

METHOD OF AND APPARATUS FOR FORMING OPTICAL DISKS

The present invention relates to a method and an apparatus for forming optical disks.

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Fig. 6 shows a known optical disk forming method, in which a dose of resin material is fed by a sprue 6 into a space between a stamper 1 fixedly mounted on a lower mold 2 and an upper mold 10, impressed with a pattern of rises 10 and falls engraved in the stamper 1, and is cooled down. After the two molds are opened, the formed resin is upwardly ejected together with the sprue 6 by an eject rod 7 for removal from the lower mold 2. When the ejecting action is completed, the formed product is taken 15 out from the forming apparatus by the action of a transfer mechanism. Numerals 8 and 9 in Fig. 6 denote a gate cut punch and a cylinder, respectively.

During the above described process of forming optical 20 disks, the stamper 1 suffers a stress created by heat and viscosity of the resin upon receiving the resin from the sprue 6. The stress yields a force of friction between the lower mold 2 and the stamper 1 hence causing abrasion of the stamper 1 and the mold 2. This is generally 25 called "cohesive abrasion", and causes a transfer of constituents between the stamper 1 and the mold 2. As a result, humps of a few micrometers high are created on the mold 2 causing the stamping surface of the stamper 1

to undulate and a resultant stamped product to be defective. It is thus necessary to exchange stampers 1 before the quality of the resultant stamped products exceeds a permissible limit. Since this exchanging operation of stampers 1 takes a lot of time, the efficiency of production is declined. Also, a high level of cleanness is required, and the overall cost for maintenance is thus increased.

10 The surface of the mold 2 is often coated with an appropriate material to protect the stamper 1 and to decrease the number of times for exchanging the stampers. The coating material is, however, commonly made of titanium nitride (TiN), which increases abrasion-proof capacity of the surface of the mold 2 but also causes even severer abrasive friction between the mold 2 and the stamper 1. Although the stamper 1 becomes less susceptible to the cohesive abrasion, its mechanical characteristics is hardly maintained.

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For this reason, the mold 2 is sometimes applied with wax or lubricant oil. However, it is difficult to form a perfectly even film of lubricant agent, and also, the lubricant agent must be repeatedly applied. Adhesive lubricant agent tends to invite dust and dirt adhered thereto, which causes defective products, with the contour of the dust or dirt transferred on the formed product.

In view of the foregoing, it is an object of the present invention to provide a method and an apparatus for forming optical disks which successfully decreases
5 frictional force generated between a stamper, a mold, and a cassette to prevent abrasion of the stamper, as well as favorably maintains thermal conductivity between the mold and the cassette, thereby increasing the productivity and improving the quality and yield of products.

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The above said object is basically attained by providing a method of forming optical disks comprising the step of forming a layer of metal or metallic compound between a mold and a stamper or a cassette with a built-in stamper
15 which is fixedly placed on a predetermined location in the mold for impressing patterns on a surface of an optical disk board in a process of forming optical disks. The metal or metallic compound layer may be mainly made of at least one of Ge, Ag, In, Sn, Th, Sb, Pb, Bi, Cu,
20 Se, Cd, Tl, and Au.

The above said object is also attained by providing a method of forming optical disks comprising the step of forming a layer of metal or metallic compound between a
25 cassette fixedly placed on a predetermined location in a mold and a stamper built in the cassette for impressing patterns on a surface of an optical disk board in a process of forming optical disks. The metal or metallic

compound layer may be mainly made of at least one of Ge, Ag, In, Sn, Th, Sb, Pb, Bi, Cu, Se, Cd, Tl, and Au.

In accordance with the present invention, the frictional
5 force generated between the mold and stamper is absorbed
by the deformation of the layer of metal or metallic
compound provided therebetween. As a result,
deterioration of the stamper is restrained and quite a
large number of optical disks can be formed with a single
10 stamper, contributing to increase in productivity.

Other and further objects, features and advantages of the
invention will appear more fully from the following
description.

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Fig. 1 is a schematic model view showing the relation
between a nozzle, molds, and a stamper in a first
embodiment of the present invention;

20 Fig. 2 is a schematic model view showing a contacting
part between the mold and the stamper of the first
embodiment;

Fig. 3 is a schematic model view showing a contacting
25 part between a mold and a cassette in a second embodiment
of the present invention;

Fig. 4 is a quantitative diagram of thermal conditions in the second embodiment in comparison between the presence and the absence of an air layer;

5 Fig. 5 is a schematic model view showing a contacting part between a mold and a stamper in a third embodiment of the present invention; and

Fig. 6 is a schematic model view showing a contacting
10 part between a mold and a stamper in a conventional forming apparatus.

Preferred embodiments of the present invention will be hereinafter described in conjunction with Figs. 1 to 5.

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(First Embodiment)

Fig. 1 is a schematic model view showing the relation between a nozzle 11, a pair of molds 2 and 10, and a stamper 1 in an optical disk forming apparatus
20 according to a first embodiment of the present invention.

Fig. 2 is an enlarged view of the area P encircled by a solid line in Fig. 1. More specifically, Fig. 2 shows schematically a contacting part between the mold 2 and the stamper 1 in the first embodiment. As shown in Figs.
25 1 and 2, a metallic layer 3 is provided between the stamper 1 and the mold 2 which fixedly supports the stamper 1. The metallic layer 3 is mainly composed of at least one of germanium (Ge), silver (Ag), indium (In),

tin (Sn), thorium (Th), antimony (Sb), lead (Pb), bismuth (Bi), copper (Cu), selenium (Se), cadmium (Cd), thallium (Tl), and gold (Au). Optical disks are stamped in a similar manner as described with respect to the prior art.

The stamper 1 is heated on inpouring of a resin material and stretched by the influence of thermal expansion thereof as well as a tension caused by the viscosity of the resin material. Since the mold 2 is free from the tension caused by the viscosity of the resin material, a frictional force is exerted to the metallic layer 3 between the mold 2 and the stamper 1. The metallic layer 3 made of soft metal absorbs the energy of frictional force or a stress from the resin material by deformation of itself. Consequently, the metallic layer 3 helps lessen the load on the stamper 1 and lengthen its life.

According to the first embodiment, the provision of the metallic layer 3 between the stamper 1 and the mold 2 greatly increases the productivity. Specifically, a single stamper 1 is able to produce approximately 60,000 optical disks while one stamper 1 in a prior arrangement could only produce about 30,000 disks.

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Instead of the metal layer, a layer of laminated solids may be provided to the interface between the mold 2 and the stamper 1. As the laminated solids deform in

accordance with the thermal and physical expansion or shrinkage of the stamper 1, the stress exerted to the stamper 1 is effectively absorbed. Deterioration of the stamper 1 is thus minimized, leading to increase in productivity. The laminated solid material further has an advantage of being easily exchangeable.

The layer provided between the stamper 1 and the mold 2 may also be made of fluorine compound. The fluorine compound prevents dust and dirt from adhering thereto as well as allows them to be easily rubbed off. It is thus prevented that the stamper 1 is damaged or deformed by an inadvertent operation in cleaning, thereby improving the efficiency in handling of the stampers 1.

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Further, the layer provided to the interface between the stamper 1 and the mold 2 may be made mainly of a compound including boron (B), carbon (C), or nitrogen (N). The compound composed of B, C, or N remains rigid in any conditions and helps reduce abrasion of the stamper 1.

As the stamper 1 is strengthened, it can be used for a longer time, thereby improving productivity. The above mentioned hard material also permits dirt or dust on the surface thereof to be easily removed.

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(Second Embodiment)

Fig. 3 is a schematic model view showing a contacting part between the mold 2 and a cassette 4

equipped with a built-in stamper in the optical disk forming apparatus according to a second embodiment of the present invention. As shown in Fig. 3, the metallic layer 3 is provided between the mold 2 and the cassette 5 4. The metallic layer 3 is substantially identical to the one described with respect to the first embodiment.

The cassette 4 is joined by the metallic layer 3 to the mold 2, between which there is no air layer thus
10 eliminating any insulated parts. The thermal conductivity is hence increased between the mold 2 and the cassette 4 so that the temperature control over the cassette 4 can be conducted with much ease. Fig. 4 illustrates a qualitative comparison of thermal
15 conditions when there is an air layer and there is not. The temperature of the cassette 4 is maintained substantially at the same level as that of the mold 2 by the provision of the metallic layer 3, facilitating production of good quality optical disks.

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Instead of the metal layer, a layer of laminated solids may be provided to the interface between the mold 2 and the cassette 4. The laminated solid material helps reduce the stress exerted to the stamper 1 by internal
25 deformation of itself. It also has an advantage of being easily exchangeable, facilitating the maintenance operation and quality control.

The layer provided to the interface between the mold 2 and the cassette may also be a fluorine compound which prevents generation of metallic powders created by sliding movements between both metallic members. It also prevents air layer between the mold 2 and the cassette 4 and helps enhancing the thermal conductivity.

As set forth above, the second embodiment of the present invention is capable of maintaining the temperature difference between the mold 2 and the cassette 4 at less than 1°C, thereby contributing to improved quality of the products.

(Third Embodiment)

Fig. 5 is a schematic model view showing a contacting part between the mold 2 and the stamper 1 in the optical disk forming apparatus according to a third embodiment of the present invention. Numeral 5 denotes a film 5 of hard material mainly composed of boron nitride.

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The film 5 is directly deposited on the contacting surfaces between the stamper 1 and the mold 2, and capable of limiting the extension or shrinkage of the stamper 1 while allowing the sliding movements between the stamper 1 and the mold 2. The provision of the film 5 prevents the friction normally created on the sliding surface of the stamper 1, enabling the stamper to be continuously used with the initial characteristics

maintained. The film 5 is made of as a hard material as Hk 3,500 to 10,000, and thus is hardly worn down by friction even when powders of ceramic compounds such as TiN and TiC or metal oxide are generated on the sliding surfaces thereof. Also, dirt or dust adhered to the film 5 can be rubbed away without marking the surface of the film 5. The quality of stamped products can be thereby stably controlled. The film 5 may be made of DLC (diamond-like carbon) or boron carbide instead of boron nitride with equal effects and advantages.

As set forth above, the film 5 between the stamper 1 and the mold 2 protects the stamper 1 hence contributing to the stable quality of products and increasing the productivity.

Instead of providing a protective layer or film between the mold 2 and the stamper 1 or between the mold 2 and the cassette 4 equipped with a built in stamper, it is also advantageous to provide a layer of laminated solid material or fluorine compound to the interface between the stamper 1 and the cassette 4. The layer of laminated solid material can be disposed to a surface of the stamper 1 which is contacted with the cassette 4 in the process of producing the stamper 1, which facilitates the mounting of the stamper 1 onto the cassette 4 as well as prevents deterioration of the stamper 1 caused by friction between itself and the cassette 4. The

provision of the fluorine compound to a surface of the
stamper 1 helps maintain the initial composition of the
stamper 1, for a metallic material hardly diffuses in a
fluorine compound. Metallic characteristics of the
5 stamper 1 can be thereby maintained for a longer period
of time.

CLAIMS

1. An apparatus for forming optical disks, characterized by having: a mold (2); a stamper (1)
5 fixedly placed in a predetermined position in the mold (2) for impressing patterns on an optical disk board; and a layer (3) of metal or metallic compound disposed between the mold (2) and the stamper (1), the layer (3) being mainly composed of at least one of In, Sn, Sb, Pb,
10 and Bi.

2. An apparatus for forming optical disks, characterized by having: a mold (2); a cassette (4) equipped with a built-in stamper and fixedly placed in a
15 predetermined position in the mold (2) for impressing patterns on an optical disk board; and a layer (3) of metal or metallic compound disposed between the mold (2) and the cassette (4), the layer (3) being mainly composed of at least one of In, Sn, Sb, Pb, and Bi.

3. An apparatus for forming optical disks, characterized by having: a mold (2); a cassette (4) equipped with a build-in stamper and fixedly placed in a predetermined position in the mold (2) for impressing
5 patterns on an optical disk board; and a layer (3) of metal or metallic compound disposed between the cassette (4) and the built-in stamper, the layer (3) being mainly composed of at least one of In, Sn, Sb, Pb, and Bi.

10 4. An apparatus for forming optical disks, characterized by having: a mold (2); a stamper (1) fixedly placed in a predetermined position in the mold (2) for impressing patterns on an optical disk board; and a layer of compound composed of at least one of B, C, N
15 disposed on a surface of the stamper (1) contacted with the mold (2).

5. An apparatus for forming optical disks according to claim 4, wherein the layer of compound is
20 one of a group consisting of boron nitride, boron carbide, and diamond-like carbon.