

METHOD OF AND APPARATUS FOR MANAGING DISC DEFECTS IN DISC, AND DISC ON WHICH DEFECTS ARE MANAGED

Technical Field

5 The present invention relates to disc defect management, and more particularly, to a method of and apparatus for managing disc defects using a temporal defect management area (TDMA), and a disc in which defect management is performed using the method and apparatus.

10

Background Art

Defect management is a process of rewriting data stored in a user data area of a disc in which a defect occurs. The data is rewritten to a new portion of the disc's data area, thereby compensating for the data
15 loss otherwise caused by the defect. In general, defect management is performed using a linear replacement method or a slipping replacement method. In the linear replacement method, the user data area in which the defect exists is replaced with a spare data area having no defects. In slipping replacement method, the user data area with the defect is
20 slipped, and the next user data area having no defects is used.

Both the linear replacement and slipping replacement methods are applicable only to discs, such as a DVD-RAM/RW, on which data can be repeatedly recorded and recording can be performed using a random access method. In other words, the linear replacement and slipping
25 replacement methods are difficult to apply to write-once discs on which recording is allowed only once.

In general, the presence of defects in a disc is detected by recording data on the disc, and then confirming whether the data has been recorded correctly on the disc. However, once the data is

recorded on a write-once disc, it is impossible to overwrite the new data and manage the defects therein.

After the development of CD-R and DVD-R, a high-density write-once disc with a recording capacity of several dozen GBs was introduced. This type of disc can be used as a backup disc since it is inexpensive and allows random access that enables fast reading operations. However, since defect management is not available for write-once discs, a backup operation is discontinued when a defective area (i.e., an area where a defect exists) is detected during the backup operation. In general, since a backup operation is performed when a system is not frequently used, such as at night when a system manager does not operate the system, it is more likely that a discontinued backup operation is maintained discontinued for the night when it is stopped because a defective area of a write-once disc is detected such that the backup operation is not completely performed.

Disclosure of the Invention

The present invention provides a defect management method and apparatus that can be applied to discs, and a disc having the defects managed using the defect management method.

The present invention also provides a defect management method and apparatus that can manage disc defects even when a defect is detected during a recording operation, enabling the recording operation without interruption, and a disc having the method.

Additional aspects and/or 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.

According to an aspect of the present invention, a disc includes a data area in which user data is recorded, and a temporary defect

management area that is present in at least one of a lead-in area and a lead-out area and in which are recorded temporary defect information and temporary defect management information regarding the user data recorded in the data area.

- 5 It is preferable, but not required, that the temporary defect information and temporary defect management information are recorded for every recording operation in which user data is recorded in the data area.

10 Also, it is preferable, but not required, that the temporary defect information contains information indicating a position of a defective area of the data area in which corresponding user data is recorded, or contains information indicating a position of a replacement area that is a substitute for the defective area.

15 According to another aspect of the present invention, a method of managing disc defects in a disc includes recording defect information regarding data, which is recorded in a data area of the disc according to a recording operation, as temporary defect information in a temporary defect management area that is present in at least one of a lead-in area and a lead-out area of the disc; and recording management information
20 for managing the temporary defect information as temporary defect management information in the temporary defect management area.

25 It is preferable, but not required, that the method further includes repeating the recording the defect information and the recording the management information for every recording operation; and recording a last recorded temporary defect management information and temporary defect information in a defect management area that is present in at least one of the lead-in area and the lead-out area.

The recording the last recorded temporary defect information is performed during finalization of the disc according to an aspect of the invention.

It is preferable, but not required, that the recording the defect
5 information further includes recording information indicating a position of
a defective area of the data area containing corresponding user data, as
the temporary defect information; recording information indicating the
position of a replacement area, which is a substitute for the defective
area, as the temporary defect information; or sequentially recording the
10 temporary defect information in a temporary defect information area
included in the temporary defect management area, starting from a start
of the temporary defect information area.

It is preferable, but not required, that the recording management
information comprises sequentially recording the defect information in a
15 temporary defect management information area included in the
temporary defect management area, starting from an end of the
temporary defect management information area.

According to yet another aspect of the present invention, a
recording and/or reproducing apparatus for use with a disc includes a
20 recording/reading unit that records data on or reads data from the disc;
and a controller that controls the recording/reading unit to record defect
information regarding the data, which is recorded in a data area of the
disc according to a recording operation, as temporary defect information
in a temporary defect management area that is present in at least one of
25 a lead-in area and a lead-out area of the disc, and to record
management information for managing the temporary defect information
as temporary defect management information in the temporary defect
management area.

It is preferable, but not required, that the controller controls the recording/reading unit to record the temporary defect information and the temporary defect management information in the temporary defect management area for every recording operation, and, during finalization of the disc, to record a last recorded temporary defect information and a last recorded temporary defect management information in a defect management area which is present in at least one of the lead-in area and the lead-out area of the disc.

According to still another aspect of the present invention, a recording apparatus for use with a disc includes a recording/reading unit that records data on or reads data from the disc; and a controller that controls the recording/reading unit to record defect information regarding first data, which is recorded in a data area of the disc according to a first recording operation, as first temporary defect information in a temporary defect management area that is present in at least one of a lead-in area and a lead-out area of the disc, to record first defect management information for managing the first temporary defect information as first temporary defect management information in the temporary defect management area, to record second defect information regarding second data, which is recorded in the data area according to a second recording operation, as second temporary defect information in the temporary defect management area, and to record defect management information for managing the second temporary defect information as second temporary defect management information in the temporary defect management area.

Brief Description of the Drawings

FIG. 1 is a block diagram of a recording and/or reproducing apparatus according to an embodiment of the present invention.

FIGs. 2A and 2B illustrate structures of a disc according to embodiments of the present invention.

FIG. 3 illustrates data structures of the discs of FIGs. 2A and 2B according to an embodiment of the present invention.

5 FIGs. 4A through 4D illustrate data structures of a defect management area according to embodiments of the present invention.

FIG. 5 illustrates recording of data in a user data area and a spare area, according to an embodiment of the present invention.

10 FIGs. 6A, 6B and 7 illustrate data structures of temporary defect information TDFL #0 and TDFL #1 according to embodiments of the present invention.

FIG. 8 is a flowchart illustrating a defect management method according to an embodiment of the present invention.

15 FIG. 9 is a flowchart illustrating a defect management method according to another embodiment of the present invention.

Best mode for carrying out the Invention

Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the
20 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. 1 is a block diagram of a recording and/or reproducing apparatus according to an embodiment of the present invention.
25 Referring to FIG. 1, the recording and/or reproducing apparatus includes a recording/reading unit 1, a controller 2, and a memory 3. The recording/reading unit 1 records data on a disc 100, which is an information storage medium according to a first embodiment of the present invention, and reads back the data from the disc 100 to verify the
30 accuracy of the recorded data. The controller 2 performs defect management according to an embodiment of the present invention. In

the shown embodiment, the controller 2 uses a verify-after-write method in which data is recorded on the disc 100 in predetermined data units and the accuracy of the recorded data is verified to detect a defect in the recorded data. In other words, the controller 2 records user data on the disc 100 in units of recording operations, and verifies the recorded user data to detect an area (i.e., a defective area) of the disc 100 in which a defect exists. After the recording the data in the predetermined units, the controller 2 creates information that indicates a position of the defective area of the disc 100 as temporary defect information and stores the created temporary defect information in the memory 3. If the amount of the stored information reaches a predetermined level, the controller 2 records the stored information as defect information on the disc 100.

Here, the recording operation is a unit of work determined according to a user's intention or is a recording work to be performed. According to this embodiment, a recording operation indicates a process in which the disc 100 is loaded into the recording and/or reproducing apparatus, data is recorded on the disc 100, and the disc 100 is taken out from the recording and/or reproducing apparatus. During the recording operation, data is recorded and verified at least once. In general, data is recorded and verified several times. Defect information, which is obtained using the verify-after-write method, is temporarily stored in the memory 3.

When a user presses the eject button (not shown) of the recording and/or reproducing apparatus in order to remove the disc 100 after recording data, the controller 2 expects the recording operation to be terminated. Next, the controller 2 reads the information stored in the memory 3, provides the read data to the recording/reading unit 1, and controls the recording/reading unit 1 to record the read data on the disc 100.

If the recording of data on the disc 100 is completed (i.e., no more data will be recorded on the disc 100 and the disc 100 is to be finalized), the controller 2 records the temporary defect information and the temporary defect management information in a defect management area
5 of the disc 100.

During reproduction, the recording and/or reproducing apparatus utilizes the defect information and the defect management information in the defect management area and/or the temporary defect management area in order to access the recorded user data. While described in
10 terms of a recording and/or reproducing apparatus as shown in FIG. 1, it is understood that the apparatus can be an individual recording or reproducing apparatus or a recording and reproducing apparatus.

FIGs. 2A and 2B illustrates structures of the disc 100 of FIG. 1 according to embodiments of the present invention. FIG. 2A illustrates
15 in detail a single record layer disc representation of disc 100 having a record layer L0. The disc 100 includes a lead-in area, a data area, and a lead-out area. The lead-in area is located in an inner part of the disc 100, and the lead-out area is located in an outer part of the disc 100. The data area is present between the lead-in area and the lead-out area,
20 and is divided into a user data area and a spare area.

The user data area is an area of the data area where user data is recorded. The spare area is an area of the data area other than the user data area which is the replacement area for a portion of the user data area having a defect. The spare area serves to compensate for a
25 loss in the recording area due to a defect in the user data area. On the assumption that defects may occur within the disc 100, it is preferable, but not required, that the spare area assumes 5% of the entire data capacity of the disc 100, so that a greater amount of data can be recorded on the disc 100.

FIG. 2B illustrates a double record layer disc representation of disc 100 having two record layers L0 and L1. A lead-in area, a data area, and an outer area are sequentially formed from the inner part of the first record layer L0 to the outer part of the first layer L0. Also, an outer area, a data area, and a lead-out area are sequentially formed from the outer part of the second record layer L1 to the second record layer L1 inner part. Unlike the single record layer disc 100 of FIG. 2A, the lead-out area is present in the inner part of the disc 100 of FIG. 2B. That is, the disc 100 of FIG. 2B has an opposite track path (OTP) in which data is recorded starting from the lead-in area of the first record layer L0 and continuing toward the outer area of the first record layer L0, and continuing from the outer area of the second record layer L1 to the lead-out area of the second record layer L1. The spare area is allotted to each of the record layers L0 and L1.

In the embodiments of FIGs. 2A and 2B, the spare areas are present between the user data area and the lead-out area and between the user data area and the outer area. If necessary, a portion of the user data area may be used as another spare area. Specifically, more than one spare area may be present between the lead-in area and the lead-out area.

FIG. 3 illustrates details of the structures of the disc 100 according to an embodiment of the present invention. Referring to FIG. 3, a temporary defect management area is present in at least one of the lead-in area, the lead-out area, and the outer area of the disc 100. Also, a temporary defect management area is present at least one of the lead-in area and the lead-out area.

In general, information that relates to managing defects in the disc 100 is recorded in a defect management area. Such information includes the structure of the disc 100 for defect management, a position of defect information, whether defect management is performed, and a

position and a size of the spare area. In the case of a write-once disc, new data is generally recorded after previously recorded data when the previously recorded data changes according to an aspect of the invention.

5 In general, when a disc is loaded into a recording/reproducing apparatus such as that shown in FIG. 1, the apparatus reads data from the lead-in area and the lead-out area of the disc 100 to determine how to manage the disc 100 and record data on or read data from the disc 100. However, if the amount of data recorded in the lead-in area
10 increases, a longer time is spent preparing the recording or reproducing of data after the loading of the disc. Accordingly, the present invention proposes temporary defect management information and temporary defect information. The temporary defect management information and the temporary defect information are recorded in a temporary defect
15 management area that is formed in the lead-in area and/or the lead-out area.

According to an embodiment of the present invention, the defect management is performed using the linear replacement method. Thus, the temporary defect information includes information indicating the
20 position of a defective area of the disc 100, and information indicating a portion of the disc 100 that can be a replacement area for the defective area. The temporary defect management information is used to manage the temporary defect information and includes information indicating the point of the disc 100 where the temporary defect
25 information is recorded.

According to an embodiment of the present invention, the temporary defect information and the temporary defect management information are recorded every time a recording operation ends. The temporary defect management area includes temporary defect
30 information #0 and temporary defect information #1. The temporary

defect information #0 includes information regarding a defect occurring in data recorded during recording operation #0 and information regarding a replacement area. The temporary defect information #1 includes information regarding a defect occurring in data recorded during
5 recording operation #1 and information regarding a replacement area as temporary defect information #1. Further, the temporary defect management area includes temporary defect management information #0, #1. The temporary defect management information #0, #1 includes corresponding information for managing the temporary defect
10 information #0, #1.

If no more data can or is to be recorded on the disc 100 or if a user does not want to record more data on the disc 100 (i.e., the disc 100 needs to be finalized), the temporary defect information recorded in the temporary defect information area and the temporary defect
15 management information recorded in the temporary defect management information area are recorded in the defect management area.

A reason for recording the temporary defect management information and the temporary defect information in the defect management area (DMA) again will now be explained. When no more
20 data will be recorded on the disc 100 (i.e., the disc 100 needs to be finalized), the temporary defect management information and the temporary defect information, which are updated several times, are moved to the defect management area of the lead-in area, thereby enabling fast reading of the information recorded in the disc 100. Also,
25 it is possible to increase the reliability of information by recording the defect management information in a plurality of areas.

In an embodiment of the invention, the defect information recorded in the temporary defect information areas #0 through #i-1 is accumulatively recorded in a temporary defect information area #i.
30 Therefore, it is sufficient to read the defect information from the last

recorded temporary defect information #i and again record the read information in the DMA during the finalization of the disc 100.

For a high-density disc with a recording capacity of several dozen GBs, it is generally desirable that a cluster is allocated to an area in which temporary defect management information #i is recorded, and four to eight clusters are allocated to an area in which temporary defect information #i is recorded. This is because it is generally preferable to record new information in units of clusters to update information when a minimum physical unit of record is a cluster, although the amount of the temporary defect information #i is just several KBs. A total amount of defects allowed in a disc 100 is preferably about 5 percent of the disc recording capacity. For instance, about four to eight clusters are required to record temporary defect information #i, considering that information regarding a defect is about 8 bytes long and the size of a cluster is 64 KB long.

A verify-after-write method can be performed on temporary defect information #i and temporary defect management information #i according to an aspect of the invention. When a defect is detected, information recorded in the defective area of the disc 100 containing the defect may be either recorded in a spare area using the linear replacement method, or recorded in an area adjacent to the defective area using the slipping replacement method.

FIGs. 4A through 4D illustrate data structures of a temporary defect management area (TDMA) according to embodiments of the present invention. Referring to FIG. 4A, a temporary defect management area is logically divided into two parts: a temporary defect information area, and a temporary defect management information area. Temporary defect information TDFL #0, TDFL #1, TDFL #2 are sequentially recorded in the temporary defect information area, starting from a start of the temporary defect information area toward the end

thereof. Temporary defect management information TDDS #0, TDDS #1, TDDS #2 are sequentially recorded starting from a start of the temporary defect management information area toward the end thereof. The temporary defect management information TDDS #0, TDDS #1, and
5 TDDS #2 correspond to temporary defect information TDFL #0, TDFL #1, TDFL #2, respectively.

Referring to FIG. 4B, a temporary defect management area is logically divided into two parts: a temporary defect information area and a temporary defect management information area, as shown in FIG. 4A.
10 However, the sequence of recording information in the temporary defect information area and the temporary defect management information area is not the same as the sequence of recording information in those of FIG. 4A. In detail, temporary defect information TDFL #0, TDFL #1, TDFL #2 are sequentially recorded starting from an end of the temporary defect
15 information area toward the start thereof. The temporary defect management information TDDS #0, TDDS #1, TDDS #2 are sequentially recorded starting from an end of the temporary defect management information area toward the start thereof. The temporary defect management information TDDS #0, TDDS #1, and TDDS #2 correspond
20 to temporary defect information TDFL #0, TDFL #1, and TDFL #2, respectively.

Referring to FIG. 4C, corresponding temporary defect information and temporary defect management information are a pair of information in a corresponding temporary management information recorded in the
25 temporary defect management area (TDMA). That is, temporary management information TDMA #0, TDMA #1, TDMA #2 are sequentially recorded starting from the start of the temporary defect management area toward an ending point thereof. The temporary management information TDMA #0 contains a corresponding pair of the temporary
30 defect management information TDDS #0 and the temporary defect

information TDFL #0. The temporary management information TDMA #1 contains a corresponding pair of the temporary defect management information TDDS #1 and the temporary defect information TDFL #1. The temporary management information TDMA #2 contains a
5 corresponding pair of the temporary defect management information TDDS #2 and the temporary defect information TDFL #2.

Referring to FIG. 4D, compared to the temporary defect management area of FIG. 4C, corresponding temporary defect information and temporary defect management information are a pair of
10 information in a corresponding temporary management information recorded in a temporary defect management area, but the sequence of recording the information is not the same. That is, temporary management information TDMA #0, TDMA #1, TDMA #2 are sequentially recorded starting from the end of the temporary defect management
15 area toward the start thereof. The temporary management information TDMA #0, TDMA #1, and TDMA #2 contain a pair of the corresponding temporary defect management information TDDS #0 and temporary defect information TDFL #0, a pair of the corresponding temporary defect management information TDDS #1 and temporary defect information
20 TDFL #1, and a pair of the corresponding temporary defect management information TDDS #2 and temporary defect information TDFL #2, respectively.

FIG. 5 illustrates recording of data in a user data area A and a spare area B according to an embodiment of the present invention. Data
25 can be processed in units of sectors or clusters. A sector denotes a minimum unit of data that can be managed in a file system of a computer or in an application. A cluster denotes a minimum unit of data that can be physically recorded on a disc at once. In general, one or more sectors constitute a cluster.

There are two types of sectors: a physical sector and a logical sector. The physical sector is an area on a disc where a sector of data is to be recorded. An address for detecting the physical sector is called a physical sector number (PSN). The logical sector is a unit in which data
5 can be managed in a file system or an application. An address for detecting the logical sector is called a logical sector number (LSN). A disc recording/reproducing apparatus such as that shown in FIG. 1 detects the recording position of data using a PSN, and when recording data on the disc 100, the entire data is managed in units of LSNs in a
10 computer or an application and the position of data is detected using the LSN. The relationship between an LSN and a PSN is changed by a controller 2 of the recording/reproducing apparatus, based on whether the disc 100 contains a defect and an initial position of recording data.

Referring to FIG. 5, A denotes a user data area and B denotes a
15 spare area in which PSNs are allocated to a plurality of sectors (not shown) in ascending order. In general, each LSN corresponds to at least one PSN. However, since LSNs are allocated to non-defective sectors in ascending order, the correspondence between the PSNs and the LSNs is not maintained when the disc 100 has a defective area, even
20 if the size of a physical sector is the same as that of a logical sector.

In the data area A, sections 1001 through 1007 denote predetermined units of data in which the verify-after-write method is performed. A recording apparatus records user data in section 1001, returns to the start of section 1001, and checks if the user data is
25 appropriately recorded or a defect exists in section 1001. If a defect is detected in a portion of section 1001, the portion is designated as defect #1. The user data recorded in defect #1 is also recorded on a portion of the spare area B. Here, the portion of the spare area B in which data recorded in defect #1 is rewritten is called replacement #1.

Next, the recording apparatus records user data in section 1002, returns to the start of section 1002, and checks whether the data is properly recorded or a defect exists in section 1002. If a defect is detected in a portion of section 1002, the portion is designated as defect
5 #2. Likewise, replacement #2 corresponding to defect #2 is formed in the spare area B. Further, defect #3 and replacement #3 are designated in section 1003 of the user data area A and the spare area B, respectively. In section 1004, a defect does not occur and a defective area is not designated.

10 The recording apparatus records information regarding defect #1, #2, and #3 occurring in sections 1001 through 1003 as temporary defect information TDFL #0 in the temporary defect management area when recording operation #0 is expected to end, after the recording and verifying of data to section 1004, i.e., when a user presses the eject
15 button of a recording apparatus or recording of user data allocated in a recording operation is complete. Also, defect management information for managing the temporary defect information TDFL #0 is recorded as temporary defect management information TDDS #0 in the temporary defect management area.

20 When recording operation #1 starts, data is recorded in sections 1005 through 1007 and defects #4 and #5 and replacements #4 and #5 are formed in the user data area A and the spare area B in the temporary defect management area, respectively, as explained with respect to sections 1001 through 1004. If the second recording operation is
25 expected to end, the recording apparatus records information regarding defects #4 and #5 as temporary defect information TDFL #1, and records the information contained in the temporary defect information TDFL #0 once again. Thereafter, defect management information for managing the temporary defect information TDFL #1 is recorded in the temporary
30 defect management area.

FIGs. 6A and 6B illustrate data structures of temporary defect information TDFL #0 and TDFL #1 according to an embodiment of the present invention. FIG. 7 illustrates a data structure of information regarding defect #i.

5 Referring to FIGs. 6A and 6B, the temporary defect information TDFL #0 contains information regarding defects #1 through #3. In detail, the information regarding defect #1 indicates the position of an area in which defect #1 exists and the position of an area in which replacement #1 is recorded. The information regarding defect #2 indicates the
10 position of an area in which defect #2 exists and the position of an area in which replacement #2 is recorded. The information regarding defect #3 indicates the position of an area in which defect #3 exists and the position of an area in which replacement #3 is recorded.

The temporary defect information TDFL #1 further contains
15 information regarding defects #4 and #5 in addition to the information contained in the temporary defect information TDFL #0. That is, the temporary defect information TDFL #1 includes the information regarding defect #1, the information regarding defect #2, the information regarding defect #3, the information regarding defect #4, and the information
20 regarding defect #5.

Referring to FIG. 7, the information regarding defect #i describes a pointer pointing to defect #i and a pointer pointing to replacement #i. In detail, the pointer for defect #i specifies the starting and ending points of the defect #i, and the pointer for replacement #i specifies the starting and
25 ending points of the replacement #i.

Hereinafter, a defect management method according to an embodiment of the present invention will be described with reference to FIG. 8. Referring to FIG. 8, in action 801, a recording apparatus records defect information regarding data recorded according to a first recording

operation as first temporary defect information in a temporary defect management area of a disc. This process serves to manage disc defects. In action 802, management information for managing the first temporary defect information is recorded as first temporary defect
5 management information in the temporary defect management area.

In action 803, it is checked whether the disc needs to be finalized. In action 804, if it is determined in action 803 that the disc does not need to be finalized, actions 801 and 802 are repeated while increasing indexes given to the recording operation, temporary defect information,
10 and temporary defect management information by 1. However, it is understood that other numbers can be used for the index to the extent that the numbers serve to distinguish sets of recorded data.

In action 805, if it is determined in action 803 that the disc needs to be finalized, a last recorded temporary defect management
15 information and a last recorded temporary defect information are recorded in a defect management area. That is, the last recorded temporary defect management information and the last recorded temporary defect information are recorded as the final temporary defect management information and temporary defect information in the defect
20 management area (DMA). The final temporary defect management information and temporary defect information may be repeatedly recorded so as to increase the reliability of data detection according to an aspect of the invention.

Also, the verify-after-write method may be performed on the final
25 temporary defect management information and the final temporary defect information according to an aspect of the invention. If a defect is detected from final temporary defect management information and the final temporary defect information, an area of the disc in which the defect occurs and data recorded after the area having the defect may be
30 regarded as being unavailable (i.e., the areas of the final temporary

defect management information and the final temporary defect information are designated as a defective area) and the final temporary defect management information and the final temporary defect information may be again recorded after the defective area.

5 FIG. 9 is a flowchart illustrating a disc defect management method according to another embodiment of the present invention. Referring to FIG. 9, a recording apparatus records user data in a data area in units of data to facilitate the verify-after-write method (in action 901). In action 902, the user data recorded in action 901 is verified to detect the
10 existence of defects in any area of the disc 100. In action 903, the controller 2 of FIG. 1 designates the area having the defect as a defective area, rewrites the user data recorded in the defective area in a spare area to create a replacement area, and creates pointer information pointing to the defective area and the replacement area, respectively. In
15 action 904, the pointer information is stored as first temporary defect information in the memory 3 of FIG. 1. In action 905, it is checked whether the recording operation is expected to end. If it is determined in action 905 that the recording operation is not likely to end, actions 901 through 904 are repeated.

20 However, in action 906, if it is determined in step 905 that the recording operation is likely to end (i.e., when the recording of the user data is complete by user input or according to the recording operation), the controller 2 reads temporary defect information #0 from the memory 3 and records the temporary defect information #0 as temporary defect
25 information TDFL #0 in a temporary defect management area. In action 907, management information for managing temporary defect information TDFL #0 is recorded as temporary defect management information TDDS #0 in the temporary defect management area.

 In action 908, it is checked whether the disc 100 needs to be
30 finalized. If it is determined in action 908 that the finalizing of the disc

100 is not needed, actions 901 through 907 are repeated while indexes given to the recording operation, temporary defect information, and temporary defect management information are increased by 1. However, it is understood that other numbers can be used for the index
5 to the extent that the numbers serve to distinguish sets of recorded data.

In action 910, if it is determined in action 908 that finalization of the disc 100 is needed, a last recorded temporary defect information TDFL #i and a last recorded temporary defect management information TDDS #i are recorded as defect information DFL and defect
10 management information DDS in a defect management area (DMA). The defect information DFL and defect management information DDS may be repeatedly recorded several times to increase the reliability of data detection according to an aspect of the invention.

Further, the verify-after-write method may be performed on the
15 defect information DFL and defect management information DDS according to an aspect of the invention. If a defect is detected from those DFL and DDS, an area having the defect and data recorded after the area having the defect may be regarded as being unavailable (, i.e., the area including the DFL and DDS is designated as a defective area),
20 and the defect management information and defect information may be again recorded after the defective area.

The aforementioned defect management method may be embodied as a computer program that can be run by a computer. Codes and code segments, which constitute the computer program, can
25 be easily reasoned by a computer programmer in the art. The program is stored in a computer readable medium. When the program is read and run by a computer, the defect management method according to the present invention is performed by the computer. Here, the computer-readable medium may be a magnetic recording medium, an

optical recording medium, a carrier wave medium firmware or other recordable medium.

While not required in all aspects, it is understood that the controller 2 can be computer implementing the method using the computer program encoded on a computer readable medium. The
5 computer can be implemented as a chip having firmware, or can be a general or special purpose computer programmable to perform the method.

In addition, it is understood that, in order to achieve a recording
10 capacity of several dozen gigabytes, the recording and/or reproducing unit 1 could include a low wavelength, high numerical aperture type unit usable to record dozens of gigabytes of data on the disc 100. Examples of such units include, but are not limited to, those units using light wavelengths of 405 nm and having numerical apertures of 0.85, those
15 units compatible with Blu-ray discs, and/or those units compatible with Advanced Optical Discs (AOD).

Industrial Applicability

As described above, the present invention provides disc defect
20 management that is applicable to discs. According to an aspect of the present invention, a temporary defect information area is present in a lead-in area and/or a lead-out area, so that defect information can be accumulatively recorded. Also, during finalization of a disc, only last recorded temporary defect information is read from a temporary defect
25 management area and is recorded in a defect management area, thereby enabling efficient use of the defect management area. Accordingly, it is possible to record user data on even a write-once disc while performing defect management, thereby more stably backup operations can be performed without interruptions.

While described in terms of a write-once disc, it is understood that the method can be used with rewritable media or where the medium has write-once and rewritable portions.

Although a few embodiments of the present invention have been
5 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.

What is claimed is:

1. A disc usable with respect to a recording and/or reproducing apparatus, the disc comprising:
 - a data area in which user data is recorded; and
 - 5 at least one of a lead-in area and a lead-out area adjacent the data area and which comprises a temporary defect management area which comprises temporary defect information and temporary defect management information regarding the user data recorded in the data area and which is accessible by the recording and/or reproducing
 - 10 apparatus to perform defect management on the disc.
2. The disc of claim 1, wherein:
 - the data area further comprises additional user data recorded in the data area in an additional recording operation other than a recording
 - 15 operation during which the user data was recorded in the data area, and
 - the temporary defect management area further comprises additional temporary defect information and additional temporary defect management information recorded in the temporary defect management area and corresponding to the additional user data recorded in the
 - 20 additional recording operation.
3. The disc of claim 1, wherein the temporary defect information comprises information indicating a position of a defective area of the data area in which a corresponding unit of user data is
- 25 recorded.
4. The disc of claim 3, further comprising a replacement area in which is recorded the unit of the user data so as to be a substitute area for the defect area, wherein the temporary defect information
- 30 contains information indicating a position of the replacement area.

5. The disc of claim 1, wherein the temporary defect management area comprises a temporary defect information area, and the temporary defect information is recorded in the temporary defect information area.

5

6. The disc of claim 1, wherein the temporary defect management area comprises a temporary defect management information area, and the temporary defect management information is recorded in the temporary defect management information area.

10

7. The disc of claim 1, wherein the corresponding temporary defect information and temporary defect management information are recorded as a pair of information in the temporary defect management area.

15

8. The disc of claim 1, further comprising a defect management area that is present in at least one of the lead-in area and the lead-out area,

wherein, during finalization of the disc, a last temporary defect information and a last temporary defect management information, which are last recorded in the temporary defect management area, are recorded as final defect information and defect management information in the defect management area.

25

9. A method of managing disc defects in a disc, the disc comprising a data area and a temporary defect management area in one of a lead-in and a lead-out area, the method comprising:

recording temporary defect information in the temporary defect management area, the temporary defect information comprising defect information regarding data recorded in the data area according to a recording operation; and

30

recording temporary defect management information in the temporary defect management area, the temporary defect management information comprising management information for managing the temporary defect information.

5

10. The method of claim 9, further comprising:

repeating the recording the temporary defect information and the recording the temporary defect management information for each unit of the data recorded during a plurality of recording operations; and

10

recording a last recorded temporary defect management information and a last temporary defect information in a defect management area that is present in at least one of the lead-in area and the lead-out area.

15

11. The method of claim 9, wherein the recording the last recorded temporary defect management information is performed during finalization of the disc.

20

12. The method of claim 9, wherein the recording the temporary defect information comprises recording in the temporary defect information defect position information indicating a position of a defective area of the data area.

25

13. The method of claim 11, wherein the recording the temporary defect information further comprises recording in the temporary defect information replacement position information indicating a position of a replacement area that includes a portion of the data also recorded in the defective area so as to be a substitute for the defective area.

30

14. The method of claim 9, wherein:

the temporary defect information comprises multiple units of temporary defect information,

the temporary defect management area further comprises a temporary defect information area, and

5 the recording the temporary defect information further comprises sequentially recording the units of the temporary defect information in the temporary defect information area starting from a start of the temporary defect information area.

10 15. The method of claim 9, wherein:

the temporary defect management information comprises multiple units of temporary defect management information,

the temporary defect management area further comprises a temporary defect management information area, and

15 the recording the temporary defect management information comprises sequentially recording the units of the temporary defect management information in the temporary defect management information area, starting from an end of the temporary defect management information area.

20

16. The method of claim 9, wherein:

the temporary defect information comprises multiple units of temporary defect information,

25 the temporary defect management area further comprises a temporary defect information area and a temporary defect management information area,

the temporary defect management information comprises multiple units of temporary defect management information, and

30 the recording the temporary defect information and the recording the temporary defect management information comprise sequentially recording corresponding units of the temporary defect information and

temporary defect management information as a pair of information in corresponding units of temporary management information, starting from a start of the temporary defect management area.

5 17. The method of claim 9, wherein:
 the temporary defect information comprises multiple units of
 temporary defect information,
 the temporary defect management area further comprises a
 temporary defect information area and a temporary defect management
10 information area,
 the temporary defect management information comprises multiple
 units of temporary defect management information, and
 the recording the temporary defect information and the recording
 the temporary defect management information comprise sequentially
15 recording corresponding temporary defect information and temporary
 defect management information as a pair of information, starting from an
 end of the temporary defect management area.

 18. The method of claim 9, wherein the recording the
20 temporary defect information further comprises:
 recording the data in predetermined units of the data;
 verifying the recorded data to detect a defective area of the disc in
 which a defect exists;
 if a defective area is detected, storing first temporary defect
25 information in a memory, the first temporary defect information
 comprising information pointing to a position of the defective area and
 information pointing to a replacement area that contains a unit of data
 recorded in the defective area so as to be a substitute area for the
 defective area;
30 repeating the recording the data through the storing in the memory
 at least once; and

reading at least the first temporary defect information stored in the memory and recording the read information as the first temporary defect information in the temporary defect management area.

- 5 19. A recording and/or reproducing apparatus for use with a disc having a data area and a temporary defect management area in at least one of a lead in and a lead out area, the apparatus comprising:
- a recording/reading unit that records data on and/or reads data from the data area of the disc; and
- 10 a controller that controls the recording/reading unit to record temporary defect information in the temporary defect management area, the temporary defect information comprising defect information regarding the data recorded in the data area according to a recording operation, and to record temporary defect management information in the
- 15 temporary defect management area, the temporary defect management information comprising management information for managing the temporary defect information.

20. The recording and/or reproducing apparatus of claim 19,
- 20 wherein the controller further controls the recording/reading unit:
- to record additional data in the data area according to another recording operation,
- to record additional temporary defect information and additional temporary defect management information in the temporary defect
- 25 management area corresponding to the additional data recorded according to the additional recording operation, and
- during finalization of the disc, to record a last recorded temporary defect information and a last recorded temporary defect management information in a defect management area which is present in at least one
- 30 of the lead-in area and the lead-out area of the disc.

21. A recording and/or reproducing apparatus for use with a disc having a data area and a temporary defect management area in one of a lead-in and a lead-out area, the recording and/or reproducing apparatus comprising:
- 5 a recording/reading unit that records data on or reads data from the data area of the disc; and
- a controller that controls the recording/reading unit to
- record first temporary defect information in the temporary defect management area, the first temporary defect information
- 10 comprising defect information regarding a first unit of the data recorded in the data area according to a first recording operation,
- record first temporary defect management information in the temporary defect management area, the first temporary defect management information comprising defect management information for
- 15 managing the first temporary defect information,
- record second temporary defect information in the temporary defect management area, the second temporary defect information comprising defect information regarding a second unit of the data recorded in the data area according to a second recording operation,
- 20 and
- record second temporary defect management information in the temporary defect management area, the second temporary defect management information comprising defect management information for managing the second temporary defect information.

25

22. The recording and/or reproducing apparatus of claim 21, wherein the controller further controls the recording/reading unit to record additional units of the data in the data area while increasing an index given to each additional recording operation, temporary defect
- 30 information, and temporary defect management information, and to record a last recorded temporary defect management information and a

last recorded temporary defect information in a defect management area included in at least one of the lead-in area and the lead-out area of the disc.

5 23. The recording and/or reproducing apparatus of claim 21, wherein:

 the controller further controls the recording/reading unit to record last data in the data area according to a last recording operation and to record final defect management information and final defect information
10 in a defect management area, the final defect information and the final defect management information respectively comprising a last recorded temporary defect information and a last recorded temporary defect management information regarding the last data recorded according to the last recording operation, and

15 the defect management area is present in at least one of the lead-in area, the lead-out area, and an outer area of the disc.

 24. The recording and/or reproducing apparatus of claim 21, wherein the controller further controls the recording/reading unit to
20 sequentially record the temporary defect information in a temporary defect information area of the temporary defect management area, starting from a start of the temporary defect information area.

 25. The recording and/or reproducing apparatus of claim 21, wherein the controller further controls the recording/reading unit to
25 sequentially record the temporary defect management information in a temporary defect management information area of the temporary defect management area, starting from an end of the temporary defect management information area.

30

26. The recording and/or reproducing apparatus of claim 21,
wherein the controller further controls the recording/reading unit to
sequentially record temporary management information comprising a
corresponding pair of the temporary defect information and temporary
5 defect management information in the temporary defect management
area, starting from a start of the temporary defect management area.

27. The recording and/or reproducing apparatus of claim 21,
wherein the controller further controls the recording/reading unit to
10 sequentially record temporary management information comprising a
corresponding pair of the temporary defect information and temporary
defect management information in the temporary defect management
area, starting from an end of the temporary defect management area.

15 28. The recording and/or reproducing apparatus of claim 21,
further comprising a memory,
wherein the controller further
controls the recording/reading unit to record the data on the
disc in predetermined units of data according to a predetermined
20 recording operation,
verifies the recorded units of data to detect a defective area
of the disc in which a defect exists,
creates defective position information pointing to a
defective area and replacement position information pointing to a
25 replacement area that is a substitute area for the defective area,
stores the created defective position and replacement
position information as temporary defect information in the memory,
controls the recording/reading unit to record an additional
unit of the data after the defective area according to a further recording
30 operation,

reads the temporary defect information from the memory
after completion of the recording of the additional unit of the data
according to the further recording operation, and
controls the recording/reading unit to record the read
5 temporary defect information in the temporary defect management area.

29. The disc of claim 5, wherein the temporary defect
management area further comprises a temporary defect management
information area other than the temporary defect information area, and
10 the temporary defect management information is recorded in the
temporary defect management information area.

30. The disc of claim 7, wherein the corresponding temporary
defect information and temporary defect management information are
15 recorded as temporary management information in adjacent units in the
temporary defect management area.

31. The disc of claim 30, wherein:
additional user data is recorded in the data area,
20 additional temporary defect information and additional temporary
defect management information corresponding to the additional user
data is recorded as additional temporary management information in
adjacent units in a second area of the temporary defect management
area, and
25 the temporary management information is recorded in a first area
of the temporary defect management area other than the second area.

32. A storage medium usable with respect to a recording and/or
reproducing apparatus, the storage medium comprising:
30 a data area comprising user data; and

a management area other than the data area and which comprises a temporary defect management area comprising temporary defect information regarding the user data recorded in the data area and which is accessible by the recording and/or reproducing apparatus to
5 perform defect management on the disc,

wherein the storage medium is a write-once storage medium having a property which prevents, after the data is recorded on an area of the storage medium, new data from being written to the area of the storage medium.

10

33. The storage medium of claim 32, wherein the management area further comprises a defect management area other than the temporary defect management area and comprising the temporary defect information usable by the recording and/or reproducing apparatus
15 to perform the defect management on the storage medium.

34. The storage medium of claim 33, wherein:
the data area further comprises additional user data,
additional temporary defect information corresponding to the
20 additional user data is recorded as additional temporary management information in the temporary defect management area,
the additional temporary defect information further comprises the temporary defect information, and
the defect management area comprises the additional temporary
25 defect information.

35. A storage medium usable with respect to a recording and/or reproducing apparatus, the storage medium comprising:
a data area comprising user data and additional user data
30 recorded in an area other than an area in which the user data is recorded; and

a management area other than the data area and which comprises a temporary defect management area comprising temporary defect information regarding the user data recorded in the data area, and additional temporary defect information recorded in an area other than
5 an area in which the temporary defect information is recorded,
wherein the additional temporary defect information comprises defect information corresponding to the additional user data and to the user data and is accessible by the recording and/or reproducing apparatus to perform defect management on the disc.

10

36. The storage medium of claim 35, wherein the temporary defect management area further comprises:

temporary defect management information usable by the recording and/or reproducing apparatus to manage the temporary defect
15 information, and

additional temporary defect management information usable by the recording and/or reproducing apparatus to manage the additional temporary defect information.

20

37. The storage medium of claim 36, wherein:

the temporary defect information and the temporary defect management information are recorded as temporary management information in adjacent units in the temporary defect management area,

the additional temporary defect information and the additional
25 temporary defect management information are recorded as additional temporary management information in adjacent units in the temporary defect management area, and

the temporary management information is recorded in an area of the temporary defect management area other than an area in which the
30 additional temporary management information is recorded.

38. The storage medium of claim 35, further comprising a further area comprising replacement data corresponding to a portion of the user data recorded in a defective portion of the data area,

wherein one of the temporary defect information and the
5 additional the temporary defect information comprises a defect position information relating to a position of the defective portion and replacement position information relating to a position of the replacement portion.

39. The storage medium of claim 35, wherein the management
10 area further comprises a defect management area other than the temporary defect management area and comprising one of the temporary defect information and the additional temporary defect information usable by the recording and/or reproducing apparatus to perform the defect management on the disc.

15

40. The storage medium of claim 39, wherein:
the additional temporary defect information includes the temporary defect information, and

the defect management area comprises the additional temporary
20 defect information.

41. A recording and/or reproducing apparatus for use with a storage medium having a data area and a management area in an area other than the data area and which includes a temporary defect
25 management area, the recording and/or reproducing apparatus comprising:

a pickup unit that transfers data with respect to the data area; and
a controller that controls the pickup unit to transfer the data with respect to the data area, and to transfer temporary defect information
30 with respect to the temporary defect management area, the temporary defect information comprising defect information regarding the data

recorded in the data area according to a recording operation and which the controller uses to perform defect management with respect to the storage medium,

wherein the storage medium is a write-once storage medium
5 having a property which prevents, after the data is recorded on an area of the storage medium, new data from being written to the area of the storage medium.

42. The recording and/or reproducing apparatus of claim 41,
10 wherein the controller further controls the pickup unit to transfer additional data with respect to an area of the data area other than an area in which the data is recorded, and to record additional temporary defect information corresponding to the additional data in the temporary defect management area.

15 43. The recording and/or reproducing apparatus of claim 41, wherein the controller further transfers temporary defect management information with respect to the temporary defect management area, the temporary defect management information comprising management
20 information used by the controller for managing the temporary defect information.

44. The recording and/or reproducing apparatus of claim 43,
25 wherein the controller controls the pickup unit to transfer the temporary defect information and the temporary defect management information to be recorded as temporary management information in adjacent units in the temporary defect management area.

45. The recording and/or reproducing apparatus of claim 43,
30 wherein:

the controller further controls the pickup unit to transfer additional data with respect to the data area, and to transfer additional temporary defect information and additional temporary defect management information corresponding to the additional data and which is recorded
5 as additional temporary management information in adjacent units in a second area of the temporary defect management area, and

the temporary management information is recorded in a first area of the temporary defect management area other than the second area.

10 46. The recording and/or reproducing apparatus of claim 41, wherein:

the controller further controls the pickup unit to transfer replacement data corresponding to the data recorded in a defective portion of the data area with respect to a further area of the data area,
15 and

the temporary defect information comprises a defect position information relating to a position of the defective portion and replacement position information relating to a position of the replacement portion.

20 47. The recording and/or reproducing apparatus of claim 41, wherein the management area further comprises a defect management area other than the temporary defect management area, and the controller controls the pickup unit to additionally transfer the temporary defect information with respect to the defect management area.

25

48. The recording and/or reproducing apparatus of claim 47, wherein:

the controller further controls the pickup unit to transfer additional data with respect to the data area, and to transfer additional temporary
30 defect information corresponding to the additional data and which is

recorded as additional temporary management information in the temporary defect management area,

the additional temporary defect information further comprising the temporary defect information, and

5 the defect management area comprises the additional temporary defect information.

49. A computer readable medium encoded with processing instructions for implementing a method of transferring data with respect
10 to a storage medium performed by a computer, the storage medium having a data area and a management area in an area other than the data area and which includes a temporary defect management area, the method comprising:

controlling a pickup unit to transfer data with respect to the data
15 area;

obtaining temporary defect information comprising defect information regarding the data recorded in the data area according to a recording operation and which is used to perform defect management with respect to the storage medium;

20 obtaining temporary defect management information used to manage the temporary defect information; and

controlling the pickup unit to transfer the temporary defect information and the temporary defect management information with respect to the temporary defect management area.

25

50. The computer readable medium of claim 49, wherein the method further comprises transferring additional data with respect to an area of the data area other than an area in which the data is recorded, and transferring additional temporary defect information corresponding to
30 the additional data with respect to an area of the temporary defect

management area other than an area in which the temporary defect information is recorded.

51. The computer readable medium of claim 49, wherein the
5 method further comprises controlling the pickup unit to transfer the temporary defect information and the temporary defect management information to be recorded as temporary management information in adjacent units in the temporary defect management area.

10 52. The computer readable medium of claim 51, wherein:
the method further comprises controlling the pickup unit to transfer additional data with respect to the data area, and to transfer additional temporary defect information and additional temporary defect management information corresponding to the additional data and which
15 is recorded as additional temporary management information in adjacent units in a second area of the temporary defect management area, and
the temporary management information is recorded in a first area of the temporary defect management area other than the second area.

20 53. The computer readable medium of claim 49, wherein:
the method further comprises controlling the pickup unit to transfer replacement data corresponding to a portion of the data recorded in a defective portion of the data area with respect to a further area of the data area, and
25 the temporary defect information comprises a defect position information relating to a position of the defective portion and replacement position information relating to a position of the replacement portion.

54. The computer readable medium of claim 49, wherein the
30 management area further comprises a defect management area other than the temporary defect management area, and the method further

comprises controlling the pickup unit to additionally transfer the temporary defect information with respect to the defect management area.

- 5 55. The computer readable medium of claim 54, wherein:
 the method further comprises controlling the pickup unit to transfer additional data with respect to the data area, and to transfer additional temporary defect information corresponding to the additional data and which is recorded as additional temporary management information in
10 the temporary defect management area,
 the additional temporary defect information further comprising the temporary defect information, and
 the defect management area comprises the additional temporary defect information.

15