording-

start point are allocated as a linking area. In addition, there are two linking area sizes which are applied in incremental recording; 2 kilobytes and 32 kilobytes.

In the case of DVD-RW, when a defective area is registered in a defective area list which is registered in a recording management data (RMD) area, the DVD-RW uses a restricted overwrite recording mode along with the linking scheme similar to the incremental recording mode when recording actual user data after the registered defective area. Therefore, the current DVD-RW specification only applies a linking scheme for the incremental recording mode and the restricted overwrite recording mode. The DVD-RW specification does not define specific linking schemes for processing a defective area, such as defining a linking area after a defective area.

FIG. 1 is a diagram illustrating a linking scheme which occurs in a general incremental recording mode, and shows old data 4, a 32-kilobyte linking area 2 and new data 7. Referring to FIG. 1, when recording of old data 4 is completed without filling up a basic recording unit (an ECC block unit in FIG.1), padding data 5 is recorded from the remaining portion of the basic recording unit, where no data is recorded, to a first sector after a sync mark 1. Recording of the new user data 7 begins after recording linking data 6 in the 32-kilobyte linking area 2 for incremental recording.

In the meantime, in a case where reference signals such as a wobble signal or a land pre-pit (LPP) signal are not generated as in the case of an uncorrectable error, that is, in a case where a large defect exists across a plurality of tracks, all signals (a wobble signal, an LPP signal, etc.) are not generated at all when a pick-up unit passes through the defective area. In this case, continuous recording becomes impossible, and, since data must be recorded after the defective area, the same mode as an incremental recording mode is applied.

In a DVD-RW, data is recorded in groove tracks, and information which indicates physical ECC block numbers is recorded in the form of pre-pits in land tracks and referred to as the LPP signal. In addition, groove tracks are wobbled with a predetermined frequency.

Therefore, it is necessary to define a new linking scheme, since as described above currently after the defective area a linking scheme occurs which is defined only for a general incremental recording mode or a restricted overwrite recording mode. Since the linking scheme defined by the DVD-RW specification applies to only an incremental recording mode and a restricted overwrite recording mode, the new linking scheme would apply to an area immediately after the defective area.

The type of linking immediately after the defective area needs to be distinguished from the type of linking used in the general incremental recording mode and the restricted overwrite recording mode. That is, the linking in the general incremental recording mode and the restricted overwrite recording mode occurs when new data is recorded after stopping the recording of as much data as can be recorded at a time. This linking is not defined in a write-at-once recording mode.

However, according to the present invention the linking occurs immediately after the defective area, and occurs in a situation in which recording data as much as can be recorded at a time is not completely performed.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a recording medium for storing linking type information which indicates whether linking occurs immediately after a defective area, in the recording medium in which basic recording units are positioned continuously.

It is another object to provide a recording medium in which a predetermined number of error correction code (ECC) blocks, which have the same effect as a linking area, are allocated immediately after a defective area, in the recording medium in which basic recording units are positioned continuously.

It is still another object to provide a method of processing a defective area in which user data is recorded after allocating a predetermined linking area immediately after a defective area according to linking type information which indicates whether linking occurs immediately after a defective area in recording.

It is yet still another object to provide a method of processing a defective area in which recording of a user data begins after a predetermined number of ECC blocks following a defective area.

Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

To achieve the above objectives and other objectives of the present invention a recording medium having continuous basic recording units comprises a defect management area registering a list of defective areas, a linking area allocated immediately after one of the defective areas according to a predetermined linking scheme, and a predetermined area storing additional information indicating whether the predetermined linking scheme is applied to, specified in, or occurs in the linking area immediately after the one defective area.

Further, a recording medium having continuous basic recording units comprises a predetermined number of error correction code (ECC) blocks allocated to an area immediately after a defective area detected during certification and a defective management area registering in a list the defective

area and information on the predetermined number of ECC blocks allocated immediately after the defective area.

Further, a method of processing defective areas in a recording medium having continuous basic recording units and processing defective areas, comprises detecting the defective areas that occur during certification before recording user data and the defective areas that occur while recording the user data, registering a list of the defective areas in a defect management area of the recording medium, and storing in a predetermined area of the recording medium additional information indicating whether a predetermined linking scheme is applied to a linking area immediately after one of the defective areas.

Further, a method of processing a defective area before recording user data or while recording the user data in a recording medium having continuous basic recording units, comprising recording the user data after specifying a predetermined linking scheme in a linking area immediately after the defective area if the defective area is found while recording the user data in one of the basic recording units.

Further, a recording and/or reproducing apparatus recording data on a recording medium having continuous basic recording units and reading the data from the recording medium and processing defective areas of the recording medium, comprises a pick-up device which records data on the recording medium and reproduces data from the recording medium and a processing unit which upon detecting one of the defective areas specifies a predetermined linking scheme in a linking area immediately after the one defective area during data recording by the pick-up device.

Further a recording and/or reproducing apparatus recording data on a recording medium having continuous basic recording units and reading the data

from the recording medium and processing defective areas of the recording medium, comprises a pick-up device which records data on the recording medium and reproduces data from the recording medium; and a processing unit allocating a predetermined number of error correction code (ECC) blocks to an area immediately after one of the defective areas detected during certification and

registering in a list in a defective management area the one defective area and information on the predetermined number of ECC blocks allocated immediately after the one defective area.

Further, a recording and/or reproducing apparatus recording data on a recording medium having continuous basic recording units and reading the data from the recording medium and processing defective areas of the recording medium, comprising a process of specifying upon detecting one of the defective areas a predetermined linking scheme in a linking area immediately after the one defective area.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 illustrates a linking scheme occurring in a general incremental recording mode;

FIG. 2 illustrates an example of a method of processing defective area according to the present invention;

FIG. 3 illustrates the structure of a data identification (DID) area as an example of storing linking type information according to the present invention; and

FIG. 4 illustrates another example of a method of processing defective area according to the present invention.

FIG. 5 is a block diagram of a recording/reproducing apparatus for implementing the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

FIG. 2 illustrates an example of a method of processing the defective area according to the present invention. During certification, after registering a defect list in a recording management data (RMD) area, a linking area is allocated after the defective area, and the new user data is recorded after the linking area.

The RMD area stores the list of defective areas found while using the recording medium as well as the list of the defective areas found during certification. According to the present invention, the RMD area stores the list of the defective areas found before or during recording of the user data. At the same time, for example, a data identifier (DID) area at the beginning of a sector (which can be the ECC block or the sector) where the defective data is included or located stores linking type information which indicates whether or not linking is applied after the defective area when recording the user data.

Then, the new user data is recorded after applying a linking scheme to the area immediately after the defective area. In another example, the basic recording unit stores the linking type information as additional information, which indicates whether linking is applied immediately after the defective area and the linking type information can be referenced or accessed. Using the linking type information, the recording medium can recognize the linking data, thereby differentiating between the linking data and the user data.

That is, when the defective area 3, which is registered in the list of defective areas in the RMD area, is found while recording the user data 4, the defective area 3 is skipped without recording the user data. At this time, for the defective area 3, optical power beam which is emitted from an optical power source such as a laser device is lowered down to a level that cannot affect recording, for example, under a read power beam. Therefore, an optical power source emitting a write power beam during recording the user data lowers the write power beam upon detecting the defective area 3 so that the lowered power beam does not affect recording. The linking area 8 immediately after the defective area 3 is filled with linking data 9, and the new data 7 begins to be recorded. The size of the linking area 8 occurring immediately after the defective area 3 may be either 2 KB or 32 KB, however, a size of 2KB is advantageous in real time read/write (RTRW) operation.

In the meantime, since linking according to the present invention can be found through detection of the defective areas during certification, the linking data can be recorded in advance immediately after the detected defective area according to a predetermined linking scheme (2KB or 32KB). At this time, information is recorded in the data type information in the DID as shown in FIG. 3 indicating that the linking data is recorded, and the linking type

information indicating that linking occurs immediately after the defective area is recorded in the linking type information in the DID as shown in FIG. 3.

Since padding data (for example, 00h) is recorded in the remaining portion of the basic recording unit, in a padding data area immediately before the defective area, when the basic recording unit is not filled up with the user data, the padding data can be recorded in advance in the basic recording unit immediately before the defective area. This padding data area can be overwritten when recording the actual user data.

When recording the user data after certification, the linking data is recorded in advance immediately after the defective area so that the user data can be recorded immediately after the linking area. Therefore, time for recording the linking data is shortened, and it is advantageous in real-time recording because the user data is recorded immediately after the defective area and the linking area.

FIG. 3 illustrates an example of storing the linking type information according to the present invention in the DID area which is allocated for each sector and has 4 bytes. Data identification information includes sector information and a sector number, and sector information includes sector format type, tracking method, reflectivity, linking type, area type, data type, and layer number.

Sector format type information of bit position b31 represents constant linear velocity (CLV) or zone constant linear velocity (ZCLV) as follows.

0b: CLV format type

1b: Zoned format type, specified for Rewritable discs

Tracking method information of bit position b30 represents pit tracking or groove tracking as follows.

0b: Pit tracking

1b: Groove tracking, specified for Rewritable discs

Reflectivity information of bit position b29 represents whether reflectivity exceeds 40% or not as follows.

0b: If the reflectivity is greater than 40%

1b: If the reflectivity is less than or equal to 40%.

Area type information of bit position b27 and b26 represents a data area, a lead-in area, a lead-out area, or a middle area for a read-only disc as follows.

00b: In the data area

01b: In the Lead-in area

10b: In the Lead-out area

11b: In the middle area of read-only discs

Data type information of bit position b25 represents read-only data, or the linking data as follows.

0b: Read-only data

1b: Linking data

Layer number information of bit position b24 represents layer number in a single layer disc or a dual layer disc as follows.

0b: Layer 0 of dual layer discs or single layer discs

1b: Layer 1 of dual layer discs

According to the present invention, linking type information is defined as follows and recorded, by using b28 which is a reserved bit in the sector information area in conventional methods.

0b: Linking for incremental recording

1b: Linking after defective area

If the linking type information is binary number "0", it indicates linking for the incremental recording mode, and if it is binary number "1", it indicates linking

immediately after the defective area. Here, the linking type which occurs in the incremental recording mode or the restricted overwrite recording mode can be referred to as linking type I, and the linking type which occurs immediately after the defective area can be referred to as linking type II.

Therefore, by indicating the linking type in the linking type information of the DID, the general linking type and the linking type according to the present invention can be distinguished. If information indicating linking immediately after the defective area is included in the DID of the sector in which linking occurs, when linking occurs in the sector it can be shown whether the linking occurred during the incremental recording mode, or the restricted overwrite recording mode, and whether the linking occurred immediately after the defective area. In addition, the linking type information can be used for high-speed data processing in a drive since with the linking type information it can be shown at once whether recording data is continuously recorded or divided by the defective area.

The linking scheme which accompanies the defective area according to the present invention can be applied to all the recording modes of the DVD-RW, that is, the write-at-one recording mode, the restricted overwrite recording mode, and the incremental recording mode.

FIG. 4 illustrates another example of a method of processing the defective area according to the present invention. Reference number 11 is a user data area where old data is recorded, reference number 12 is a defective ECC block, reference number 13 is a predetermined number of ECC blocks allocated immediately after the defective ECC block in order to have the same effect as the linking area, and reference number 14 is a user data area where new data is recorded.

According to the present invention, by using an area equal to or larger than 1 ECC block (32KB) allocated immediately after the defective area detected in certification, the data area from which recording of the new data begins can be detected without using the linking scheme. At this time, the predetermined number of ECC blocks immediately after the defective area can be registered in the RMD area, and it can be defined that the new user data area follows the predetermined number of ECC blocks immediately after the defective area according to a predetermined rule.

In addition, for high speed seek, a reference signal such as a test signal, data or a recording mark which has predetermined patterns, which takes a role of linking data can be recorded in advance in the predetermined number of ECC block area immediately after the defective area.

In recording the actual user data after certification, after a defective area is encountered or met, it is determined whether, for example, a test signal is detected. If the test signal is detected in the ECC blocks, which are allocated immediately after the defective area to have the same effect as the linking area, the new data recording begins in the new user data area immediately after the predetermined number of ECC blocks following the defective area, which is advantageous in real-time recording. Since a groove track can be wobbled, the test signal can also be a wobble signal.

As described above, in addition to the linking which occurs in incremental recording or restricted overwrite recording, the present invention uses linking type information which indicates that linking occurs immediately after the defective area. By doing so, even if a large defect occurs in the recording medium and the reference signals required for recording/reproducing are not generated, the linking scheme can be applied to the area immediately

after the defective area, and the new user data recording can begin, which increases reliability of the user data, and performs more reliable reproduction.

Further, according to the present invention, a reference signal such as a test signal, data, a groove wobble pattern, or a recording mark which has a test pattern, which functions as linking data is recorded in advance in a block immediately after the defective area detected during certification. If, for example, the test signal is detected after the defective area, the new user data is recorded immediately after the predetermined number of ECC blocks following the defective area without using linking, reducing the time for recording linking data, which is advantageous to real-time recording.

Further, a playback apparatus reads information recorded according to the present invention.

Further, Fig. 5 is a block diagram of a recording/reproducing apparatus for implementing the present invention. The function of the recording/reproducing apparatus for recording/reproducing A/V (audio/video) data using the recordable and rewriteable recording media such as the DVD-RW, DVD-R and DVD-RAM is largely divided into recording and reproduction.

During recording, an AV codec and/or a host interface 110 compression-codes an externally applied AV signal according to a predetermined compression scheme and supplies size information for the compressed data. A digital signal processor (DSP) 120 receives the compressed A/V data supplied from the AV codec and/or the host interface 110, adds additional data for error correction code (ECC) processing thereto, and performs modulation using a predetermined modulation scheme. A radio frequency amplifier (RF AMP) 130 converts the modulated data from the DSP into a radio frequency (RF) signal. Then, a pickup 140 records the RF

signal supplied from the RF AMP 130 on a disk mounted on a turn table of the pickup 140. A servo unit 150 receives information necessary for servo control from a system controller 160 and stably performs a servo function for the mounted disk.

During playback of information data stored on the disk, the pickup 140 picks up the optical signal from the disk having the information data stored therein, and the information data is extracted from the optical signal. The RF AMP 130 converts the optical signal into an RF signal, and extracts the servo signal for performing a servo function, and modulated data. The DSP 120 demodulates the modulated data supplied from the RF AMP 130 corresponding to the modulation scheme used during modulation, performs an ECC process to correct errors, and eliminates added data. The servo unit 150 receives information necessary for servo control from the RF AMP 130 and the system controller 160, and stably performs the servo function. The AV codec and/or the host interface 110 decodes the compressed A/V data supplied from the DSP 120 to output an A/V signal. The system controller 160 controls the overall system for reproducing and recording the information data from and on the disk mounted on the turn table of the pickup 140.

The DSP 120 and the system controller 160 handle processing the data during recording and reproduction, including performing linking schemes in connection with recording and reproducing as well as performing linking schemes when processing defective areas on the media during recording and reproducing. That is, while recording the user data after certification, the system controller 160 recognizes one of defective area registered in list of defected areas and controls recording the user data processed by DSP 120 immediately after the linking area (specified by a predetermined linking scheme) following the one defective area.

Although a few preferred embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. A method of processing defective areas in a recording medium having a plurality of continuous basic recording units and defective areas, comprising:

(a) detecting the defective areas that occur during certification before recording user data and the defective areas that occur while recording the user data; and

(b) registering a list of the defective areas in a defect management area of the recording medium, and storing in a predetermined area of the recording medium additional information indicating whether a predetermined linking scheme is applied to a linking area immediately after one of the defective areas.

2. The method of claim 1, further comprising:

(c) checking the additional information, if the one defective area registered in the defect management area is found when recording user data in one of the basic recording units; and

(d) recording the user data in an area immediately after the linking area according to the predetermined linking scheme, if the additional information indicates that the linking scheme is applied to the linking area immediately after the one defective area.

3. The method of claim 1, wherein the process (b) comprises storing a first type information and a second type information as the additional information, wherein the first type information indicates whether linking for incremental recording which occurs in the incremental recording mode and a restricted overwrite recording mode occurs, and the second type information indicates whether linking which occurs immediately after the one defective area occurs.

4. The method of claim 1, wherein the process (b) comprises recording the additional information in one of the basic recording units.

5. The method of claim 1, wherein the process (b) comprises storing the additional information in a data identification area of a sector of the recording medium in which the one defective area is located.

6. The method claim 1, further comprising:

(c) recording linking data in advance in the linking area allocated immediately after the one defective area detected during the certification before recording the user data.

7. The method of claim 6, wherein the process (b) comprises storing in a data identification area linking type information which indicates linking which occurs immediately after the one defective area, and data type information which indicates that the linking data is recorded in the linking area.

8. The method of claim 6, further comprising:

(d) recording padding data in advance in the one basic recording unit immediately before the one defective area during the certification.

9. The method of claim 1, wherein the recording medium is a digital versatile disc-rewritable (DVD-RW) disk and the defect management area is a recording management data (RMD) area of the recording medium.

10. The method of claim 2, wherein the process (d) comprises maintaining power of a beam emitted from an optical power source at a write power during recording and when the one defective area is found lowering the power to an extent that the lowered power does not affect recording.

11. The method of claim 2, wherein the process (d) comprises allocating 2 kilobytes to the linking area.

12. The method of claim 2, wherein the process (d) comprises allocating 32 kilobytes to the linking area.

13. The method of claim 2, further comprising applying the linking scheme specified immediately after the one defective area to all three modes of a write-at-once recording mode, a restricted overwrite recording mode, and an incremental recording mode.

14. A method of processing a defective area before recording user data or while recording the user data in a recording medium having a plurality of continuous basic recording units, comprising:

(a) recording the user data after specifying a predetermined linking scheme in a linking area immediately after the defective area if the defective area is found while recording the user data in one of the basic recording units.

15. The method of claim 14, wherein the process (a) comprises maintaining power of a beam emitted from an optical power source at a write power during recording and when the defective area is found lowering the power down to an extent that the lowered power does not affect recording.

16. The method of claim 14, wherein the process (a) comprises allocating 2 kilobytes to the linking area.

17. The method of claim 14, wherein the process (a) comprises allocating 32 kilobytes to the linking area.

18. The method of claim 14, further comprising:

(b) allocating the linking area immediately after the defective area during certification before recording the user data; and

(c) recording linking data in advance in the linking area during the certification.

19. The method of claim 14, further comprising:

(d) recording in a data identification area linking type information which indicates linking which occurs immediately after the defective area and data type information which indicates linking data is recorded in the linking area.

20. The method of claim 18, further comprising:

(d) recording padding data in advance in the one basic recording unit immediately before the defective area during certification.

21. The method of claim 14, further comprising applying the linking scheme specified immediately after the defective area to all three modes of a write-at-once recording mode, a restricted overwrite recording mode, and an incremental recording mode in a digital versatile disc-rewritable (DVD-RW) disk.

22. A method of processing a defective area in a recording medium having continuously positioned basic recording units, comprising:

(a) allocating a predetermined number of error correction code (ECC) blocks immediately after detecting the defective area during certification; and

(b) registering in a defect management area of the recording medium a list of the defective area and information on the predetermined number of ECC blocks immediately after the defective area.

23. The method of claim 22, wherein the process (a) comprises determining the predetermined number of ECC blocks immediately after the defective area according to a predetermined rule.

24. The method of claim 22, further comprising:

(c) recording a predetermined test signal or wobble signal as reference signal in the predetermined number of ECC blocks immediately after the defective area.

25. The method of claim 24, further comprising:

(d) recording after the certification user data immediately after the predetermined number of ECC blocks following the defective area if the reference signal is detected in the predetermined number of ECC blocks following the detected the defective area.

26. A method of processing defective areas in a recording medium, comprising:

(a) detecting the defective areas that occur during certification before recording user data

(b) registering a list of the defective areas in a defect management area of the recording medium, and applying a predetermined linking scheme to a linking area immediately after one of the defective areas

27. The method of claim 26, wherein the recording medium is a digital versatile disc-rewritable (DVD-RW) disk and the defect management area is a recording management data (RMD) area of the recording medium

28. The method of claim 26, wherein the process (a) comprises allocating 2 kilobytes to the linking area.

29. The method of claim 26, wherein the process (a) comprises allocating 32 kilobytes to the linking area.