

Optical Pick-up and Setting Block

The present invention relates to an improvement in an optical pickup, particularly in an optical system setting block thereof, which is used in compact disk, laser disk, video disk, photoelectromagnetic disk or the like.

Brief Description of the Drawings:

Fig. 1 is a rough side view of an example of the optical system setting block for an optical pickup according to the present invention, Fig. 2 is a rough front view thereof and Fig. 3 is a rough sectional view taken along line III - III of Fig. 2.

As shown in Fig. 3, the optical system of an optical pickup generally comprises a light emitting element 1, an object lens 2 for directing a detected light from the light emitting element 1 to a recording medium, a photodetector 3 for receiving a reflected light from the recording medium and a reflector 4 for changing the direction of the axis of a reflected light into a direction different from that of the light from the light emitting element 1 as a principal component and additionally a diffraction grating 5, a collimator lens 6, a convex lens 7 and the like as attachments. Up to this time, an aluminum setting block 8 having a shape

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as shown in Figs. 1 to 3 has been used to set these optical parts in specified relative positions and the object lens 2 has been set by employing the block 8 as the reference standard.

Recently, a metallic part has been replaced with a plastic one in many fields. However, plastic generally exhibits a larger coefficient of expansion and a higher degree of change in dimensional accuracy depending upon temperature change or humidity change (because of its hygroscopicity) than those of metal, so that many precision parts are still made of metal.

On the other hand, it is difficult to mass-produce a metallic article having specified dimensions by a simple process, while a plastic one can be easily produced by injection. Though a so-called die casting method is known as a process similar to injection, an article produced by this method exhibits remarkably lower dimensional accuracy than that of one produced by injection, so that this article must be further finished into specified dimensions by cutting, resulting in an increase in the number of production steps.

Although many attempts to make an optical pick-off of plastic have been made up to this time, even an engineering plastic which has been used instead of metal, for example, nylon 66, glass fiber-reinforced polyester, polyacetal resin, polyphenylene ether

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resin, polyphenylene sulfide resin or polycarbonate resin was not suitable for the production of an optical system setting block for an optical pickup which requires a high dimensional accuracy, because of its insufficient reliability on changes in accuracy with time.

The inventors of the present invention have studied the production of an optical pickup made of plastic and have found that an optical pickup exhibiting very small changes in dimensional accuracy with time can be obtained by making an optical system setting block thereof from a melt-processable polyester which can form an anisotropic molten phase (hereinafter abbreviated as "liquid-crystal polyester"). The present invention has been accomplished on the basis of this finding.

An optical pickup of the invention comprises an optical system-setting block moulded from a polyester being capable of forming the anisotropic phase in the molten state and being melt-processable.

In the practical view, the optical pickup comprises a principal optical system, an additional optical system and a setting block to locate the components for the systems, said block having been made of said polyester.

The liquid-crystal polyester to be used in the

present invention is melt-processable and is characterized in that molecular chains thereof in a molten state are regularly arranged in parallel. Such an arranged state of molecules is sometimes called a liquid-crystal state or a nematic phase of a liquid-crystal substance. Such a polymer is slender and flat, exhibits a relatively high rigidity along the major axis of a molecule and is generally prepared from a monomer having a plurality of chain-lengthening bonds which are present coaxially or in parallel with each other.

The characteristics of an anisotropic molten phase can be confirmed by an ordinary deflection method utilizing a crossed polarizer. Particularly, an anisotropic molten phase can be confirmed by observing a sample placed on a Leitz* hot stage in a nitrogen atmosphere with a Leitz* polarization microscope of forty magnifications. The above polymer is optically anisotropic. That is, when a sample of the polymer is examined between crossed polarizers, light is transmitted. If the sample is optically anisotropic, polarized light must be transmitted even in a static state.

Examples of the components for constituting the above polymer which can form an anisotropic

(* Leitz is a Registered Trade Mark)

molten phase include

- (1) One or more of aromatic dicarboxylic acids and/or cycloaliphatic dicarboxylic acids,
- (2) One or more of aromatic diols, cycloaliphatic diols and/or aliphatic diols,
- (3) One or more of aromatic hydroxycarboxylic acids,
- (4) One or more of aromatic thiolcarboxylic acids,
- (5) One or more of aromatic dithiols and/or aromatic thiolphenols, and
- (6) One or more of aromatic hydroxylamines and/or aromatic diamines.

while those of the polymer which can form an anisotropic molten phase are as follows:

GROUP A

- I) polyesters comprising components (1) and (2),
- II) polyesters comprising component (3) alone,
- III) polyesters comprising components (1), (2), and (3),
- IV) polythiol esters comprising component (4) alone,
- V) polythiol esters comprising components (1) and (5),
- VI) polythiol esters comprising components (1), (4), and (5),
- VII) polyesteramides comprising components (1), (3), and (6), and

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VIII) polyester amides comprising components ①, ②, ③ and ⑥.

Further, the polymer which can form an anisotropic molten phase may be aromatic polyazomethine, though it is not belonging to the above categories. Examples thereof include poly(nitrilo-2-methyl-1,4-phenylenenitriloethylidyne-1,4-phenyleneethylidyne); poly(nitrilo-2-methyl-1,4-phenylene-nitrilomethylidyne-1,4-phenylenemethylidyne) and poly(nitrilo-2-chloro-1,4-phenylenenitrilomethylidyne-1,4-phenylene-methylidyne).

Furthermore, the polymer which can form an anisotropic molten phase may be polyester carbonate, though it is not belonging to the above categories. Such polyester carbonate essentially comprises 4-oxybenzoyl, dioxyphenyl, dioxycarbonyl and terephthaloyl units.

Now, examples of the components for constituting the polymers I) to VIII) will be described.

Examples of the aromatic dicarboxylic acid include aromatic dicarboxylic acid such as terephthalic, 4,4'-diphenyldicarboxylic, 4,4'-triphenyldicarboxylic, 2,6-naphthalenedicarboxylic, diphenyl ether-4,4'-dicarboxylic, diphenoxyethane-4,4'-dicarboxylic, diphenoxybutane-4,4'-dicarboxylic,

diphenylethane-4,4'-dicarboxylic, isophthalic, diphenyl ether-3,3'-dicarboxylic, diphenoxyethane-3,3'-dicarboxylic, diphenylethane-3,3'-dicarboxylic and naphthalene-1,6-dicarboxylic acids and alkyl-, alkoxyl- and halogen-substituted derivatives thereof, such as chloroterephthalic, dichloroterephthalic, bromoterephthalic, methylterephthalic, dimethylterephthalic, ethylterephthalic, methoxyterephthalic and ethoxyterephthalic acids.

Examples of the cycloaliphatic dicarboxylic acid include cycloaliphatic dicarboxylic acids such as trans-1,4-cyclohexanedicarboxylic, cis-1,4-cyclohexanedicarboxylic and 1,3-cyclohexanedicarboxylic acids and alkyl-, alkoxy- and halogen-substituted derivatives thereof, such as trans-1,4-(1-methyl)cyclohexanedicarboxylic and trans-1,4-(1-chloro)cyclohexanedicarboxylic acids.

Examples of the aromatic diol include aromatic diols such as hydroquinone, resorcinol, 4,4'-dihydroxydiphenyl, 4,4'-dihydroxytriphenyl, 2,6-naphthalenediol, 4,4'-dihydroxydiphenyl ether, bis(4-hydroxyphenoxy)ethane, 3,3'-dihydroxydiphenyl, 3,3'-dihydroxydiphenyl ether, 1,6-naphthalenediol, 2,2-bis(4-hydroxyphenyl)propane and 2,2-bis(4-hydroxyphenyl)methane and alkyl-, alkoxy- and halogen-

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substituted derivatives thereof, such as chlorohydroquinone, methylhydroquinone, 1-butylhydroquinone, phenylhydroquinone, methoxyhydroquinone, phenoxyhydroquinone, 4-chlororesorcinol and 4-methylresorcinol.

Examples of the cycloaliphatic diol include cycloaliphatic diols such as trans-1,4-cyclohexanediol, cis-1,4-cyclohexanediol, trans-1,4-cyclohexanedi-methanol, cis-1,4-cyclohexanedimethanol, trans-1,3-cyclohexanediol, cis-1,2-cyclohexanediol and trans-1,3-cyclohexanedimethanol and alkyl-, alkoxy- and halogen-substituted derivatives thereof, such as trans-1,4-(1-methyl)cyclohexanediol and trans-1,4-(1-chloro)cyclohexanediol.

The aliphatic diol may be either straight-chain or branched and examples thereof include ethylene glycol, 1,3-propanediol, 1,4-butanediol and neopentyl glycol.

Examples of the aromatic hydroxy carboxylic acid include aromatic hydroxy carboxylic acids such as 4-hydroxybenzoic, 3-hydroxybenzoic, 6-hydroxy-2-naphthoic and 6-hydroxy-1-naphthoic acids and alkyl-, alkoxy- and halogen-substituted derivatives thereof, such as 3-methyl-4-hydroxybenzoic, 3,5-dimethyl-4-hydroxybenzoic, 2,6-dimethyl-4-hydroxy-

benzoic, 3-methoxy-4-hydroxybenzoic, 3,5-dimethoxy-4-hydroxybenzoic, 6-hydroxy-5-methyl-2-naphthoic, 6-hydroxy-5-methoxy-2-naphthoic, 3-chloro-4-hydroxybenzoic, 2-chloro-4-hydroxybenzoic, 2,3-dichloro-4-hydroxybenzoic, 3,5-dichloro-4-hydroxybenzoic, 2,5-dichloro-4-hydroxybenzoic, 3-bromo-4-hydroxybenzoic, 6-hydroxy-5-chloro-2-naphthoic, 6-hydroxy-7-chloro-2-naphthoic and 6-hydroxy-5,7-dichloro-2-naphthoic acids.

Examples of the aromatic mercapto carboxylic acid include 4-mercaptobenzoic, 3-mercaptobenzoic, 6-mercapto-2-naphthoic and 7-mercapto-2-naphthoic acids.

Examples of the aromatic dithiol include benzene-1,4-dithiol, benzene-1,3-dithiol, 2,6-naphthalenedithiol and 2,7-naphthalenedithiol.

Examples of the aromatic mercapto phenol include 4-mercaptophenol, 3-mercaptophenol, 6-mercaptophenol and 7-mercaptophenol.

Examples of the aromatic hydroxylamine and the aromatic diamine include 4-aminophenol, N-methyl-4-aminophenol, 1,4-phenylenediamine, N-methyl-1,4-phenylenediamine, N,N'-dimethyl-1,4-phenylenediamine, 3-aminophenol, 3-methyl-4-aminophenol, 2-chloro-4-aminophenol, 4-amino-1-naphthol, 4-amino-4'-hydroxy-

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diphenyl, 4-amino-4'-hydroxydiphenyl ether, 4-amino-4'-hydroxydiphenylmethane, 4-amino-4'-hydroxydiphenyl sulfide, 4,4'-diaminophenyl sulfide (thiodianiline), 4,4'-diaminodiphenyl sulfone, 2,5-diaminotoluene, 4,4'-ethylenedianiline, 4,4'-diaminodiphenoxyethane, 4,4'-diaminodiphenylmethane (methylenedianiline) and 4,4'-diaminodiphenyl ether (oxydianiline).

Some of the above polymers I) to VIII) comprising some of the above components do not form any anisotropic molten phase depending upon the kind, ratio or sequence distribution of components. Therefore, the polymer to be used in the present invention is limited to only ones which can form an anisotropic molten phase among the polymers I) to VIII).

The above polyesters I), II) and III) and the polyester amide VIII) which are preferably used in the present invention as a polymer which can form an anisotropic molten phase can be prepared by various esterification processes from various organic monomers having functional groups which can form a desired repeating unit by condensation. For example, the functional group of these organic monomers may be carboxy, hydroxy, ester, acyloxy, acyl halide or amino group. The monomers can be reached according to a melt acidolysis process without the presence

of any heat exchange fluid. According to this process, a mixture of monomers is heated to obtain a melt. With the reaction proceeding, a polymer is generated to form a suspension of solid particles of the polymer in a liquid and generated volatiles (for example, acetic acid or water) are removed in the final step of the condensation. This removal can be easily carried out in vacuo.

Alternatively, a wholly aromatic polyester which is preferably used in the present invention can be prepared by a slurry polymerization process. According to this process, a solid product can be obtained in a state suspended in a heat exchange medium.

According either of the above two process, organic monomers which can form the wholly aromatic polyester may be used in the reaction in a modified form wherein the hydroxyl group thereof is esterified (i.e., as a lower acyl ester). The lower acyl group is preferably one having 2 to 4 carbon atoms. It is preferred to use acetates of such organic monomeric reactants.

Representative examples of the catalyst to be used in both the melt acidolysis process and the slurry process include dialkyltin oxide (for example,

dibutyltin oxide), diaryltin oxide, titanium dioxide, antimony trioxide, alkoxytitanium silicate, titanium alkoxide, alkali and alkaline earth metal salts of carboxylic acids (for example, zinc acetate), Lewis acids (for example, BF_3) and gaseous acid catalysts such as hydrogen halide (for example HCl). The amount of the catalyst used is generally about 0.001 to 1% by weight, preferably about 0.01 to 0.2% by weight based on the total amount of the monomers used.

The wholly aromatic polymer to be preferably used in the present invention tends to be substantially insoluble in an organic solvent, so that it is not suitable for solution processing. As described above, however, the polymer can be easily processed by an ordinary melt processing. Preferred examples of the wholly aromatic polymer are ones which are somewhat soluble in pentafluorophenol.

The wholly aromatic polyester to be preferably used in the present invention generally has a weight-average molecular weight of about 2,000 to 200,000, preferably about 10,000 to 50,000 and particularly preferably about 20,000 to 25,000, while the wholly aromatic polyester amide to be preferably used in the present invention generally has a molecular

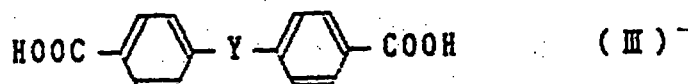
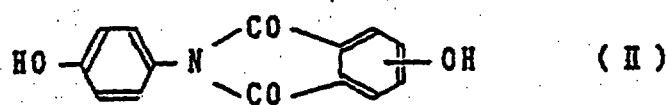
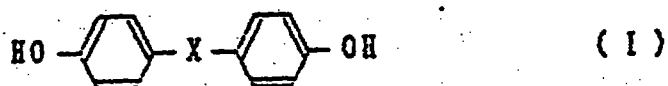
weight of about 5,000 to 50,000, preferably about 10,000 to 30,000, for example, 15,000 to 17,000. The measurement of these molecular weights can be carried out by gel permeation chromatography or other standard methods involving no formation of a polymer solution, for example, a method which comprises examining a compression molded film of such a polymer for terminal group content by infrared spectroscopy. Alternatively, it can be carried out by a light scattering method using a solution of such a polymer in pentafluorophenol.

A 0.1% (by weight) solution of the above wholly aromatic polyester or polyester amide in pentafluorophenol generally exhibits an inherent viscosity (I.V.) of at least about 2.0 dl/g, for example, about 2.0 to 10.0 dl/g at 60°C.

The polymer which can form an anisotropic molten phase to be used in the present invention is preferably an aromatic polyester or an aromatic polyester amide. Further, polyesters partially containing aromatic polyester units and aromatic polyester amide units in a molecular chain are also preferably used in the present invention.

Preferred examples of the component constituting the above polymers include naphthalene derivatives

such as 2,6-naphthalenedicarboxylic acid, 2,6-dihydroxynaphthalene, 1,4-dihydroxynaphthalene and 6-hydroxy-2-naphthoic acid; biphenyl compounds such as 4,4'-diphenyldicarboxylic acid and 4,4'-dihydroxybiphenyl; compounds represented by the following general formulas (I), (II) and (III):



wherein X stands for a group selected from among an alkylene group having 1 to 4 carbon atoms, an alkylidene group, -O-, -SO-, -SO₂-, -S- and -CO- and Y stands for a group selected from among -(CH₂)_n- and -O(CH₂)_nO- (wherein n is 1 to 4).

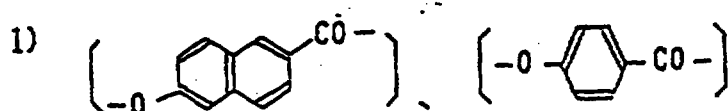
p-Substituted benzene derivatives such as p-hydroxy-

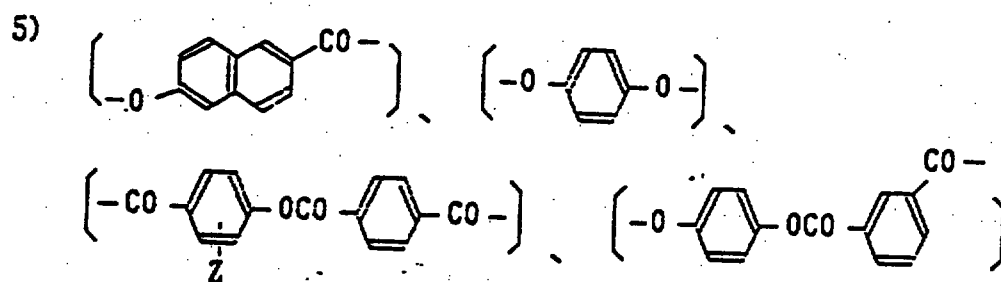
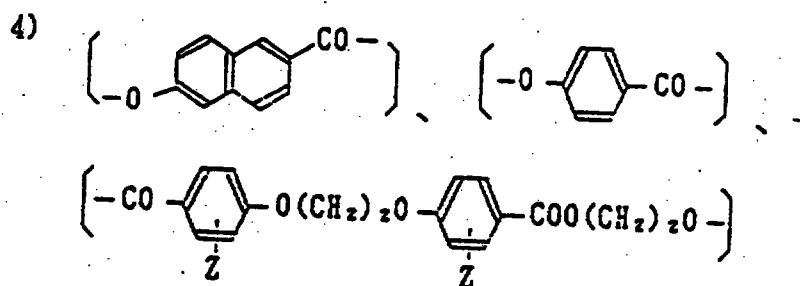
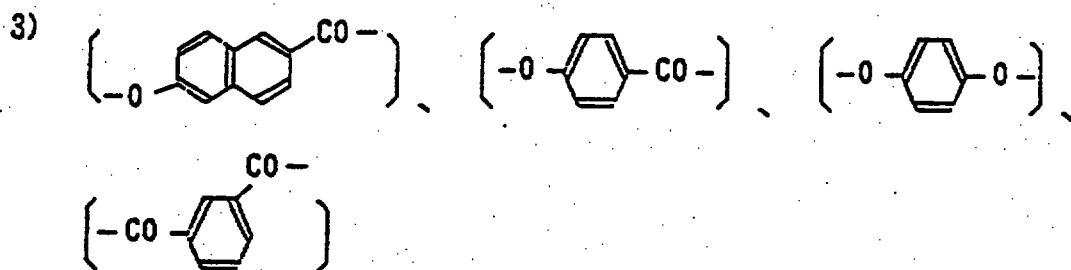
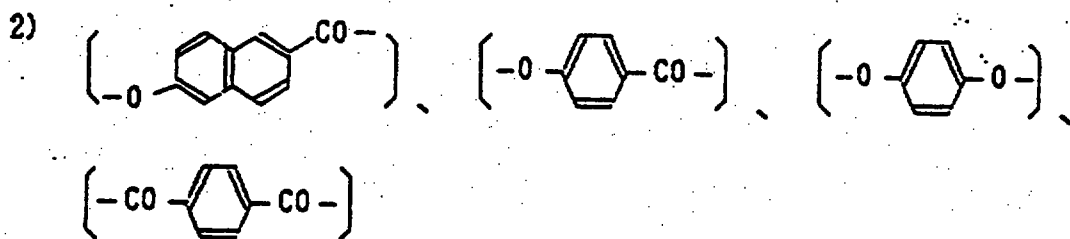
benzoic acid, terephthalic acid, hydroquinone, p-aminophenol and p-phenylenediamine and their derivatives which are substituted on their rings (wherein the substituent is selected from among chlorine, bromine, methyl, phenyl and 1-phenylethyl) and m-substituted benzene derivatives such as isophthalic acid and resorcinol.

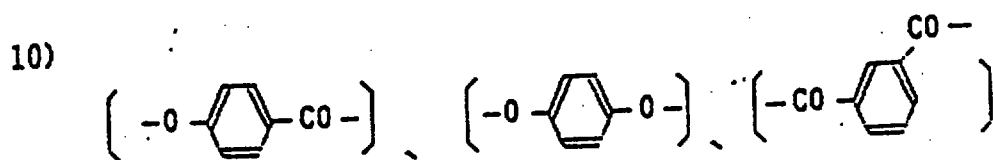
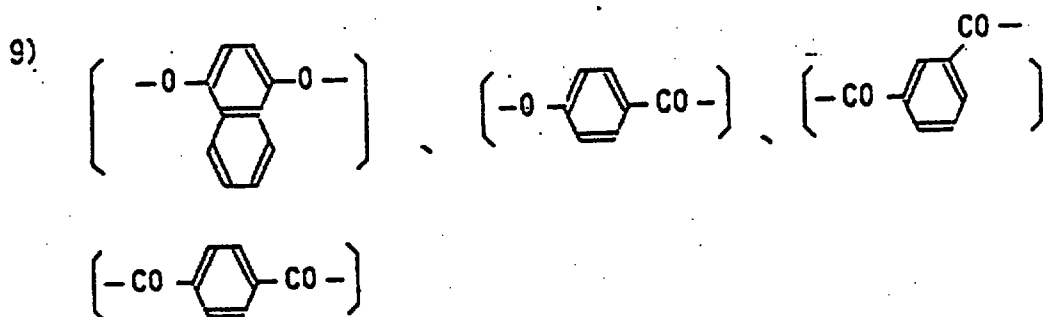
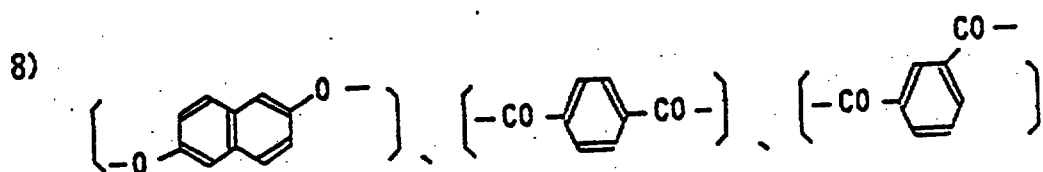
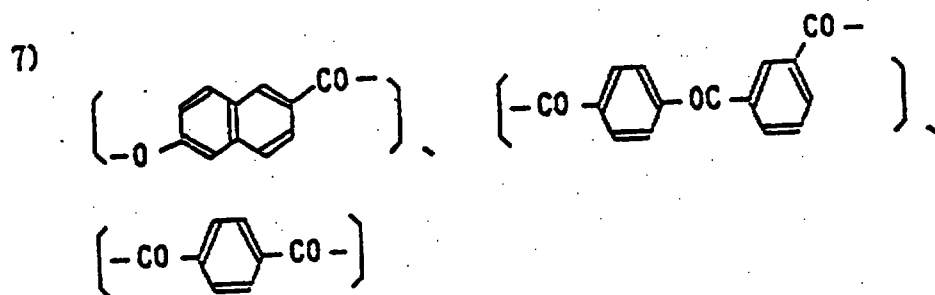
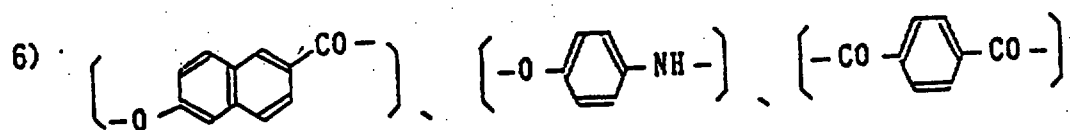
A preferred example of the polyester partially containing the above components in a molecular chain is polyalkylene terephthalate wherein said alkyl group has 2 to 4 carbon atoms.

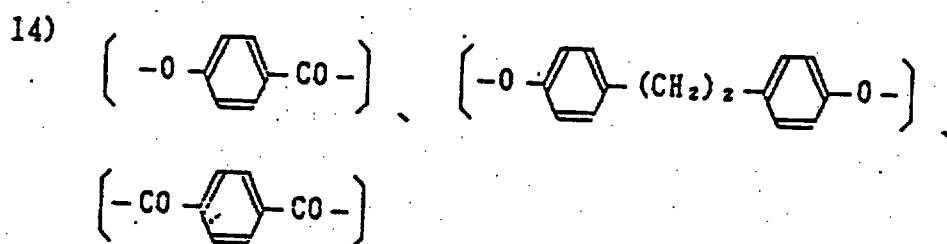
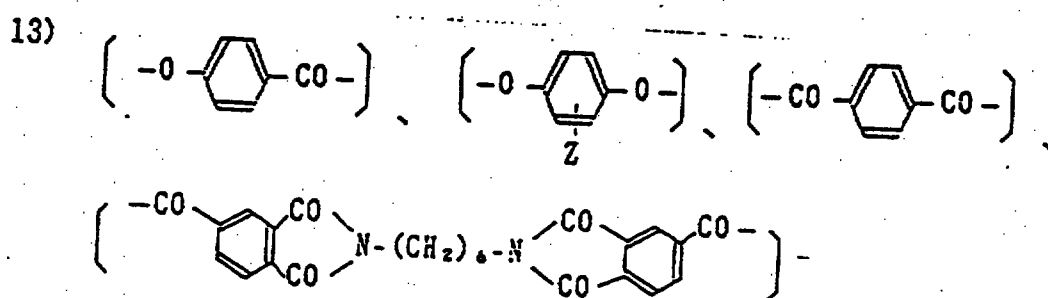
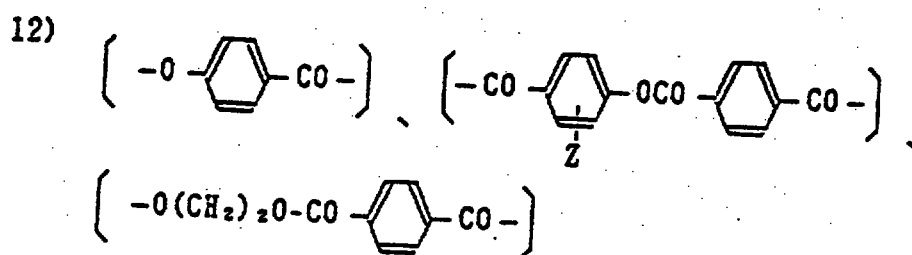
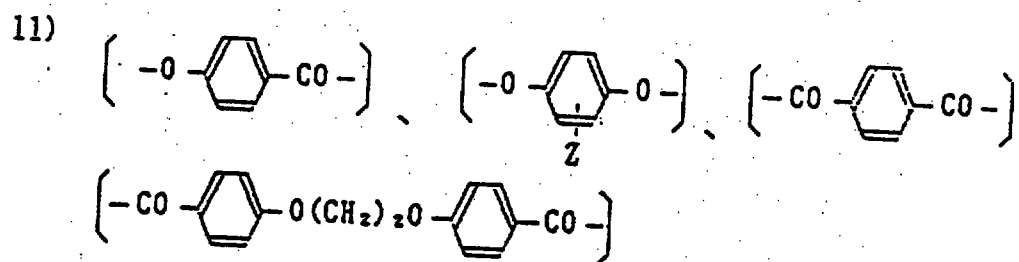
Particularly preferred examples include those containing as the essential components one or more compounds selected from the group consisting of naphthalene compounds, biphenyl compounds and p-substituted benzene derivatives among the above components. Furthermore, among the p-substituted benzene derivatives, p-hydroxybenzoic acid, methylhydroquinone and 1-phenylethylhydroquinone are especially preferred.

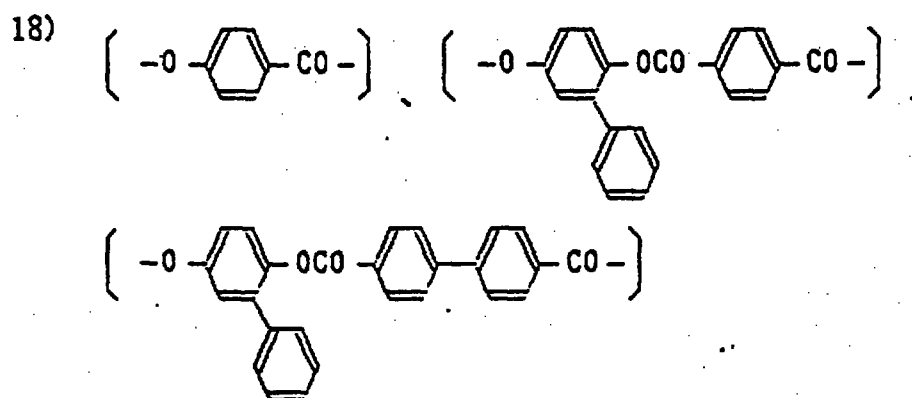
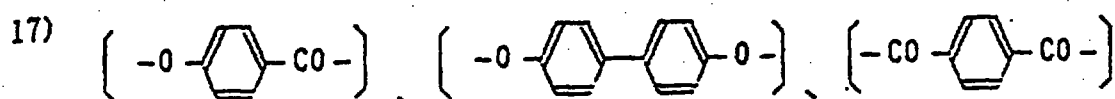
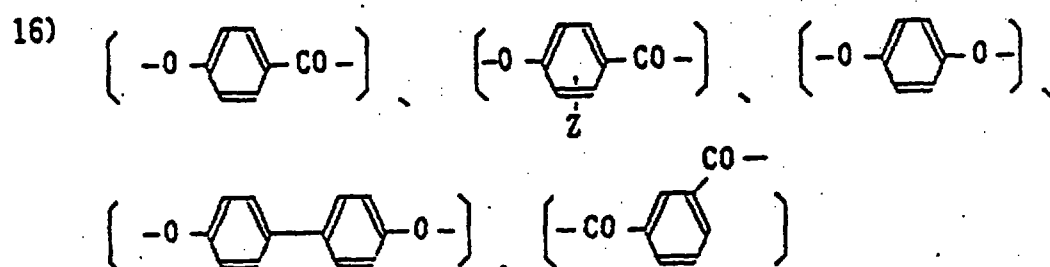
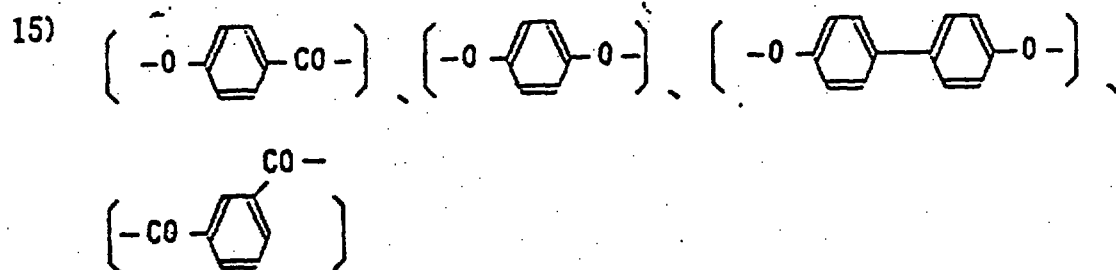
Examples of the particular combination of the components are as follows:

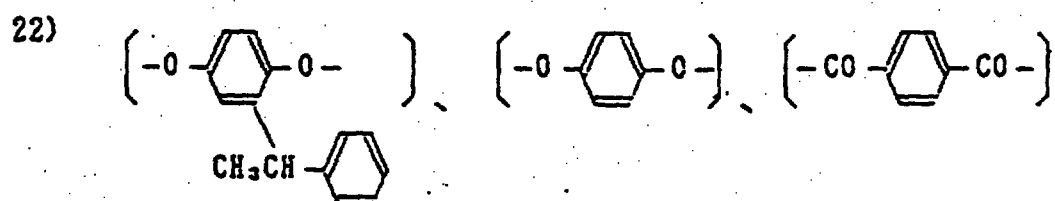
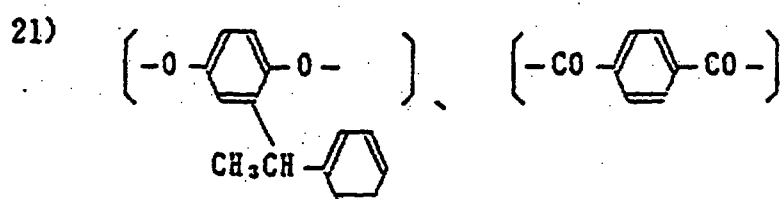
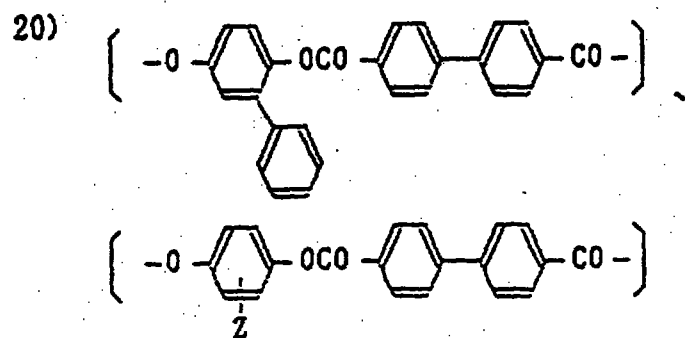
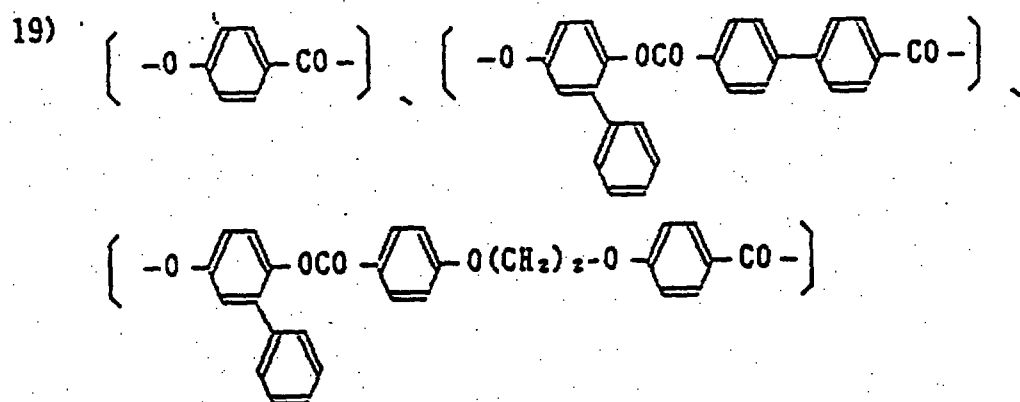


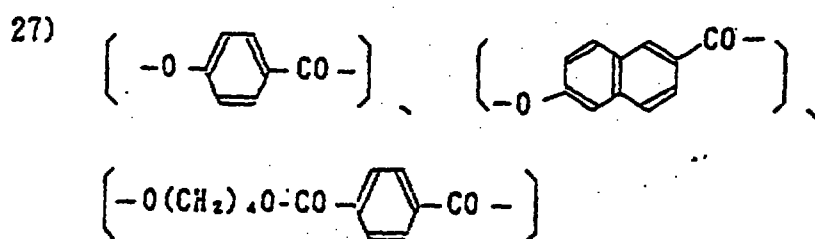
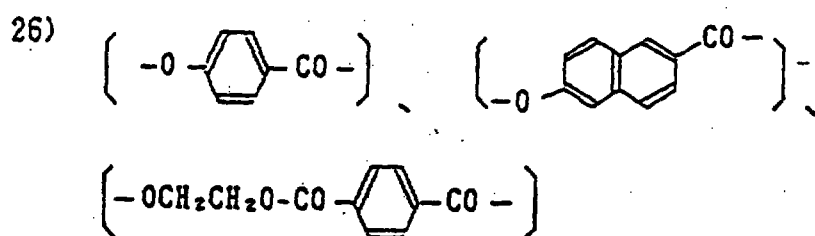
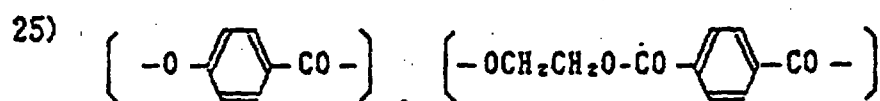
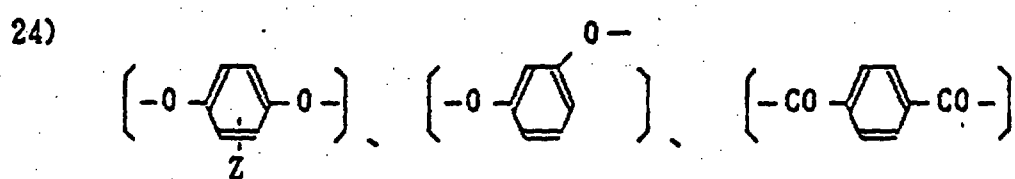
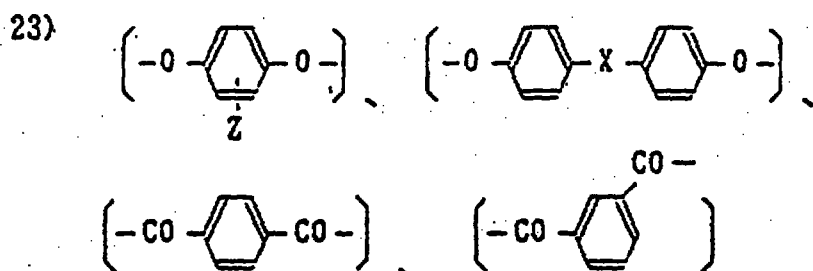








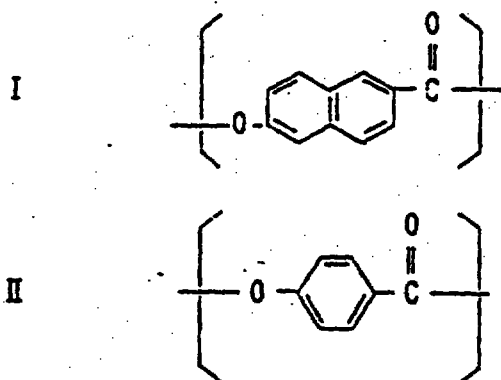




wherein Z is a substituent selected from among -Cl, -Br and -CH₃ and X is a substituent selected from among an alkylene having 1 to 4 carbon atoms, an alkylidene, -O-, -SO-, -SO₂-, -S- and -CO-.

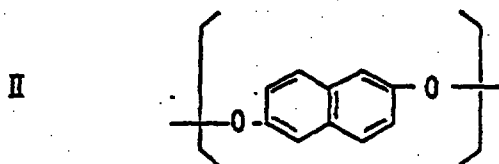
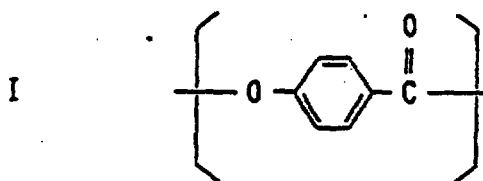
Preferred examples of the polyester which can form an anisotropic molten phase to be used in the present invention are ones containing at least 10 molar % of a repeating unit containing a naphthalene structure, such as 6-hydroxy-2-naphthoyl, 2,6-dihydroxynaphthalene or 2,6-dicarboxynaphthalene, while preferred examples of the polyester amide are ones containing a repeating unit comprising the above naphthalene structure and 4-aminophenol or 1,4-phenylenediamine. Preferred examples of the polyester and the polyester amide will now be described.

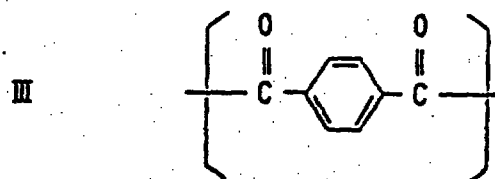
(1) Polyester substantially comprising the following repeating units I and II:



This polyester comprises about 10 to 90 molar % of the unit I and about 10 to 90 molar % of the unit II. According to an embodiment of the polyester, the unit I is contained in an amount of about 65 to 85 molar %, preferably about 70 to 80 molar % (for example, about 75 molar %), while according to another embodiment, the unit II is contained in a very small amount of about 15 to 35 molar %, preferably about 20 to 30 molar %. Further, one or more hydrogen atoms bonded to the ring may be replaced with a substituent selected from the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon atoms, a halogen atom, a phenyl group, a substituted phenyl group and a combination thereof.

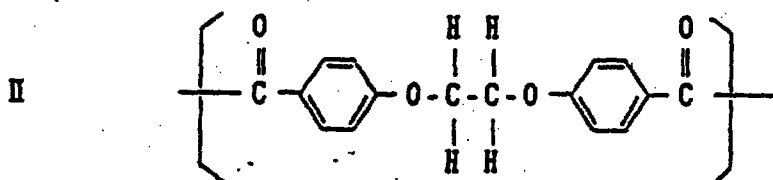
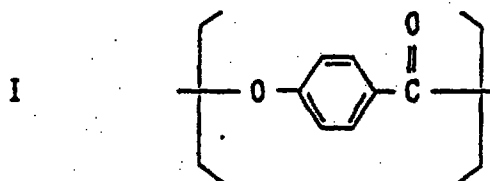
(2) Polyester substantially comprising the following repeating units I, II and III:

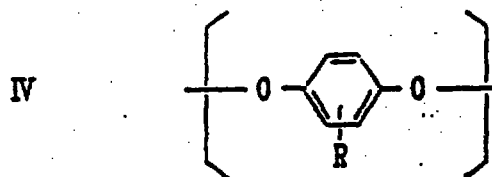
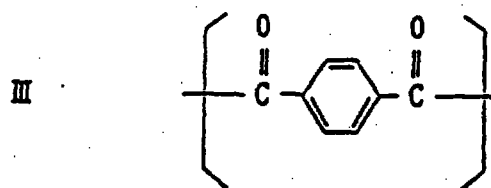




This polyester contains about 30 to 70 molar % of the unit I. It preferably comprises about 40 to 60 molar % of the unit I, about 20 to 30 molar % of the unit II and about 20 to 30 molar % of the unit III. Further, one or more hydrogen atoms bonded to the ring may be replaced with a substituent selected from the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon atoms, a halogen atom, a phenyl group, a substituted phenyl group and a combination thereof.

(3) Polyester substantially comprising the following repeating units I, II, III and IV:



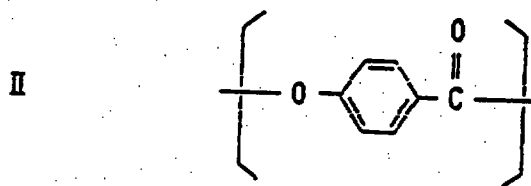
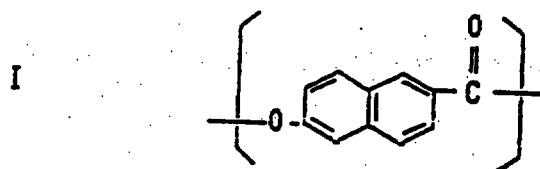


wherein R is a substituent replacing a hydrogen atom on the aromatic ring and stands for methyl, chloro or bromo or a combination thereof.

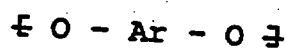
This polyester comprises about 20 to 60 molar % of the unit I, about 5 to 18 molar % of the unit II, about 5 to 35 molar % of the unit III and about 20 to 40 molar % of the unit IV, while it preferably comprises about 35 to 45 molar % of the unit I, about 10 to 15 molar % of the unit II, about 15 to 25 molar % of the unit III and about 25 to 35 molar % of the unit IV, with the proviso that the sum total of the molar % of the unit II and that of the unit III is substantially equal to that of the unit IV. Further, one or more hydrogen atoms bonded to the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon

atoms, a halogen atom, a phenyl group, a substituted phenyl group and a combination thereof. A 0.3% (w/v) solution of this wholly aromatic polyester in pentafluorophenol generally exhibits an inherent viscosity of at least 2.0 dl/g, for example, 2.0 to 10.0 dl/g at 60°C.

(4) Polyester substantially comprising the following repeating units I, II, III and IV:



III: dioxyaryl unit represented by the general formula:



wherein Ar stands for a divalent group containing at least one aromatic ring, and

IV: dicarboxyaryl unit represented by the general formula:



wherein Ar' stands for a divalent group containing at least one aromatic ring.

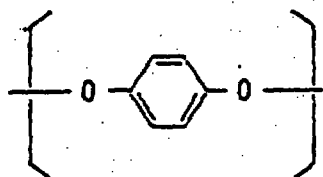
This polyester contains the unit I in an amount of about 20 to 40 molar %, the unit II in an amount which is exceeding 10 molar % and is not more than about 50 molar %, the unit III in an amount which is exceeding 5 molar % and is not more than about 30 molar % and the unit IV in an amount which is exceeding 5 molar % and is not more than about 30 molar %, while it preferably comprises about 20 to 30 molar % (for example, about 25 molar %) of the unit I, about 25 to 40 molar % (for example, about 35 molar %) of the unit II, about 15 to 25 molar % (for example, about 20 molar %) of the unit III and about 15 to 25 molar % (for example, about 20 molar %) of the unit IV. Further, one or more hydrogen atoms bonded to the ring may be replaced with a substituent selected from the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon atoms, a halogen atom, a phenyl group, a substituted phenyl group and a combination thereof.

It is preferred that the units III and IV are

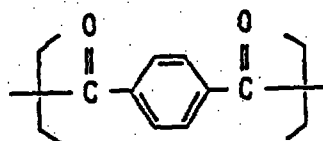
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symmetric wherein the term "symmetric" means that the two bondings which are each connected with other units on the both sides in a backbone chain of a polymer are present symmetrically on one or more rings (for example, when the bondings are present on a naphthalene ring, they are present at the relative p-positions to each other or on opposite rings). However, unsymmetric units such as ones derived from resorcinol or isophthalic acid can be also used.

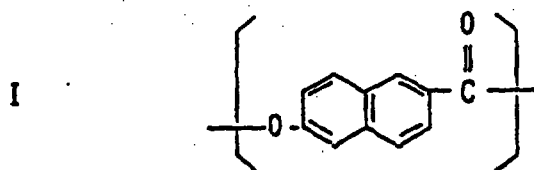
A preferred example of the dioxyaryl unit III is



, while that of the dicarboxyaryl unit IV is



(5) Polyester substantially comprising the following repeating units I, II and III:

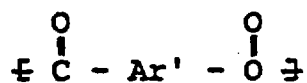


II: dioxyaryl unit represented by the general formula:



wherein Ar stands for a divalent group containing at least one aromatic ring, and

III: dicarboxyaryl unit represented by the general formula:



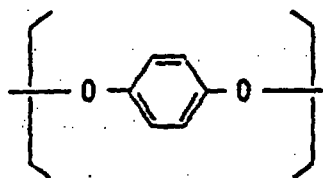
wherein Ar' stands for a divalent group containing at least one aromatic ring.

This polyester comprises about 10 to 90 molar % of the unit I, 5 to 45 molar % of the unit II and 5 to 45 molar % of the unit III, while it preferably comprises about 20 to 80 molar % of the unit I, about 10 to 40 molar % of the unit II and about 10 to 40 molar % of the unit III. Particularly, it preferably comprises about 60 to 80 molar % of the unit I, about 10 to 20 molar % of the unit II and about 10 or 20 molar % of the unit III. One or

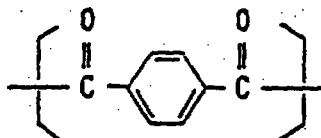
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more hydrogen atoms bonded to the ring may be replaced with a substituent selected from the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon atoms, a halogen atom, a phenyl group, a substituted phenyl group and a combination thereof.

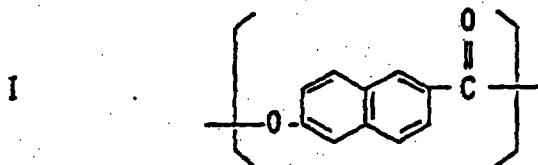
A preferred example of the dioxyaryl unit II is



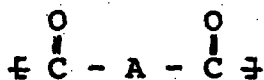
, while that of the dicarboxyaryl unit III is



(6) Polyester amide substantially comprising the following repeating units I, II, III and IV:



II: unit represented by the general formula:



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wherein A stands for a divalent group containing at least one aromatic ring or a divalent trans-cyclohexane group,

III: unit represented by the general formula:



wherein Ar stands for a divalent group containing at least one aromatic ring; Y stands for O, NH or NR and Z stands for NH or NR (wherein R stands for an alkyl group having 1 to 6 carbon atoms or an aryl group), and

IV: unit represented by the general formula:

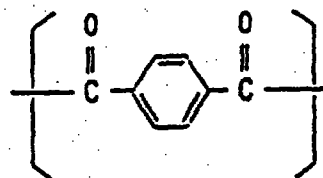


wherein Ar' stands for a divalent group containing at least one aromatic ring.

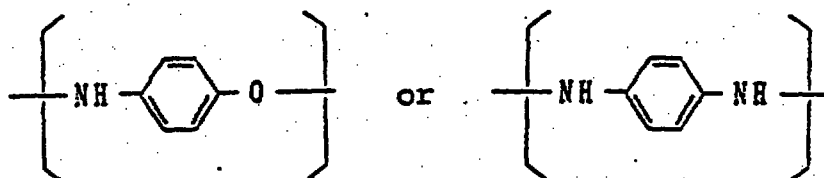
This polyester amide comprises about 10 to 90 molar % of the unit I, about 5 to 45 molar % of the unit II, about 5 to 45 molar % of the unit III and about 0 to 40 molar % of the unit IV. Further, one or more hydrogen atoms bonded to the ring may be replaced with a substituent selected from the group consisting of an alkyl group having 1 to 4 carbon atoms, an alkoxy group having 1 to 4 carbon atoms, a halogen atom, a phenyl group, a substituted phenyl

group or a combination thereof.

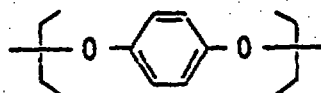
A preferred example of the dicarboxy unit II is



and that of the unit III is



, while that of the dioxyaryl unit IV is



Further, the polymer which can form an anisotropic molten phase to be used in the present invention may be a polymer wherein part of a polymer chain comprises a segment of the above polymer which can form an anisotropic molten phase and the other part thereof comprises a segment of a thermoplastic resin which cannot form such a phase.

The above liquid-crystal polyester is a high-strength material in cooperation with its self-reinforcing effect and exhibits a small coefficient

of linear expansion and a small mold shrinkage factor, so that the dimensional distortion thereof is small. Further, although it exhibits an excellent fluidity owing to its low melt viscosity, it is resistant to high temperature of 180 to 200°C. Furthermore, it is chemically inert to exhibit excellent resistance to chemicals, weather and hot water and has no influence on other materials.

According to the present invention, various inorganic fillers can be added to a liquid-crystal polyester depending upon the object to thereby further enhance the performance of an optical pickup. The inorganic filler may be any one which is generally added to a thermoplastic or thermosetting resin and examples thereof include fibrous fillers such as glass, carbon, metal, ceramic, boron and potassium titanate fibers and asbestos; powdery fillers such as potassium carbonate, highly dispersible silicate, alumina, aluminum hydroxide, talc, mica, glass flake, glass bead, quartz powder, quartz sand, wollastonite, various metal powders, carbon black, barium sulfate and plaster of Paris; inorganic compounds having a form of fine granule or plate, such as silicon carbide, alumina, boron nitride and silicon nitride and whisker and metallic

whisker. Further, the use of a conductive filler such as fibrous or powdery carbon is preferable from the viewpoint of the protection of semiconductor laser, because such a filler exhibits an antistatic effect.

Although a larger amount of a filler can give a better result, the amount is preferably at most 70% by weight based on the mixture thereof with a resin.

Further, any known additive which is generally added to a thermoplastic or thermosetting resin may be suitably used depending upon the required performance. Examples of the additive include plasticizer, stabilizer such as antioxidant or UV absorber, antistatic agent, flame retarder, coloring material such as dye or pigment, lubricant for improving fluidity or mold release characteristics and crystallization accelerator (nucleating agent).

The optical system setting block for an optical pickup made of the above melt-processable polyester according to the present invention can be easily obtained by an ordinary injection process.

[Effect of the Invention]

The optical system setting block for an optical pickup according to the present invention exhibited

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a smaller coefficient of linear expansion than that of a block made not only of other resin but also of aluminum to result in a small temperature dependence of dimensions. Further, the optical system setting block exhibited sufficiently excellent mechanical properties. Thus, it was confirmed that the optical system setting block according to the present invention exhibited excellent performance. For example, the block according to the present invention exhibits not only a smaller molding shrinkage, particularly a remarkably smaller coefficient of linear expansion, than that of a block made of a high-strength engineering plastic such as nylon 66, glass fiber-reinforced polyester, polyacetal, polyphenylene ether or polycarbonate or a composition thereof, particularly than that of a block made of polyphenylene sulfide (PPS) or a composition thereof which is particularly excellent among engineering plastics, but also a small dimensional change due to damping which is corresponding to about one-fifth of that of a block made of the above general engineering plastic and a flexural rigidity which is higher than that of a block made of the above general engineering plastic by about 50%. Thus, the block according to the

present invention exhibits overall performances equivalent to those of a block made of aluminum.

Further, the resin or composition thereof to be used in the present invention exhibits a smaller coefficient of linear expansion than that of aluminum and excellent fluidity, so that an optical system setting block can be very easily mass-produced only by molding without requiring cutting, while an aluminum block produced by die casting must be further cut. Thus, the present invention is expected to bring about a large cost reduction and a large merit as a whole.

The coefficient of linear expansion, dimensional change due to damping, shrinkage factor and flexural rigidity of a composition of Resin A, B, C or D or PPS resin containing 40% of glass fiber are shown in Table 1. The Resins A, B, C and D are prepared as described in the following Referential Examples 1 to 4, respectively, and used in the following Examples as a representative Example of the resin to be used in the present invention. It can be understood from Table 1 that the product of the present invention is excellent in these characteristics.

Table 1

	Resin A	Resin B	Resin C	Resin D	Aluminum	PPS
Coefficient of linear expansion cm/cm/°C	1.8×10^{-5}	2.0×10^{-5}	1.7×10^{-5}	1.6×10^{-5}	2.5×10^{-5}	3.0×10^{-5}
Dimensional change ^{*1} due to damping %	0.010	0.013	0.012	0.009	-	0.047
Shrinkage factor %	0.2	0.2	0.2	0.2	-	0.3
Flexural rigidity kg/cm ²	21×10^4	20×10^4	18×10^4	24×10^4	70×10^4	12×10^4

*1; 70°C x 95% RH x 500 hours (in the direction of flow)

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[Example]

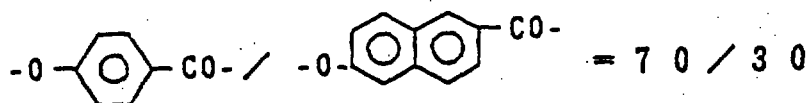
The present invention will be further described by the following Examples, though it is not limited to them.

Referential Example 1 (Resin A)

1261 parts by weight of 4-acetoxybenzoic acid and 691 parts by weight of 6-acetoxy-2-naphthoic acid were fed to a reactor fitted with a stirrer, a nitrogen gas inlet tube and a distilling-off tube. The content was heated to 250°C in a nitrogen atmosphere and vigorously stirred at 250°C for 3 hours and at 280°C for 2 hours, while distilling off acetic acid from the reactor. The content was heated to 320°C. After stopping the introduction of nitrogen, the internal pressure of the reactor was gradually reduced to 0.1 mmHg over a period of 20 minutes. The content was further stirred at this temperature under this pressure for 1 hour.

The obtained polymer had an intrinsic viscosity of 5.4 as determined in pentafluorophenol at 60°C with a concentration of 0.1% by weight.

The polymer comprised the following constituent units:



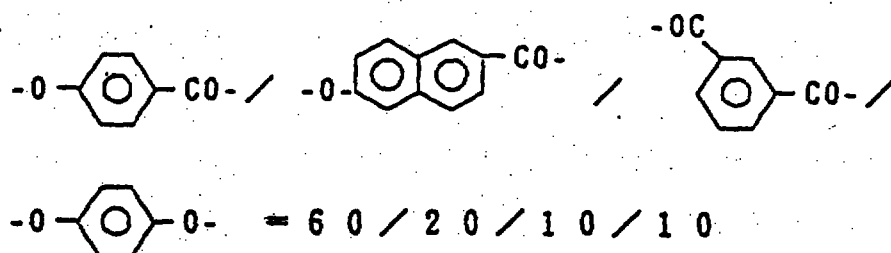
Referential Example 2 (Resin B)

1081 parts by weight of 4-acetoxybenzoic acid, 460 parts by weight of 6-acetoxy-2-naphthoic acid, 166 parts by weight of isophthalic acid and 194 parts by weight of 1,4-diacetoxybenzene were fed to a reactor fitted with a stirrer, a nitrogen gas inlet tube and a distilling-off tube. The content was heated to 260°C in a nitrogen atmosphere and vigorously stirred at 260°C for 2.5 hours and at 280°C for 3 hours, while distilling off acetic acid from the reactor. The content was heated to 320°C. After stopping the introduction of nitrogen, the internal pressure of the reactor was gradually reduced to 0.1 mmHg over a period of 15 minutes. The content was further stirred at this temperature under this pressure for one hour.

The obtained polymer had an intrinsic viscosity of 5.0 as determined in pentafluorophenol at 60°C with a concentration of 0.1% by weight.

The polymer comprised the following constituent units:

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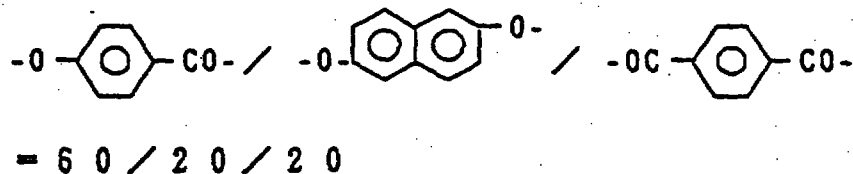
Referential Example 3 (Resin C)

1081 parts by weight of 4-acetoxynaphthalene, 489 parts by weight of 2,6-diacetoxynaphthalene and 332 parts by weight of terephthalic acid were fed to a reactor fitted with a stirrer, a nitrogen gas inlet tube and a distilling-off tube. The content was heated to 250°C in a nitrogen atmosphere and vigorously stirred at 250°C for 2 hours and at 280°C for 2.5 hours, while distilling off acetic acid from the reactor. The content was heated to 320°C. After stopping the introduction of nitrogen, the internal pressure of the reactor was gradually reduced to 0.2 mmHg over a period of 30 minutes. The content was further stirred at this temperature and under this pressure for 1.5 hour.

The obtained polymer had an intrinsic viscosity of 2.5 as determined in pentafluorophenol at 60°C with a concentration of 0.1% by weight.

The polymer comprised the following constituent

units:



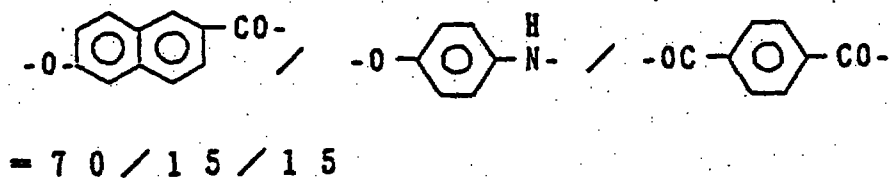
Referential Example 4 (Resin D)

1612 parts by weight of 6-acetoxy-2-naphthoic acid, 290 parts by weight of 4-acetoxyacetanilide, 249 parts by weight of terephthalic acid and 0.4 part by weight of sodium acetate were fed to a reactor fitted with a stirrer, a nitrogen gas inlet tube and a distilling-off tube. The content was heated to 250°C in a nitrogen atmosphere and vigorously stirred at 250°C for one hour and at 300°C for 3 hours, while distilling off acetic acid from the reactor. The content was heated to 340°C. After stopping the introduction of nitrogen, the internal pressure of the reactor was gradually reduced to 0.2 mmHg over a period of 30 minutes. The content was further stirred at this temperature under this pressure for 30 minutes.

The obtained polymer had an intrinsic viscosity of 3.9 as determined in pentafluorophenol at 60°C with a concentration of 0.1% by weight.

The polymer comprised the following constituent

units:



Example 1

A composition comprising 40 parts by weight of a liquid-crystal polyester (Resin A) having a weight-average molecular weight of 20,000, prepared in Referential Example 1, 30 parts by weight of glass fiber and 30 parts by weight of wollastonite was molded at 300°C with an ordinary injection machine into a block for an optical pickup [30 x 55 x 30 (height)] shown in Figs. 1 to 3.

This block was subjected to a thermal cycle test of from -20°C to +80°C. The dimensional change of each part was 2 μ.

Comparative Example 1

The same procedure as that described in Example 1 was repeated except that polyphenylene sulfide resin was used instead of Resin A. The obtained block was tested in a similar manner to that described in Example 1. The dimensional change of each part of the block reached as much as 20 μ.

Examples 2 to 4

The same procedure as that described in Example 1 was repeated except that a liquid-crystal polyester (Resin B, C or D) prepared in Referential Examples 2 to 4, respectively, was used instead of Resin A. The obtained blocks were subjected to a thermal cycle test under the same conditions as the one used in Example 1. The dimensional change was 3μ , 3μ and 2μ respectively.

Thus, in summary this invention consists in the use of a polyester which is capable of forming the anisotropic phase in the molten state and being melt-processable, and which is moulded to form an optical system setting block for an optical pick-up, which block has high order of dimensional stability under changing temperatures as just demonstrated.

In particular the invention provides:-

An optical system setting block for an optical pick-up, the setting block being moulded to shape from a plastics composition and housing a plurality of components of the optical pick-up system, and wherein the setting block is moulded to shape from a polyester which is capable of forming the anisotropic phase in the molten state and which is melt processable to shape, and which when moulded to shape has a high order of dimensional stability even when subjected to fluctuations of temperature in the range minus 20°C to plus 80°C .

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Preferably the polyester is a wholly aromatic polyester having a weight average molecular weight of 20,000 to 25,000, or a wholly aromatic polyesteramide with a weight average molecular weight of 10,000 to 30,000.

In preferred embodiments, the polymer of the optical system setting block is a polyester or a polythiol ester or a polyester amide or a combination of two or three of these such as those in GROUP A as described above in the text which are capable of adopting the anisotropic phase in the molten state and during melt-processing.

In a first such preferred embodiment, a polyester comprises:-

a) one or more of aromatic dicarboxylic acids and/or cycloaliphatic dicarboxylic acids, and one or more of aromatic diols, cycloaliphatic diols and/or aliphatic diols,

and/or comprises

b) one or more of aromatic hydroxycarboxylic acids.

In a second such preferred embodiment a polythiol ester comprises:-

- a) one or more of aromatic dicarboxylic acids and/or cycloaliphatic dicarboxylic acids, and one or more of aromatic dithiols and/or aromatic thiolphenols

and/or comprises

- b) one or more of aromatic thiolcarboxylic acids.

In a third such preferred embodiment a polyesteramide comprises:-

- a) one or more of aromatic dicarboxylic acids and/or cycloaliphatic dicarboxylic acids, one or more of aromatic hydrocarboxylic acids, and one or more of aromatic hydroxylamines and/or aromatic diamines

and comprises

- b) one or more of aromatic diols, cycloaliphatic diols, and/or aliphatic diols.

In another such embodiment, the polymer is an aromatic polyester in combination with an aromatic polyesteramide, the polymer being in the anisotropic phase when moulded. Polyalkylene terephthalate in which the alkyl group has 2 to 4 carbon atoms is preferred as such a polymer. Preferably the polyester contains at least 10 mol% of a naphthalene

moiety-containing recurring unit such as 6-hydroxy-2-naphthoyl, 2,6-dihydroxynaphthalene, and 2,6-dicarboxynaphthalene. Preferred polyesteramides are those having a recurring unit comprising the above-mentioned naphthalene moiety and 4-aminophenol or 1,4-phenylenediamine moiety.

The polymer employed in the setting block of the invention includes those wherein part of a polymer chain of the polymer comprises a segment of the anisotropic molten phase-forming polymer and the balance comprises a segment of a thermoplastic resin which does not form an anisotropic molten phase.

In one embodiment of the invention, the polyester is combined with a filler and glass fibres to form a resin composition for melt-processing into the body, the filler, with the glass fibres, not exceeding 70% by weight of the composition.

And the invention extends to a method of manufacturing an optical system setting block for an optical pickup, comprising the step of injection moulding an anisotropic phase of a melt-processable polyester.

CLAIMS

1. An optical pick-up which includes an optical system setting block moulded from a polyester being capable of forming the anisotropic phase in the molten state and being melt-processable.
2. An optical pick-up as claimed in Claim 1, which comprises a principal optical system, an additional optical system and a setting block to locate the components for the systems, said block having been made of said polyester.
3. A optical pick-up as claimed in Claim 1 or 2, in which said polyester comprises an inorganic filler.
4. An optical pick-up as claimed in Claim 1, in which said polyester is an aromatic polyester in combination with an aromatic polyesteramide, which is in the anisotropic phase when moulded.
5. A optical pick-up as claimed in Claim 3, in which said polyester contains at least 10 mol% of a naphthalene moiety-containing recurring unit.



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6. A optical pick-up as claimed in Claim 1, wherein part of a polymer chain of said polyester comprises a segment of the anisotropic molten phase-forming polyester and the balance comprises a segment of a thermoplastic resin which does not form an anisotropic molten phase.

7. An optical pick-up according to claim 1, characterised in that said polyester is combined with a filler and glass fibres to form a resin composition for melt-processing into said body, the filler and the glass fibres not exceeding 70% by weight of the composition.

8. A setting block for an optical pick-up system, the setting block being moulded to shape from a plastics composition and housing a plurality of components of the optical pick-up system, and wherein the setting block is moulded to shape from a polyester which is capable of forming the anisotropic phase in the molten state and which is melt processable to shape, and which when moulded to shape has a dimensional stability even when subjected to fluctuations of temperature in the range minus 20°C to plus 80°C.



9. A setting block as claimed in Claim 8 wherein, the polyester is a wholly aromatic polyester having a weight average molecular weight of 20,000 to 25,000, or a wholly aromatic polyesteramide with a weight average molecular weight of 10,000 to 30,000.

10. A method of manufacturing an optical system setting block for an optical pickup, comprising the step of injection moulding an anisotropic phase of a melt-processable polyester.

