Method of recording information on a multi layer record carrier, and device for recording on a dual layer record carrier

The invention relates to a method of recording information on a multi-layer record carrier. In particular, the invention relates to a method of recording information on a dual layer DVD+R or DVD+R/W disc, such that it becomes compliant with the dual layer DVD-ROM Standard.

Information is stored on optical record carriers according to specific rules and layouts, generally referred to as Formats, which are described in documents generally referred to as a Standards.

Recordable (both write-once and rewritable) optical storage for video and data applications is a rapidly growing market. For DVD+R discs, comprising a single information layer, the storage capacity is 4.7 Gbyte. This is a limited amount of storage for video recording and data applications. With MPEG2 compression it is possible to record one hour of high quality digital video and two hours of standard quality. More data storage capacity is desirable. An option is to use optical discs with multiple information layers. Such discs are already available for DVD-ROM.

Recordable optical discs with two information layers are developed to double the data storage capacity and video recording time. Such a dual layer disc is schematically shown in Fig. 1. The dual layer disc comprises two information layers, generally referred to as the L0 and L1 layers. The L0 layer is the information layer located closest to the side of a disc where a radiation beam, such as a laser beam, used for reading and/or recording the information enters the disc.

A dual layer DVD+R disc has recently been suggested by Philips and is disclosed in International Patent Application WO 03/060895-A1. Such a disc is in principle compatible with the dual layer DVD-ROM Standard. As an example, the reflection levels of both layers are >18% which adheres to the DVD-ROM Standard (Standard ECMA –267, 120 mm DVD – Read-only disc).

It is, however, a problem that the information recorded on a dual layer recordable DVD disc cannot always be reproduced on a DVD-ROM player without errors.

This, so-called compatibility issue, is especially a problem since a large installed base of DVD-ROM players is already available all around the world.

It is an object of the present invention to provide a method of recording a multi layer record carrier, and especially a dual layer recordable DVD disc, in such a way that it can be reproduced in DVD-ROM players without errors.

According to the dual layer DVD-ROM Standard two different disc types are described: Opposite Track Path, OTP, discs (shown in Fig. 2B), and Parallel Track Path, PTP, discs (shown in Fig. 2A). Fig. 3A shows a fully written OTP type dual layer DVD-ROM disc with the full amount of 8.5 GByte of data stored on the disc, while Fig. 3B shows a fully written OTP type dual layer DVD-ROM disc with less than the full amount of 8.5 GByte of data stored on the disc.

After finalization a dual layer DVD+R disc should comply with the dual layer DVD-ROM Standard, when it is to be played back on a DVD player (or DVD recorder). In this DVD-ROM Standard (Standard ECMA –267, 120 mm DVD – Read-only disc) it is demanded that the whole data zone after the lead out is written with data (data patterns) in case of an OTP type disc. In case of an OTP like dual layer DVD+R disc, the disc can in principle be closed when the data zone of layer L1 (or layers L0 and L1) is not completely written (see Fig. 4). However, such a recorded disc is not DVD-ROM compliant, because the whole data area is not filled with data, and problems can occur when it is inserted in a DVD-player (or a DVD-recorder) and played-back.

Fig. 5 shows two possible paths (path 1 and path 2) of a DVD player during play back jumping from layer L0 to layer L1. The two possible search paths (path 1 and path 2) are indicated going from position A on L0 to position B on L1. Path 1 is the shortest and most likely option to be selected. However, during such a layer jump, or focusing routine, the read-out spot jumps to the blank data area. According to the DVD-ROM standard, data should be present here. Therefore, a DVD-ROM player will become confused and, most likely, reject the disc. This effect is confirmed by recent measurements.

An option to solve this problem and to make a dual layer DVR+R or DVD+R/W disc DVD-ROM compliant is to finalize the disc by writing dummy data, such as a random data pattern or an all-zero data pattern, on the remaining blank data area, as is shown in Fig. 6. However, this may take a considerable amount of time (up to over one hour), which is unacceptable for consumer applications.

The recording method and recording device according to the present invention allow for making dual layer DVD+R or DVD+R/W disc recordings compliant with the dual layer DVD-ROM OTP standard without significantly increasing the recording time (including the finalization time), thereby increasing the ease of use and guaranteeing playback of the recorded disc on any DVD players now in the market.

According to the invention, writing the data (for example a video-stream) in a DVD-ROM compliant way on the dual layer DVD+R or DVD+R/W disc is done by shifting the middle zone area towards the inner radius in such a way that the data zones of both information layers are filled up with data. The data is recorded while shifting the middle zone area towards the inner radius of the disc in such a way that the whole data area is filled up with data, as is shown in Fig. 7.

Besides that a DVD-ROM compliant disc is produced, this method has the advantages that no time-consuming finalization procedure has to be performed because no dummy date needs to be recorded.

In an embodiment of the invention, it is proposed to minimize the finalization area. This is especially advantageous when it appears difficult to exactly tune the shift of the middle zone area. Fig. 8 shows a recording on a dual layer DVD+R disc in such as a way that the finalization area is minimized. The size of the finalization area should be significantly smaller that the size of the data area (for example smaller than 5% of the data area).

In a further embodiment the data content is evenly distributed over both information layers L0 and L1. When the size of the data content is known (for example in case of recording from hard disc to dual layer DVD+R or DVD+R/W disc, or during disc-to-disc recording), this content can be evenly distributed over both information layers. For example, when 6 GByte of data has to be copied from a hard disc to a dual layer DVD+R disc. Instead of writing 4.7 GByte on layer L0 and 1.3 GByte on layer L1 (as shown in Fig. 4 and Fig. 6), it is proposed to write 3 GByte on layer L0 and 3 GByte on layerL1 by shifting the middle zone to the inner radius. Now, the data is written in such a way that a long finalization area is avoided (or made very small when still necessary).

In a further embodiment an estimate of the disc space required for storing the data is made prior to the recording itself. This is especially useful when the recording time is known, for example when recording a video or data stream directly to a dual layer DVD+R or DVD+R/W. When the recording time is known (for example from a TV guide or from a time programmed in a video-recorder) we can beforehand make an estimate of the disc space that is needed. For example, a recording is programmed for 3 hours. Instead of recording 2

hours on layer L0 and 1 hour on layer L1, we propose to record 1.5 hours on layer L0 and 1.5 hours on layer L1. Preferably, some recoding space is reserved on layer L1 to anticipate for possible variable bit rates during compression of the stream.

It is noted that although the invention is explained with reference to a dual layer record carrier, it should be obvious to a man skilled in the art that the invention can be applied to multi layer record carriers having more than 2 information layers as well, without departing from the essence of the invention.

CLAIMS:

1. Method of recording information on a recordable multi-layer record carrier, said record carrier comprising a first information layer and a second information layer for storing information, each of the information layers comprising a data zone for recording the information,
wherein the information is recorded such that an area containing information in a data zone on the first information layer and an area containing information in a data zone on the second information layer are of substantial equal size and such that both area's are superjacent.

2. Method according to claim 1, wherein at least one area comprises a sub-area comprising dummy data, said sub-area having a size significantly smaller that the size of the area.

3. Method according to claim 1, wherein the information to be recorded is evenly distributed over all layers of the multi-layer record carrier.

4. Method according to claim 3, wherein the middle zones of the information layers are shifted towards the inner radius of the record carrier such that the data zones are filled up with information.

5. Method according to claim 3, further comprising the step of estimating the space required for storing the information prior to the recording of the information.

6. A recording device for recording information on a recordable multi-layer record carrier, wherein said device is operative for executing a method according to claim 1, 2, or 3.