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SPECIFICATION

TITLE OF THE INVENTION

OPTICAL INFORMATION MEDIUM, STAMPER FOR MANUFACTURING TRANSPARENT SUBSTRATE THEREFOR AND RECORDING METHOD THEREFOR

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to an optical information medium, a transparent substrate and a stamper for use in manufacturing thereof, and a recording method therefor, on which can be recorded information being optically reproducible, and in particular relates to an optical information medium having a sector address information detection means therein, being suitable for a high density recording medium on which the information can be recorded and reproduced with red laser beam of short wavelength from 630 nm to 670 nm.

2. DESCRIPTION OF RELATED ART

With the recent advances in development and application of a short wavelength laser, standardization is proceeded on the standard for DVDs (Digital Versatile Discs) which enables recording and reproducing with high density, as well as the practical application thereof. On the DVD is provided a data recording area at least on one surface thereof, in which pits are formed as a means for recording information, and a reflection layer made of metal film is formed on the data recording area.

For the DVDs, a different standard for high density is determined,

comparing to the standard for the optical information medium being the most general or popular now, such as a CD (Compact Disc). For example, with the optical pickup, it is determined to use the red laser of short wavelength from 630 nm to 670 nm, and to use an objective lens of high numerical aperture, such as of 0.6 in NA, etc.

Also, accompanying with this, for dealing with a curve or bend of the disc, the thickness thereof is determined 0.6 mm, to be about half (1/2) of that of the CD. However, for maintaining a compatibility or interchangability in sizes between the CD having thickness of 1.2 mm, the disc of DVDs applies such structure that two pieces of discs are filed up and pasted together. According to the DVD standard, it is standardized that one piece of the disc has recording capacity of 4.7 GB at the maximum, in average thereof, i.e., video and audio information for approximately 133 minutes long.

Up to now, with a recordable CD, such as CD-R, etc., an address information, i.e., ATIP (Absolute Time In Pregroove) is obtained through FM modulation of wobbling of the spiral groove tracking guide. On the contrary to this, with the recordable DVD, such as a DVD-R, etc., the address information including a position information on the optical information medium or the like is obtained by means of pre-pits which are provided in advance on a land portion between the tracking guides, and the wobbling as well, in the place of the ATIP.

The pre-pits which is applied to the DVD-R as the high density recording medium mentioned above can be read out by the optical pickup together with the pits of the record signal, however in this instance, the optical pickup is controlled by a tracking servo along with the tracking guide. Therefore, under a normal condition, the pre-pits are read out discriminating from the pits for

recording of data signals which are formed on the groove. However, depending upon the shapes, sizes and so on thereof, the pre-pits may be read out mixing with RF signals which are obtained from the pits for recording of data signals. In this case, it may be a cause of occurrence of errors in reading of the data signals.

In the DVD-R and/or DVD-RW, the pre-pits are necessary for obtaining the address information as the position information on the optical information medium when recording. However, though they are not used when reproducing, the fact that the signals obtained from the pre-pits are mixed into the RF signals indicative of the record data may be the cause of occurrence of the errors in the reading of the RF data signals.

On the other hand, if it is difficult to read out the pre-pits when recording, the information, such as the address, cannot be read out correctly during the recording, therefore the recording comes to be unstable, and there remains a problem that the reproduction itself of the record signals is unable.

SUMMARY OF THE INVENTION

In accordance with the present invention, taking into consideration those problems accompanying with the reading of the pre-pits for reading the address information of the optical information medium in conformity such the high density recording, an object thereof is to provide an optical information medium, a substrate for use of the optical information medium and a stamper for forming the substrate, with which the address information can be read out from the pre-pits with certainty when recording, including information on shifting when the pickup is shifted to a starting position of the recording after accessing to non-recorded area, and the error is removed or dissolved in reading due to interference between

the signal obtained from the pre-pits indicative of the address information and the record data read out from the pits on the tracking guide, thereby enabling to prevent from the mixture of the signal obtained from the pre-pits into the data signal when being reproduced.

For accomplishing the object mentioned above, according to the present invention, the pre-pits 6 provided on the land for indicating the address information are shifted from the land 8 with intention, thereby increasing up the intensity of the tracking error signal, as well as weakening the leakage into the RF signal, so as to discriminate between the tracking error signal and the RF signal which is obtained from the pits on the grooves 3, and preventing them from being erroneously read out with confusing with each other.

According to the present invention, there is provided a stamper, comprising concave and convex-like steps being formed in an concentric or a spiral shape thereof, wherein in the concave portion of said stamper is formed a projection portion in such a manner that the projection portion is connected to at least one of the convex portions adjoining said concave portion.

Also, according to the present invention, there is provided a substrate for use in an optical information medium, being formed from a resin by a stamper comprising concave and convex-like steps being formed in concentric or a spiral shape thereof, wherein on said substrate is provided pre-pits indicative of an address information, being formed by means of a projection portion, which is provided on the concave portion of said stamper in such manner that the projection portion is connected to at least one of the convex portions adjoining the concave portion.

According to the present invention, there is provided an optical

information medium, comprising: a transparent substrate 1 for penetrating a recording laser beam therethrough, a recording layer 12 being formed on said transparent substrate; and a reflective layer 13 for reflecting reproducing laser beam thereupon, thereby enabling to record optically readable signals by means of the recording laser beam being incident upon from said transparent substrate 1, wherein said transparent substrate has spiral-like tracking guides 3 on a surface thereof, on which the recording layer 12 is formed, and pre-pits 6 indicative of address information, being formed on a land 8 defined between the tracking guides 3, and wherein the pre-pits 6 are formed with shifting from a center of the land 8. Thereby, the pre-pits 6 are opened to the side of the tracking guide 3 neighboring the land 8. On such the optical information medium, the optically readable signals are recorded with tracking the recording laser beam incident upon from said transparent substrate 1 along with said tracking guide 3.

In the optical information medium using such the substrate for an optical information medium, which is formed by such the stamper, since the pre-pits 6 are formed with shifting from the center of the land 8, in more detail, the pre-pits 6 are formed with shifting from the center of the land 8 in a direction of an inner periphery of the disc, then the pre-pits are formed in such a manner that they come near to the center of the beam spot more when tracking, therefore it is possible to obtain an amplitude of signal as the reproduced signal of the pre-pits, being larger than that in a case where the pre-pits are formed at the center of the land, thereby to perform the reading with certainty.

Also, with such the construction mentioned above, it is possible to make the shape of the pre-pits 6 smaller than that in the case where the pre-pits are formed at the center of the land. This is caused by the fact that it is possible to

obtain the signal amplitude being larger than that in the case where the pre-pits are formed at the center of the land, because the pre-pits 6 are off-set from the center of the land 8 in the inner periphery direction of the disc, as mentioned previously. And in this case, since the pre-pits 6 can be made small in shape physically up to such a level that the signal amplitude thereof can be read out (for example, at the signal amplitude when the pre-pits 6 are formed at the center of the land 8), even in the case where the signal due to the pre-pits is leaked into the RF signal, it comes to be sufficiently smaller than the time duration of the minimum signal as the data signal when it is decoded into an EFM signal, therefore it is easy to discriminate it from the data signal, thereby to prevent from reading the signal due to the pre-pits erroneously.

For example, when reading the data pits formed on the tracking guide 3 while conducting the tracking servo on the optical pickup along with the tracking guide 3, the address signal obtained from the pre-pits 6 come to be weaker comparing to the signal obtained from the data pits. Thereby, the signal of the pre-pits 6 which is mixed into the RF signal obtained from the data pits comes to be weak, therefore there hardly occurs the problem of mixing of noises into the data signal.

The pre-pits 6 are preferably to be shifted in the direction of inner periphery of the transparent substrate 1, with respect to the center of the land. This is because, as was mentioned previously, the pre-pits are formed in such a manner that they come close to the center of beam spot more when tracking, therefore the reproduced signal of the pre-pits obtains the amplitude of signal being larger than that in the case where the pre-pits are formed at the center of the land.

The pitch p of the tracking guide 3 is p = 0.74 μ m, and the half-width

w thereof is preferable to lie within a range, 0.23 μ m $\leqq$ w $\leqq$ 0.38 μ m. And, the half-width d of the pre-pit 6 is preferable to lie within a range, 0.20 μ m $\leqq$ d $\leqq$ 0.33 μ m. From this relationship, the ratio w/d between the half-width w of the tracking guide 3 and the half-width d of the pre-pits 6 comes to be within a range, 0.5 $\leqq$ w/d $\leqq$ 1.7. The off-set dimension δ of the pre-pit 6 from the center of the land 8, though depending upon the width of the land 8, is preferably to lies within a range, 0 μ m $\leqq \delta \leqq$ 0.2 μ m, and the width l from the boundary portion between the tracking guide 3 and the land 8 to the pre-pit 6 is preferably to lies within a range, 0 μ m $\leqq$ l $\leqq$ 0.2 μ m.

As mentioned in the above, with the optical information medium according to the present invention, wherein the signals can be recorded onto the optical information medium in conformity with the high density recording, optically with using the optical pickup, the address signal can be read out from the pre-pits with certainty when recording, and when reading out the signals recorded, errors are eliminated in reading the signals obtained from the land pre-pits indicative of the sector information and the record data read out from the pits on the tracking guide, thereby enabling to read out the address information when recording and the data signals when reproducing, with discriminating between them with accuracy.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is an exploded perspective view of two pieces of substrates in an example of an optical information medium according to the present invention, under a condition before they are pasted together, including a partial cross-section view thereof;

Fig. 2 is a perspective view of showing the same optical information medium, including a partial cross-section view thereof;

Fig. 3 is a plane view of a principle portion of a transparent substrate which is applied to the same optical information medium;

Fig. 4 is a perspective view of the transparent substrate, including a cross-section view which is cut along with a line A-A in the Fig. 3;

Fig. 5 is a vertical side cross-section view of the principle portion of the same optical information medium;

Fig. 6 is an enlarged vertical side cross-section view of the principle portion of the same optical information medium; and

Fig. 7 is a perspective view of a stamper.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, detailed explanation of the embodiments according to the present invention will be given by referring to attached drawings.

A write once optical information medium is shown in Figs. 1 and 2, which is pasted on both surfaces and is recordable and reproducible from the one surface thereof, as an example of the optical information medium according to the present invention.

A transparent substrate 1 is a substrate in a disc-like shape, having a center hole 4 in the central portion thereof. This transparent substrate 1 is most preferably to be made of transparent resin, such as polycarbonate, polymethyl metacrylate (PMMA), etc., by means of injection molding.

Here, when forming the transparent substrate 1, a stamper 21 is used, on which concave/convex like steps are formed in a spiral-like shape, as shown in

Fig. 7. In the concave portion 23 of the stamper 21 is provided projection portion 22, which is connected with at least one of the convex portions 24 being adjacent to the said concave portion 23, in this embodiment, connected to an inner periphery side thereof.

However, in the portion which is connected between the projection portion 22 and the convex portion, there may be formed a hang or a rise in the shape thereof.

In a substrate being formed from a resin by this stamper 21, a projecting land 8 is formed on the substrate 1 by a concave portion 23 of the stamper 21, while a concave tracking guide 3 is formed on the substrate 1 by a projection portion 24 of the stamper 21. Further, a concave-like pre-pit 6 indicative of an address information is formed on the substrate 1 by a projection portion 22 being formed in the concave portion 23 of the stamper 21 to be connected with the convex portion 24 thereof. The pre-pit 6 is formed in a portion of the land 8 adjoining the tracking guide 3 to be connected with the tracking guide 3 on the substrate 1.

On the one surface of the substrate 1 having the transparency, and in an outside of the above-mentioned center hole 4, there is provided a clamping area, and in an outside thereof is formed a data recording area or region. In the data recording area of the transparent substrate 1 is formed a tracking guide 3 with a spiral-like groove(s). The pitch of the tracking guide 3 is 0.74 μ m at the standard thereof.

As is shown in Figs. 3 to 6, in the land 8 between the tracking guides 3 mentioned above, the recess-like pre-pits 6 indicative of the address information are formed at an appropriate distance therebetween when recording the signals

onto the optical information medium. Those pre-pits 6 are formed in advance, together with the tracking guides mentioned above, when forming the transparent substrate 1 by the injection molding.

As is indicated in those Figs., the pre-pits 6 are formed with shifting by an off-set dimension δ with respect to the center of the land 8. Therefore, the pre-pits 6 are opened at the edge on one side of the land 8. All the shiftings of the pre-pits 6 with respect to the center of the land 8 are in the same direction, in the example shown in the Figs., at the left-hand side of the land in the Fig. 3, i.e., being opened to the side of inner periphery of the land 8. In the portion being opened is formed a projection-like rim 7. It is, of course, that the depth of this rim 7 is lower than the depths of the tracking guide 3 and the pre-pits 6, namely the height of the land 8 from the bottom surface of the tracking guide 3. This rim 7 may be formed with interrupting on the way thereof.

Since this rim portion is lower than the height of the land, contribution to the reflection amount of laser beam upon the land portion is decreased down when being irradiated with the laser beam thereupon. For bringing an amplitude of the LPP signal obtained in this instance at the maximum, the less the reflection amount of laser beam upon the land portion, the more advantageous, therefore the rim is preferable to be low.

The off-set dimension δ of the above-mentioned pre-pits with respect to the center of the land 8, though depending upon the width of the land, is preferable to be within a range, $0\ \mu m \leqq \delta \leqq 0.2\ \mu m$, while also the width l from the boundary portion between the tracking guide 3 and the land 8 to the pre-pit 6 is preferable to be within a range, $0\ \mu m \leqq l \leqq 0.2\ \mu m$. Further, the pitch of the tracking guide 3 is $p = 0.74\ \mu m$, and a half-width w

thereof is within a range, 0.23 μ m $\leqq$ w $\leqq$ 0.38 μ m.

The diameter d of this pre-pit 6 is made different from the length of the pits which are formed when recording the signals onto the optical information medium. For example, in the DVDs, the length of the data pits are about from 0.4 μ m to 1.9 μ m, however the diameter d of the pre-pit 6 is determined to be shorter than the minimum pit length 0.4 μ m. In more detail, the diameter d of the pre-pit 6 is determined to be from 50% to 83% of the minimum pit length. For example, in the DVDs, the minimum pit length should be that of three (3) channel clocks, however the length of the pre-pit 6 is determined to be equal to the length of 1.5 to 2.5 channel clocks. As the values in concrete, the diameter d of the pre-pit 6 is determined to be within a range, 0.20 μ m $\leqq$ d $\leqq$ 0.33 μ m. With this relationship, the ratio w/d between the half-width w of the tracking guide 3 and the half-width d of the pre-pit 6 is within a range, 0.5 $\leqq$ w/d $\leqq$ 1.7. With such the construction, it is possible to obtain a necessary signal for each of the pre-pits formed on the tracking guide 3 and the data pits formed on the land, without interference between them, therefore enabling to suppress leakage of the signals into the data due to the signals on the pre-pits.

Also, as shown in Fig. 3, the pre-pit 6 is preferable to be formed curvilinearly directing to an outside of the outer periphery of the pre-pit, seeing from a plane view thereof, so that it contacts with the boundary portion between the tracking guide 3 and the land 8. With such the configuration, the surface of the pre-pit 6 is enlarged in the shape thereof in that portion, and the contribution of the land potion to the amount of the reflection laser beam, in a case of seeing from the optical view point thereof, comes to be small, then it is possible to take the amplitude of the pre-pit signal large. Therefore, it is possible to maintain or

ensure the output of the pre-pit signals being obtainable when the pre-pit is in a standard shape thereof, even in a case where the shape of the pre-pit is changed to be smaller than that of the standardized shape thereof, thereby enabling to reduce errors in reading the pre-pit signals.

Further, as shown in the Figs. 1, 2, 5 and 6, on the portion of the main surface of the data recording area is formed or coated a recording layer 12. The recording layer 12 is formed, for example, by applying or painting organic dye by means of a spin coat method or the like.

Figs. 5 and 6, each shows the cross-section in the radial direction of the transparent substrate 1. As is apparent from the Fig. 6, the pre-pit 6 is at the left-hand side, namely being shifted to the inner periphery side of the disc, and as a result of this, the left-hand side of the land 8 is opened. Further, in the portion being opened at a side of the land 8 of the pre-pit 6, there is formed a projection-like rim 7 being shallower than the depth of the tracking guide 3.

Here, the laser beam, in general, shows the strongest intensity at the center in a regular distribution thereof. If the pre-pits 6 are off-set to the inner periphery of the land 8 as mentioned in the above, since the pre-pit 6 comes to be close to the center of beam when tracking, it is possible to obtain the diffraction intensity, being much more than that obtained when the pre-pit is located at the center of the land.

However, the pre-pits 6 mentioned above are provided for the purpose of obtaining the signals to be the address information of the optical information medium, however by using those pre-pits 6 in common, it may be possible to obtain a rotation control information with the wobbling of the tracking guide 3.

As shown in the Figs. 1, 2, 5 and 6, on the recording layer 12 formed in

such the manner as mentioned above is formed a reflection layer 13 from a metal film of gold, aluminum, silver, copper, etc., or a layer of alloy thereof. Furthermore, on the reflection layer 13 is formed a protection film 14, such as of ultraviolet ray curable resin.

As shown in the Figs. 1 and 2, a piece of substrate 5 is prepared other than the transparent substrate 1. This substrate 5 is made of the same material as the transparent substrate 1, as well as has the same sizes, however, is not provided with such the travcking guide 3, the recording layer 12 and the reflection layer 13 on the main surface thereof, as be provided on the transparent substrate 1 mentioned above. Of course, otherwise, the other substrate 5 having the tracking guide may be provided, the recording layer 12 and the reflection layer 13, in the similar manner of the transparent substitute 1 mentioned above.

Next, those two pieces of substrates 1 and 5 are filed up and pasted together. For example, reactive curable resin is applied or coated on the main surface of at least one of those two pieces of substrates 1 and 5 as adhesive, by means of spin coat method or the like, and is hardened after they are piled up and pasted together opposing those surfaces to each other. In this manner, those two pieces of substrates 1 and 5 are bonded together upon the main surfaces thereof, with adhesive layer 11 formed by hardening the above-mentioned reactive curable resin. In this instance, the transparent substrate 1 is adhered on the surface, on which the recording layer 12 and the reflective layer 13 are formed.

In the example mentioned above, on the transparent substrate 1, being formed with the recording layer 12 and the reflection layer and having the tracking guide 3 thereon, is pasted the other substrate 5 having no such the recording layer 12 and the reflection layer 13 thereon. In this instance, the

recording and/or reproducing is able only on one Side surface thereof. The other substrate 5 may have no transparency, or be colored for maintaining a durability against laser beam, or have a region on the surface, where letters or patterns can be written in.

On the other hand, preparing two pieces of the transparent substrates 1, each being formed with the recording layer 12 and the reflection layer 13 and having the tracking guide 3 thereon, it is also possible to paste them together opposing the recording layer 12 and the reflection layer 13 to each other, so as to obtain an optical information medium, with which the recording and/or reproducing can be performed on both surfaces thereof.

However, in Figs. 1 and 2, a reference numeral 9 indicates a projection formed ring-like in an outside of the data recording area on the side surface of the transparent substrate 1, upon which the recording laser beam is incident. This is for the purpose of protecting the recording surface of the optical information medium from touching with the surface of other one, when the plurality of the optical information media are filed up.

Next, examples of the present invention will be explained by referring concrete numerical values thereof.

<Embodiment 1>

Applying a photosensitizer (i.e., photo-resist) upon the glass substrate which is polished, a cutting process is performed by running the laser beam spirally from the inner periphery to the outer periphery thereof, while rotating that glass substrate. A cutting machine is called by LBR (Laser Beam Recorder) and has a krypton-argon laser of the wave-length from 351 nm to 458 nm as the laser beam source thereof. This laser beam is spotted spirally upon the photo-resist

layer being rotated with wobbling, by using a mastering signal which is treated by a photo-converter, which can adjust the intensity of the penetrating laser beam electrically. In this instance, the laser beam passing through an irradiation path which is separately provided is turned ON/OFF at a predetermined timing, and the exposed portion of the photosensitive layer is dissolved into a developing liquid for exclusive use thereof, so as to form the concave-like gutters and the pre-pits in that portion. Thereafter, a conductive material is coated upon the surface of it so as to make it as an electrode(s) for conducting Ni plating on the surface of the photosensitive layer. Removing that, a master stamper is completed. Further, the plating is performed upon the surface with using the master stamper as the electrode(s), in the same manner as mentioned above, thereby enabling to obtain a mother stamper by removing the plating.

By molding the thrmoplastic with using such the stamper as is obtained in this manner, a transparent substrate 1 is prepared from a polycarbonate substrate of 120 mm Φ in an outer diameter, 15 mm Φ in an inner diameter, 0.597 mm in a thickness, and 1.59 in a refractive index, having the grooves 3 for tracking on the one side of the main surfaces, being 0.31 μ m in the half-width, 140 nm in the depth, and 0.74 μ m at the pitch. On the portion of the lands 8, each being defined between the tracking guides 3, are formed a plurality of pre-pits 6, being 0.27 μ m in the half-width of the diameter d and within 0.02 μ m in the fluctuation thereof. Those pits 6 are shifted by 0.1 μ m at the maximum, 0.05 μ m at the minimum, and only by 0.07 μ m on the average thereof.

On the side surface of the transparent substrate 1, having the groove 3 thereon, the recording layer 12 is formed by the spin coat film forming of a

solution of cyanine dye.

Further, Au is spattered onto the recording layer 12 so as to form the reflection layer 13 therewith. On this, ultraviolet ray curable resin (SD 211 of Dainippon Ink Chemical Industry Co., Ltd.) is coated by the spin coating and is hardened by irradiating the ultraviolet ray on it, so as to form the protection layer 14 therewith. On this protection layer 14, being applied with an adhesive of ultraviolet ray curable resin, the substrate is piled up and pasted together, which having the same material and sizes as that of the mentioned above. And, the ultraviolet ray is irradiated upon the adhesive to harden, thereby producing the optical information medium.

On the optical information medium manufactured in this manner, when trying to read out the address signals with using the optical pickup (NA=0.6), the address information can be taken out with stability. Also, an 8/16 modulation signal (converted 8 bits into16 bits) is recorded with using the same system, at recording power of 10 mW. When trying to reproduce the optical information medium by a DVD player after being recorded, a PI error within the data signals is only 3 counts per 8 ECC blocks (an average value per one (1) minutes) emitting the laser beam of 637 nm, therefore the reproduction is possible with stability. The modulation amplitude of the recorded signal is 61%, the maximum value of lengths errors of the pit and land is 6.0 nsec for each signal, and the data to clock jitter is 7.5%, respectively, thereby obtaining good or preferable results.

<Embodiment 2>

The optical information medium is manufactured in the same manner to that of the example 1 mentioned above, but the diameter of the land pre-pits 6 is set to be 0.28 μm in the half-width thereof, within fluctuation of 0.02 μm.

On the optical information medium manufactured in this manner, when the sector information is read out with using the optical pickup (NA=0.6) emitting the laser beam of wavelength of 650 nm, the address information can be read out with stability. Further, the 8/16 modulated signals (converted from 8 bits to 16 bits) are recorded at a recording power of 10.5 mW with using the same system. When the optical information medium is reproduced by the DVD player after the recording thereof, the PI error in reading the data signals is five (5) counts per 8 ECC blocks (an averaged value per a minute), i.e., obtaining stable reproduction. The modulation amplitude of the signals recorded is 65%, the maximum value of errors in the lengths of the pits and lands is 5.8 ns and the jitter is 7.3%, thereby obtaining the preferable result.

<Comparison Example 1>

The optical information medium is manufactured in the same manner to that of the example 1 mentioned above, but an offset amount of the pre-pit from the center of the land 8 in the direction of an outer periphery of the disc is 0.1 μ m, the half-width d of the land pre-pit 6 is 0.41 μ m, and the half-width w of the tracking guide 3 is 0.20 μ m, (the ration between the half-width d of the land pre-pit 6 and the half-width of the tracking guide 3, w/d = 0.49).

On the optical information medium manufactured in this manner, when the sector information is read out with using the optical pickup (NA=0.6) emitting the laser beam of wavelength of 650 nm, the address information can be read out with stability. Further, the 8/16 modulated signals (converted from 8 bits to 16 bits) are recorded at a recording power of 10.0 mW, with using the same system. When the optical information medium is reproduced by the DVD player after the recording thereof, the PI error in reading the data signals comes to be

three-hundreds (300) counts per 8 ECC blocks (an averaged value per a minute), i.e., in an undesirable condition for reproduction of the data. The modulation of amplitude of the signals recorded is 65%, the maximum value of errors in the lengths of the pits and lands is 6.5 ns and the jitter is 9%, respectively.

<Comparison Example 2>

The optical information medium is manufactured in the same manner to that of the example 1 mentioned above, but the shifting of the pre-pits 6 on the land is 0.3 μ m at the maximum, 0.2 μ m at the minimum, and 0.25 μ m at the average thereof.

On the optical information medium manufactured in this manner, when the address information is read out with using the optical pickup (NA=0.6) emitting the laser beam of wavelength of 650 nm, then no address information can be read out therefrom.

What is claimed is :

1. An optical information medium, comprising:
a transparent substrate (1) for penetrating a recording laser beam therethrough;
a recording layer (12) being formed on the transparent substrate; and
a reflective layer (13) formed on the recording layer to reflect a reproducing laser beam, wherein the transparent substrate has a spiral-like tracking guide (3) on a surface thereof, on which the recording layer (12) is formed, and a pre-pit (6) indicative of an address information, being formed on a land (8) adjoining the tracking guide (3), so that the pre-pit (6) is opened to a side of the tracking guide (3) adjoining the land (8), and wherein a rim (7) is formed in an opening portion of the pre-pit (6).

2. An optical information medium as defined in the claim 1, wherein in an opening portion of the pre-pit (6) formed on the land (6), both end portions of the pre-pit is formed m a direction opposing to an inner side of the pre-pit, from a plane view point thereof and the both end portions contact with a boundary portion between the tracking guide (3) and the land (8), curvilinearly.

3. An optical information medium as defined in the claim 1, wherein the pre-pit (6) is shifted into a direction of inner periphery of the transparent substrate (1) with respect to the center of the land (8).

4. An optical information medium, comprising:
a transparent substrate (1) for penetrating a recording laser beam therethrough;
a recording layer (12) being formed on the transparent substrate; and
a reflective layer (13) formed on the recording layer to reflect a reproducing laser beam, wherein the transparent substrate has a spiral-like tracking guide (3) on a surface thereof, on which the recording layer (12) is formed, and a pre-pit (6) indicative of an address information, being formed on a land (8) adjoining the tracking guide (3), and wherein an offset size δ of the pre-pit (6) from the center of the land (8) is within a range, $0\ \mu m \leqq \delta \leqq 0.2\ \mu m$.

5. An optical information medium, comprising:
a transparent substrate (1) for penetrating a recording laser beam therethrough;
a recording layer (12) being formed on the transparent substrate; and
a reflective layer (13) formed on the recording layer to reflect a reproducing laser beam, wherein the transparent substrate has a spiral-like tracking guide (3) on a surface thereof, on which the recording layer (12) is formed, and a pre-pit (6) indicative of an address information, being formed on a land (8) adjoining the tracking guide (3), and wherein a width l from a boundary portion between the tracking guide (3) and the land (8) to the pre-pit (6) is within a range, $0\ \mu m \leqq l \leqq 0.2\ \mu m$.

6. An optical information medium, comprising:
a transparent substrate (1) for penetrating a recording laser beam therethrough;
a recording layer (12) being formed on the transparent substrate; and
a reflective layer (13) formed on the recording layer to reflect a reproducing laser beam, wherein the transparent substrate has a spiral-like tracking guide (3) on a surface thereof, on which the recording layer (12) is formed, and a pre-pit (6) indicative of an address information, being formed on a land (8) adjoining the tracking guide (3), and wherein a ratio w/d between a half-width w of the tracking guide (3) and a half-width d of the pre-pit (6) on the land is within a range, $0.5 \leqq w/d \leqq 1.7$.

7. A recording method for recording optically readable signals onto an optical information medium comprising:
a transparent substrate (1) for penetrating a recording laser beam therethrough;
a recording layer (12) being formed on the transparent substrate (1); and
a reflection layer (13) for reflecting a reproducing laser beam thereupon, being formed on said recording layer (12), thereby enabling to record the optically readable signals by means of the recording laser beam being incident upon from said transparent substrate (1), wherein on any one of the optical information medium described in the claims 1 - 6, the optically readable signals are recorded while tracking the recording laser beam being incident upon from a side of the transparent substrate (1) along a tracking guide (3).