

MULTILAYER OPTICAL DISC

5 Pertinent art

The invention is related to three-dimensional optical memory devices and it may be used in all computer fields where there is required to record large information files on compact
10 carriers.

Prior art practice

15 When creating multilayer optical disks with a large number of information layers, one of the main problems is addressing the information layer during a readout procedure. In prior-art one-layer and two-layer optical disks, the reading radiation is furnished to the information layer via flat surface of the
20 disk. However, if the number of layers increases, there occur big problems with determination of the number of information layer from which the signal with recorded data is received. This problem is solved by directing the reading radiation to a special ducting layer located near the disk addressable
25 information layer via its lateral surface (cylindrical surface).

Previously known is a multilayer optical disk (USA patent application No. 2008/0305324 A1, published 11.12.2008, B32B
30 17/10) including several information layers separated from one another by at least two insulating layers made of polymers with different mechanical properties. One of the insulating layers possesses an increased rigidity at the expense of a filler

introduced into it, and its thickness is from 5 to 15 μm , and the other possesses an increased elasticity and has a thickness of 10 to 50 μm . The said structure ensures excellent mechanical properties of a multilayer optical disk, namely: deformational stability. However, this disk is not intended for use in readout devices having high addressing accuracy, since its structure does not assume availability of a ducting layer and does not envisage a possibility of introducing the reading radiation via its lateral surface.

Previously known is a multilayer optical disk (USA patent No. 7449278 B2, published 11.11.2008, G1 1B 7/24) including groups of layers spaced in series where each group consists of three layers: the information layer where under the effect of radiation with a wave length λ_1 there occur photochemical processes resulting in variation of optical properties of the material the information layer is composed of; the photochromic layer the reflecting capability of which is increased under the effect of radiation with a wave length λ_2 and the ducting layer intended for propagation therein of radiation with a wave length of λ_2 and introduced into a multilayer disk via its lateral surface. The data addressing reliability in this disk is higher than that of aforesaid analog since in the readout mode, the reflecting photochromic layer isolates the data receiver from the signals coming to it from underlying information layers, but the signals coming from the overlying non-addressable information layers can still reach the receiver thus reducing the data readout reliability.

A multilayer optical disk (USA patent No. 6045888, published 04.04.2000, B32B 3/00) is the closest one to the claimed invention by its technical essence, it consists of a series of alternating layers of optically transparent materials combined

into groups incorporating a layer of glass of 140 μm in thickness with a refraction index $n_1=1.515$ enclosed between a polymer with a refraction index n_2 satisfying the interrelationship $n_2 < n_1$ and a layer of photochromic material with a refraction index $n_3=1.47$, which can change its optical properties under the effect of radiation with a wave length λ_1 and acquire a property of fluorescenting under the effect of radiation with a wave length λ_2 at a wave length λ_3 . During the information readout, the radiation with a wave length λ_2 is directed to this multilayer optical disk via its lateral surface, i.e., to the glass surface. During waveguide propagation of light in a glass, an insignificant portion of radiation power, only, penetrates the photochromic material information layer in the form of evanescent mode. Therefore, the value of the signals, arriving at the radiation receiver at a wave length λ_3 from those sections (pixels) of the glass-adjoining information layer, which were previously illuminated by radiation with a wave length λ_1 and which contain the information bits, is very small. In order to increase the signal-to-noise ratio and obtain a reliable registration of radiation at a wave length λ_3 , the lateral dimensions of pixels in the photochromic layer plane should be increased, and this results in a decrease of information capacity of the multilayer optical disk.

Essence of invention

Technical result the attainment of which the claimed invention is striving for consists in increasing the information capacity of the multilayer optical disk with a simultaneous increase of the recorded information readout reliability.

The said technical result is obtained by the fact that in the multilayer optical disk including a series of alternating layers of optically transparent materials combined into groups incorporating a ducting layer of material with a refraction index of n lying between the insulating layer of material with a refraction index n_2 satisfying the interrelationship $n_2 < n_1$ and a layer of photochromic material with a refraction index n_3 , the refraction indices of materials of the ducting and information layers satisfy the condition $|n_3 - n_1| < 0.001$.

Besides, the thickness of information layer d satisfies the condition $1 \mu\text{m} < d < 10 \mu\text{m}$.

Besides, the thickness of information layer D satisfies the condition $5 \mu\text{m} < D < 100 \mu\text{m}$.

Besides, the thickness of insulating layer δ satisfies the condition $1 \mu\text{m} < \delta < 5 \mu\text{m}$.

The essence of invention consists in the following. The value of radiation signal at a wave length λ_3 is proportional to the product of readout radiation at a wave length λ_2 by the pixel volume. If the absolute value of difference of the refraction indices of ducting material and its adjoining information layer in the multilayer optical disk does not exceed the claimed value of 0.001, then the waveguide mode of the reading radiation with a wave length λ_2 does not propagate in these two layers without deformation and loss as in the single ducting layer. The intensity of waveguide mode is in large excess over the intensity of evanescent mode and, consequently, the fluorescent radiation signal value at a wave length λ_3 will be considerably higher even if the pixel volume is decreased by several times at the expense of decreasing its area in the

information layer plane. In other words, the claimed invention is expected to provide a simultaneous increase of the recording density and reliability of the recorded information readout. It should be noted that the information layer thickness shall not be chosen too large. The matter is that the photochromic material refraction indices in the initial state and in the state changed under the effect of radiation with a wave length λ_1 are slightly different. In this connection, as a result of recording the data, a light dissipation in the information layer increases. This may result in deformation and attenuation of the waveguide mode of reading radiation. The claimed absolute difference value of refraction indices of the ducting material and its adjoining information layers equal to 0.001 is rather significant. Exceedance of this value will result in the fact that the waveguide mode will propagate in the layer the material refraction index of which is higher: either in the ducting layer (in this case, the claimed invention will be identical to the prototype) or in the information layer (in this case, optical heterogeneities of the photochromic material will cause dissipation and degradation of the reading radiation).

Brief description of drawing figures

The essence of invention is explained by the drawings where shown in Fig. 1 is the general view of multilayer optical disk 1 with focusing system 2 and information readout device 3; shown in Fig. 2 are typical absorption spectra of photochromic material in the initial state (solid line) and changed state (dashed line) under the effect of radiation with a wave length λ_1 , and also the fluorescence spectrum (dashed line) under the effect of radiation with a wave length λ_2 ; presented in Fig. 3

is multilayer optical disk plex 1 in section with ducting layers 4, insulating layers 5, information layers 6 and pixel 7 of information layer 6 interacting with the radiation waveguide mode having a wave length λ_2 .

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In the example of the invention best realization, ducting layer 4 with a thickness of 50 μm is made of polycarbonate with a refraction index $n_1=1.5$, insulating layer 5 of 2 μm in thickness is made of polymethyl acrylate alloyed with
10 spirobenzopyran having a refraction index $n_1=1.5$. The said photochromic material has two stable forms: spiropyran and merocyanine. Transition from the first form to the second form is carried out under the effect of ultraviolet radiation.

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Realization of invention

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Claimed multilayer optical disk 1 operates as follows. In the recording mode, the radiation is directed at a wave length λ_1 to focusing system 2 thus providing for positioning of the light beam focusing fields at a wave length λ_1 inside multilayer optical disk 1. Recording of information is carried out by changing the optical properties of photochromic material in information layer 6 selected for recording. In the readout
25 mode, information readout device 3 directs the radiation at a wave length λ_2 to ducting layer 4 adjoining addressable information layer 6. The waveguide mode limited by insulating layers 5 adjacent on one side to addressable information layer 6 and on the other side, to light ducting layer 4, propagates over
30 specified ducting layer 4 and information layer 6, and interacts with the pixels containing the recorded information. The data readout is performed by registering the fluorescent radiation at a wave length λ_3 excited by radiation with a wave length λ_2

in those pixels of the information layer, which were
previously illuminated by the radiation with a wave length λ_1 .
The fluorescent radiation emitted by these pixels partially
gets into the aperture of focusing system 2 and then, it
arrives at the receiver input.

The inventor failed to disclose multilayer optical disks
containing the adjoining ducting and information layers with
evened refraction indices among the solutions known in the
scientific and technical publications, which is indicative of
the fact that the invention corresponds to the novelty
criterium. Within the framework of this approach, there is
substantiated a sufficiency of essential features for attainment
of the claimed technical result.

When estimating the importance of invention for industrial
use, it is necessary to point out that production of the
claimed multilayer optical disk does not require application
of precise technologies as distinct from the analogs.

Claims

1. A multilayer optical disk consisting of a series of
5 alternating layers of optically transparent materials
combined into groups incorporating a ducting layer of
material with a refraction index of n_1 lying between the
insulating layer of material with a refraction index n_2
satisfying the interrelationship $n_2 < n_1$ and a layer of
10 photochromic material with a refraction index n_3 , the
refraction indices of materials of the ducting and
information layers satisfy the condition $|n_3 - n_1| < 0.001$.
2. The multilayer optical disk according to claim 1,
15 characterized by that the thickness of information layer d
satisfies the condition $1 \mu\text{m} < d < 10 \mu\text{m}$.
3. The multilayer optical disk according to claim 1,
characterized by that the thickness of information layer D
20 satisfies the condition $5 \mu\text{m} < D < 100 \mu\text{m}$.
4. The multilayer optical disk according to claim 1,
characterized by that the thickness of insulating layer δ
satisfies the condition $1 \mu\text{m} < \delta < 5 \mu\text{m}$.

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