

POLYACETAL RESIN COMPOSITION HAVING HIGH TEMPERATURE STIFFNESS

1 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a novel polyacetal resin composition, and more particularly to a
5 polyacetal resin composition simultaneously having an excellent high-temperature stiffness and an excellent lubricity.

Related Art

Polyacetal resin is an engineering resin
10 excellent in strength characteristics, fatigue resistance, self-lubricating property, etc., and is extensively in use in many fields such as automobiles, machines, electrical industry, electronic industry and the like. On the other hand, polyamide resin is an engineering resin excellent in
15 impact resistance, frictional resistance, abrasion resistance, flexibility, etc., and is extensively in use in many fields such as automobiles, machines, electrical industry, electronic industry and the like, similarly to polyacetal resin.

20 In the recent years, higher properties have become required of these engineering resins, and today such requirements cannot be satisfied by a single resin. Thus, polymer alloys, such as a polymer alloy formed between polyacetal resin and polyolefin resin are observed
25 with interest.

On the other hand, regarding polymer alloy made of polyacetal resin and polyamide resin, no method capable of controlling the morphology of such a polymer alloy is known, and therefore no polymer alloy having both a high stiffness at high temperatures and good lubricity has yet been found.

As examples of a blended mixture consisting of a polyacetal resin and a polyamide resin, a polyacetal resin composition prepared by adding 1-40 parts by weight of an inorganic powdery material to 100 parts by weight of a composition consisting of 5% by volume or more of a polyacetal resin and 95% by volume or less of a polyamide resin is known from Japanese Patent Application Kokai (Laid-Open) No. 63-34377, and a polyacetal resin composition prepared by dispersing a polyamide having a maximum particle diameter of 10 μ m and consisting of 90% by weight or more of a polyacetal resin and 0.01-10% by weight of a polyamide resin (4,6-nylon) into a polyacetal resin is known from Japanese Patent Publication No. 2-11625. There is described in Japanese Patent Kokai No. 63-34377 that another resin having a melting temperature similar to that of polyoxymethylene may be used to produce a synthetic resin needle valve having high anticorrosion, employing polyoxymethylene in place of metal. Also, there is disclosed in Japanese Patent Unexamined Publication (KOKAI) No. 2-11625 the above composition employing a specific polyamide having a high melting point in order to

prevent polyamide added to polyoxymethylene as a heat stabilizer from separating out in a molding machine screw or a metal mold. In those prior art references, there are no description nor suggestion as to the composition of a polyacetal resin and polyamide resin having both high temperature stiffness and lubricity.

On the other hand, it is a well known technique to reinforce a polyacetal resin with a filler, such as glass fiber and the like, for the purpose of enhancing its high-temperature stiffness. However, the reinforcing effect brought about by this technique has been small, because polyacetal resin is poor in wetness at the interface with filler, such as glass fiber and the like, and therefore quite low in adhesive strength to glass fiber and the like. In addition, such a reinforcement using a filler has been disadvantageous in that it simultaneously deteriorates the lubricity to a large extent, which is an original property of polyacetal resin.

SUMMARY OF THE INVENTION

The present invention relates to a polyacetal resin composition comprising 100 parts by weight of a resin ingredient (A) which comprises 90-50% by weight of a polyacetal resin (a) and 10-50% by weight of a polyamide resin (b) having a melting point of up to 230°C, 0.05-20 parts by weight of a dispersant (B) and 5-40 parts by weight

of a filler (C), said polyamide resin (b) having a maximum particle diameter of 0.03-10 μm and a maximum aspect ratio of up to 2 and being dispersed in a matrix of said polyacetal resin (a). Preferably, the filler (C) is coated by the polyamide resin (b) in the polyacetal resin composition of the present invention.

Using this composition it is possible to prepare a polymer alloy which is excellent in high-temperature stiffness and lubricity, and has a good colour tone.

BRIEF DESCRIPTION OF DRAWINGS

Figures 1(a) and 1(b) are each a scanning electron microscopic photograph illustrating a rupture cross-section of one example of molded product made of a composition of the present invention.

Figures 2(a) and 2(b) are each a scanning electron microscopic photograph illustrating a rupture cross-section of a molded product made of a composition which contained no polyamide resin, but otherwise was in accordance with the present invention.

Figures 3(a) and 3(b) are each a transmission type electron microscopic photograph illustrating the morphology of a composition which contained no filler, but otherwise was in accordance with the present invention.

Figures 4(a) and 4(b) are each a transmission type electron microscopic photograph illustrating the morphology of a composition which contained no dispersant and no filler, but otherwise in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The polyacetal resin used in the present invention may be any oxymethylene homopolymer or copolymer. The oxymethylene homopolymer is obtained by polymerizing formaldehyde or any of its cyclic oligomers such as trimer (trioxane), tetramer (tetraoxane) and the like, and is constituted substantially of oxymethylene units $\text{--CH}_2\text{O--}$.

On the other hand, the oxymethylene copolymer may be comprised of a polymeric structure in which oxyalkylene units other than oxymethylene are randomly introduced into a chain constituted of oxymethylene units. The content of said other oxyalkylene units in the oxymethylene copolymer is preferably selected from a range of 0.05-50 moles and more preferably from a range of 0.1-20 moles, both being per 100 moles of the oxymethylene unit.

The other suitable oxyalkylene units, include oxyethylene, straight or branched chain oxypropylene, and straight or branched chain oxybutylene, and oxyphenylene units. The introduction of one or more types of oxyalkylene units are allowable. Among these other oxyalkylene units, the oxyethylene unit

$\text{-(CH}_2\text{)}_2\text{O-}$ and the straight chain oxybutylene unit (oxytetramethylene unit) $\text{-(CH}_2\text{)}_4\text{O-}$ are particularly preferably from the view point of improving the physical properties of the polyacetal resin composition.

The oxymethylene copolymers may be obtained by copolymerizing formaldehyde or a cyclic oligomer of formaldehyde such as trioxane or tetraoxane, with a cyclic ether such as ethylene oxide, propylene oxide, epichlorohydrin, 1,3-dioxolane, glycol formal or diglycol formal. Oxymethylene block copolymers where at least 50% by mole of the main chain is constituted of oxymethylene units and the remainder is constituted of units other than oxymethylene are also included in the oxymethylene copolymer referred to in the present invention.

In the composition of the present invention, one type of said polyacetal resin or two or more types in combination are used.

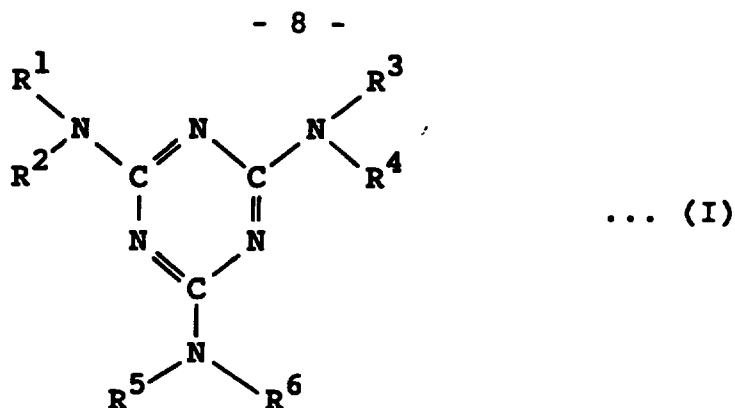
As examples of the polyamide resin used in the composition of the present invention are: nylons such as nylon 11, nylon 12, nylon 6, nylon 610, nylon 12 and copolymers of these nylons; polyamide resins containing in its molecular chain 0.1-50% by weight of straight chain alkylene oxide units having 1-10 carbon atoms; polyamide resins containing in its molecular chain 0.1-50% by weight of straight chain alkyl ester units having 1-10 carbon atoms; polyamide resins wherein the amide bond hydrogen of the main chain is partially substituted by an alkoxymethyl group such as a methoxymethyl group; and copolymer comprising any of the above polyamide resins. Among these

1 polyamide resins, those having a melting point of up to
230°C are used in the present invention. In the present
invention, these polyamide resins may be used singly, or two or more
may be used in combination.

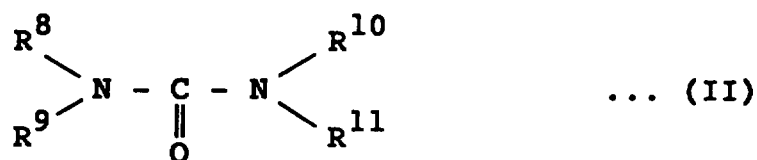
5 In the composition of the present invention, it
is necessary to use the polyacetal resin and the polyamide
resin in a ratio, such that 90-50% by weight of polyacetal
resin and 10-50% by weight of polyamide resin, preferably
90-60% by weight of polyacetal resin and 10-40% by weight
10 of polyamide resin, and more preferably 90-70% by weight
of polyacetal resin and 10-30% by weight of polyamide
resin are used based on the total weight of the resin
ingredient.

If the amount of polyacetal resin is smaller
15 than 50% by weight, the composition obtained therefrom
cannot sufficiently exhibit the characteristic properties
of polyacetal resin and therefore the object of the
present invention cannot be achieved. If the amount of
polyacetal resin exceeds 90% by weight, the characteristic
20 properties of polyamide resin cannot sufficiently be
exhibited, and therefore the object of the present
invention cannot be achieved.

As examples of the dispersant used in the
present invention, the following can be referred to:
25 melamine derivatives represented by the following general
formula (I):

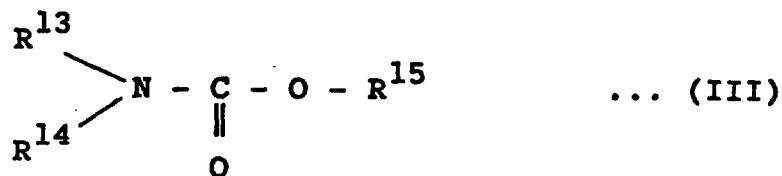


- 1 wherein R^1 to R^6 each represents hydrogen atom, straight
 or branched chain alkyl group having 1-30 carbon atoms,
 cycloalkyl group having 3-30 carbon atoms, aryl group or
 $-(\text{CH}_2)_m-\text{OR}^7$ (R^7 represents a straight chain alkyl group
 5 having 1-5 carbon atoms and m represents an integer of
 1-4), wherein at least one of R^1 to R^4 is $-(\text{CH}_2)_m-\text{OR}^7$;
 urea derivatives represented by the following general
 formula (II):

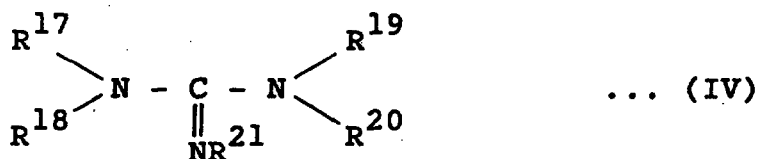


- wherein R^8 to R^{11} each represents hydrogen atom, straight
 10 or branched chain alkyl group having 1-30 carbon atoms,
 cycloalkyl group having 3-30 carbon atoms, aryl group or
 $-(\text{CH}_2)_n-\text{OR}^{12}$ (R^{12} represents straight chain alkyl group
 having 1-5 carbon atoms and n represents an integer of
 1-4), wherein at least one of R^8 to R^{11} is $-(\text{CH}_2)_n-\text{OR}^{12}$;
 15 aminoformic acid derivatives represented by the following

1 general formula (III):



wherein R^{13} and R^{14} each represents hydrogen atom,
 straight or branched chain alkyl group having 1-30 carbon
 atoms, cycloalkyl group having 3-30 carbon atoms, aryl
 5 group or $-(\text{CH}_2)_p-\text{OR}^{16}$ (R^{16} represents straight chain alkyl
 group having 1-5 carbon atoms and p represents an integer
 of 1-4), wherein at least one of R^{13} and R^{14} is
 $-(\text{CH}_2)_p-\text{OR}^{16}$, and R^{15} represents hydrogen atom, straight
 or branched chain alkyl group having 1-30 carbon atoms,
 10 cycloalkyl group having 3-30 carbon atoms or aryl group;
 guanidine derivatives represented by the following general
 formula (IV):



wherein R^{17} to R^{20} each represents hydrogen atom, straight
 or branched chain alkyl group having 1-30 carbon atoms,
 15 cycloalkyl group having 3-30 carbon atoms, aryl group or
 $-(\text{CH}_2)_q-\text{OR}^{22}$ (R^{22} represents straight chain alkyl group
 having 1-5 carbon atoms and q represents an integer of

1 1-4), wherein at least one of R^{17} to R^{20} is $-(CH_2)_q-OR^{22}$,
and R^{21} represents hydrogen atom, straight or branched
chain alkyl group having 1-30 carbon atoms, or cycloalkyl
group having 3-30 carbon atoms or aryl group.

5 Examples of the melamine derivatives represented
by general formula (I) include the following compounds
such as monomethoxymethylmelamine, dimethoxymethylmel-
amine, trimethoxymethylmelamine, tetramethoxymethylmel-
amine, pentamethoxymethylmelamine, hexamethoxymethyl-
10 melamine, and derivatives of these compounds obtained by
partially or wholly replacing the methoxy groups of these
compounds with at least one member selected from the group
consisting of ethoxy group, n-propoxy group, iso-propoxy
group, n-butoxy group, iso-butoxy group, sec-butoxy group,
15 t-butoxy group, pentyloxy group and the like.

 Examples of the urea derivative represented by
general formula (II) include the following compounds such
as N-methoxymethylurea, N,N-dimethoxymethylurea, N,N'-
dimethoxymethylurea, N-methoxymethyl-N'-methylurea,
20 N,N-dimethoxymethyl-N',N'-dimethylurea, N,N,N'-trimethoxy-
methylurea, N,N-dimethoxymethyl-N'-ethylurea, and
derivatives of these compounds obtained by partially or
wholly replacing the methoxy groups of these compounds
with at least one member selected from the group
25 consisting of ethoxy group, n-propoxy group, iso-propoxy
group, n-butoxy group, iso-butoxy group, sec-butoxy group,
t-butoxy group, pentyloxy group and the like, etc.

1 Examples of the aminoformic acid derivatives
represented by general formula (III) include the following
compounds such as N,N-dimethoxymethylaminoformic acid,
N-methoxymethylaminoformic acid, methyl N-methoxy-
5 methylaminoformate, ethyl N-methoxymethylaminoformate, and
derivatives of these compounds obtained by partially or
wholly replacing the methoxy group of these compounds with
at least one member selected from the group consisting of
ethoxy group, n-propoxy group, iso-propoxy group, n-butoxy
10 group, iso-butoxy group, sec-butoxy group, t-butoxy group,
pentyloxy group and the like, etc.

 Examples of the guanidine derivatives repre-
sented by general formula (IV) include the following
compounds such as monomethoxymethylguanidine, dimethoxy-
15 methylguanidine, trimethoxymethylguanidine, tetramethoxy-
methylguanidine, and derivatives of these compounds
obtained by partially or wholly replacing the methoxy
groups of these compounds with at least one member
selected from the group consisting of ethoxy group,
20 n-propoxy group, iso-propoxy group, n-butoxy group,
iso-butoxy group, sec-butoxy group, t-butoxy group,
pentyloxy group and the like, etc.

 In the above-mentioned compounds, the alkylene
group in N-alkylalkoxy group has 1-4 carbon atoms,
25 preferably 1 or 2 carbon atoms, and particularly
preferably one carbon atom.

 Further, hexamethylene diisocyanate (HMDI),
dicyclohexylmethane diisocyanate, isophorone diisocyanate,

diphenylmethane diisocyanate (MDI), phenylene diisocyanate, tolylene diisocyanate (TDI), compounds obtained by releasing of CO₂ from these compounds to a carbodiimide, compounds obtained by modifying these compounds with an alcohol, diisocyanates compounds of oligomers such as dimer, trimer, tetramer and the like, and all of the compounds having two or more functional groups reactive with alcoholic hydroxyl group such as compounds having two or more maleic anhydride units in one molecule are also included.

Among the compounds having N-alkylalkoxy group constituting the dispersant of ingredient (B), hexaalkoxymethylmelamine, tetraalkoxymethylurea, methyl N-alkoxymethylaminoformate and tetraalkoxyalkylguanidine are preferable, and hexamethoxymethylmelamine, tetramethoxymethylurea, methyl N-methoxymethylaminoformate and tetramethoxymethylguanidine are particularly preferable.

In the present invention, one type of said dispersant or two or more types in combination are used. The amount of the dispersant is selected from a range of 0.05-20 parts by weight, preferably 0.1-10 parts by weight and more preferably 0.2-5 parts by weight, per 100 parts by weight of the sum of polyacetal resin (a) and polyamide resin (b). If this amount is less than 0.05 part by weight, a sufficient lubricity of the composition cannot be attained since the polyamide resin will not diffuse as granules present in the matrix of the polyacetal resin. If the amount exceeds 20 parts by

weight, heat stability of the composition would become (greatly deteriorated, making the work of melting and kneading the composition to be difficult.

An example of the morphology of a composition consisting of a polyacetal resin and a polyamide resin observed by a transmission electron microscope is shown in Fig. 4(A) (magnification: 1,000 times) and Fig. 4(B) (magnification: 5,000 times). In the measurement of the morphology, a super-thin specimen having a thickness of 100 nm was prepared from a composition identical to that of Comparative Example 1, except in that it contains no glass fibers. In a composition free from a dispersant, a polyamide resin is observed to form streaks in a polyacetal resin matrix.

As the filler (C) used in the composition of the present invention, silica, carbon black, talc, wollastonite, calcium carbonate, potassium titanate whiskers, carbon whiskers, clay, glass beads, glass fibers, carbon fibers, and organic fibers, can be referred to. Among those fillers, glass fibers, plaster-form talc, prism-form wollastonite, needle-form calcium carbonate, glass beads, potassium titanate whiskers and carbon whiskers are preferable, and glass fibers may be more preferable. The fiber length of the glass fibers may be 0.1-10 mm, preferably 0.3-8.0 mm, and more preferably 0.5-7.0 mm. Its fiber diameter may be 0.1-50 μ m, preferably 5-20 μ m, and more preferably 6-15 μ m. Although the glass fibers may be made of any of E glass and A glass, the glass fibers made of E glass are more preferable. The glass fibers

1 may have an untreated surface, or it may also be used
after a surface treatment using various surface-treating
agents. As examples of these surface-treating agent,
silane couplers, such as alkoxysilane, silazane,
5 chlorosilane, aminosilane, glycidosilane and the like,
titanate type couplers, aluminum type couplers, urethane
type treating agents and the like can be referred to.
Among these, aminosilane is particularly preferable. The
surface treatment exhibits its effect not only on glass
10 fiber but also on other fillers.

In the present invention, one type of filler or
two or more types in combination are used. The amount
of said filler (C) is selected from a range of 5-40 parts
by weight, preferably 7-35 parts by weight and more
15 preferably 10-30 parts by weight, per 100 parts by weight
of the sum of polyacetal resin (a) and polyamide resin
(b). If this amount is smaller than 5 parts by weight,
the effect of improving high-temperature stiffness and
lubricity cannot be exhibited sufficiently. If the amount
20 exceeds 40 parts by weight, heat stability would become
greatly deteriorated, making the work of melting and
kneading the composition to be difficult.

In the polyacetal resin composition of the
present invention, polyamide resin is prepared in such
25 a manner that it is present in a
particle form having a maximum particle diameter of
0.03-10 μm , preferably 0.05-8 μm , and a maximum aspect
ratio of 2 or less, preferably 1.8 or less, when the resin

composition contains no filler (C).

As used herein, the term "maximum particle diameter" means the longest particle diameter of polyamide resin particles existing in polyacetal resin medium which can be observed by preparing a super-thin specimen having a thickness of 100 nm from a polyacetal resin composition containing no filler (C) but otherwise in accordance with the present invention, and observing its morphology by means of a transmission type electron microscope. In other words, it means such a large size present that no other size present which exceeds it can be found in any other specimens.

An example of the morphology thereof is shown in Fig. 3(A) (magnification: 1,000 times) and Fig. 3(B) (magnification: 5,000 times). Figs. 3(A) and 3(b) are electron transmission microphotographs of a super-thin specimen having thickness of 100 nm prepared from the composition of Example 2 described below, from which fillers were excluded so as to enable easy observation of the morphology of the resin.

As used herein, the term "maximum aspect ratio" means the maximum value of (maximum particle diameter)/(minimum particle diameter) ratio of the polyamide resin present.

Into the polyacetal resin composition of the present invention may be incorporated additive components which are conventionally added to thermoplastic resins. Examples of said additives include antioxidant, heat stabilizer, plasticizer, ultraviolet absorber, lubricant,

1 flame retardant, pigment and the like.

The method for preparing the thermoplastic resin composition of the present invention is not critical, but methods having been conventionally adopted in the preparation of thermoplastic resin compositions up to the present time can be used. For example, it can be prepared, by melting and kneading the above-mentioned ingredients (a), (b), (B), (C) and optionally used additive components, by the use of known apparatuses conventionally used for kneading molten resins, such as Banbury mixer, roll kneader, extruder, ball mill, high-speed agitater, shaker and the like. Among these kneading apparatuses, the extruder is most desirable from the viewpoint of interruption of oxygen, working environment, working efficiency, etc. As the types of extruders, single shaft type, double shaft type, vent type, no-vent type, etc. can be referred to. With any of these extruders, the composition of the present invention can be prepared.

In preparing a composition of the present invention, the conditions of extrusion are not critical, so far as the conditions are those which are conventionally adopted in the preparation of thermoplastic resin compositions. Preferably, however, the maximum resin temperature is 210°C or above, more preferably 220°C or above, and the time period of melting and kneading is 0.2 minute or longer, more preferably 0.5 minute or longer. If the maximum resin temperature is lower than 210°C or the time period of melting and kneading is shorter than

- 1 0.2 minute, it is difficult to obtain a composition having the intended high-temperature stiffness and lubricity.

As used in the present invention, the term "maximum resin temperature" means the equilibrium resin
5 temperature under predetermined conditions of melting and kneading which can be detected by a thermometer provided in the system, when the melting-kneading machine is a batchwise kneading machine such as kneader, roll mill and the like. On the other hand, when the melting-kneading
10 machine is an extruder, the term "maximum resin temperature" means an equilibrium temperature of a resin just after being extruded out of the extruder under predetermined conditions of melting and kneading.

The term "time period of melting and kneading"
15 means a period of time measured from the time when resin temperature has reached the above-mentioned maximum resin temperature. Particularly when the melting-kneading machine is an extruder, it indicates a mean residence time in a state where a resin has reached the maximum resin
20 temperature. The mean residence time is the period from a time when a black-colored pigment (acetylene black) is added through the raw material feeding hole in an amount of 5% by weight to a time when the resin discharged from die has become assuming the deepest color.

25 The polyacetal resin composition of the present invention can be used as a material for sliding parts, precision parts and the like where a polyacetal resin is conventionally used and as a material for sliding parts,

1 impact-resistant parts, composite parts and the like where
a polyamide resin is conventionally used. More specifi-
cally, the resin composition of the present invention is
successfully usable as an elementary material for gear,
5 bearing, lever, key stem, cam, ratchet, roller, screw,
water feeding parts, toy parts, fan, film, silkworm gut,
pipe, filament, tube and precision composite materials
reinforced with fillers.

Next, the present invention is explained in more
10 detail by way of the following examples. The present
invention is by no means limited by the examples. The
properties of compositions mentioned in the examples were
measured in the following manner.

(1) Flexural strength and flexural modulus:

15 These were determined according to ASTM D-790.

Environmental temperatures of the test were 23°C
and 80°C. The test piece of flexural test was prepared by
melting and kneading a composition and forming it by means
of a forming machine in which the cylinder temperature had
20 been adjusted to 200°C according to ASTM D-790 (die
temperature 70°C, cooling time 20 seconds).

(2) Friction test

Average coefficient of friction was determined
according to JIS K-7218.

- 1 (3) Measurement of maximum particle diameter and maximum aspect ratio

A super-thin specimen having a thickness of 100 nm was prepared from a polyacetal resin composition of the present invention, but which contained no filler, and its morphology was examined by means of transmission type electron microscope. The longest particle diameter of polyamide resin (b) present in the polyacetal resin (a) was taken as maximum particle diameter. The ratio of maximum particle diameter of the polyamide resin present to its minimum particle diameter was taken as the maximum aspect ratio. The morphology could also be examined similarly by observing the rupture cross-section of a resin ingredient (A) containing filler with scanning electron microscope (SEM).

Examples 1 - 9

Resin compositions were prepared by melting, kneading and pelletizing polyacetal resin (a), polyamide resin (b), dispersant (B) and filler (C) of which types and amounts were as shown in Table 1.

The resin compositions thus obtained were subjected to flexural test and friction test. The results are shown in Table 1.

Comparative Examples 1 - 7

Resin compositions were prepared by melting, kneading and pelletizing polyacetal resin (a), polyamide

resin (b), dispersant (B) and filler (C) of which types and amounts were as shown in Table 2.

The resin compositions were subjected to flexural test and friction test. The results are shown in Table 2. It is apparent from a comparison of Tables 1 and 2 that the compositions of the present invention exhibit an excellent effect having both excellent high-temperature stiffness and improved lubricity, in comparison with prior compositions.

Fig. 1(A) and 1(B) illustrate the rupture cross-section of a molded product of the composition of Example 2 of the present invention; and Figs. 2(A) and 2(B) illustrate the rupture cross-section of a molded product of the composition of Comparative Example 6. These results suggest that the effect of the present invention can be exhibited by coating the filler, such as glass fiber or the like, with a polyamide resin.

Meanings of the terms used in Tables 1 and 2 are as follows:

1) Oxymethylene homopolymer

A formaldehyde polymer of which both molecular terminals are acetylated; melt index 9.9 g/10 min. [ASTM D-1238-57T (condition E)].

2) Oxymethylene copolymer obtained by copolymerizing 97% by weight of trioxane and 3% by weight of ethylene oxide; melt index 10.0 g/10 min. [ASTM D-1238-57T (condition E)].

- 1 3) Nylon 12
Nylon 12 having a melting point of 178°C; melt index
8.0 g/10 min. [ASTM D-1238 (235°C, 1 kg load)].
- 4) Nylon 6
5 Nylon 6 having a melting point of 220°C; melt index
8.0 g/10 min. [ASTM D-1238 (235°C, 1 kg load)].
- 5) Nylon 610
Nylon 610 having a melting point of 215°C; melt
index 8.0 g/10 min. [ASTM D-1238 (235°C, 1 kg
10 load)].
- 6) Polyether-amide
A copolymer of 75% by weight of nylon 12 and 25% by
weight of tetrahydrofuran having a melting point of
160°C; melt index 8.0 g/10 min. [ASTM D-1238
15 (235°C, 1 kg load)].
- 7) Polyester-amide
A copolymer of 75% by weight of nylon 12 and 25% by
weight of γ -lactone having a melting point of
165°C; melt index 8.0 g/10 min. [ASTM D-1238
20 (235°C, 1 kg load)].
- 8) Nylon 66
Nylon 66 having a melting point of 265°C; melt index
8.0 g/10 min. [ASTM D-1238 (235°C, 1 kg load)].
- 9) Glass fiber
25 A glass fiber having a length of 3 mm and a diameter
of 13 μ m, surface treated with 0.3% by weight of
aminosilane.

1 10) Plate-form talc

A plate-form talc surface-treated with 0.3% by weight of aminosilane.

Table 1

Resin composition (parts by wt.)							
		Polyacetal resin (a)		Polyamide resin (b)		Dispersant (B)	
		Type	Amount	Type	Amount	Type	Amount
Example	1	Polyoxymethylene homopolymer	90	Nylon 12	10	Hexamethoxy - methylmelamine	1
	2	Polyoxymethylene copolymer	90	Nylon 12	10	Hexamethoxymethyl-melamine	1
	3	Polyoxymethylene homopolymer	50	Nylon 6	50	Hexamethoxy-methylmelamine	1
	4	Polyoxymethylene homopolymer	60	Nylon 6	40	Hexamethoxymethyl-melamine	1
	5	Polyoxymethylene copolymer	90	Nylon 12	10	Hexamethoxymethyl-melamine	0.1
	6	Polyoxymethylene copolymer	90	Nylon 12	10	Hexamethoxymethyl-melamine	15
	7	Polyoxymethylene homopolymer	80	Nylon 610	20	Tetramethoxy-methylurea	5

Table 1 (cont'd)

Resin composition (parts by wt.)							
		Polyacetal resin (a)		Polyamide resin (b)		Dispersant (B)	
		Type	Amount	Type	Amount	Type	Amount
Example	8	Polyoxymethylene copolymer	80	Polyether-amide	20	Methyl N-methoxymethylaminoformate	1
	9	Polyoxymethylene copolymer	80	Polyester-amide	20	Tetramethoxymethylguanidine	1

- cont'd -

Table 1 (cont'd)

Filler (C)	Flexural strength	Flexural modulus	Average frictional coefficient	Particle diameter	
				Maximum particle diameter	Maximum aspect ratio
Type	Amount	23°C 80°C	23°C 80°C	(μm)	
Glass fiber	10	940 510	42,000 24,000	0.36	4 1.3
Glass fiber	10	930 500	41,000 23,000	0.36	3 1.2
Glass fiber	10	800 400	32,000 18,000	0.28	8 2.0
Glass fiber	10	850 440	34,000 19,000	0.29	7 2.0
Glass fiber	10	890 480	40,000 22,000	0.36	5 1.8
Glass fiber	15	920 500	40,000 23,000	0.37	3 1.2
Plate-form talc	35	1,130 680	51,000 29,000	0.43	4 1.7

- cont'd -

Table 1 (cont'd)

		Flexural strength	Flexural modulus	Average frictional coefficient	Particle diameter	
Filler (C)		(kg/cm ²)	(kg/cm ²)		Maximum particle diameter	Maximum aspect ratio
Type	Amount	23°C 80°C	23°C 80°C		(μm)	
Plate-form talc	8	880 460	36,000 20,000	0.34	3	1.2
Glass fiber	6	840 440	33,000 19,000	0.33	3	1.4

Table 2

Resin composition							
	Polyacetal resin (a)		Polyamide resin (b)		Dispersant (B)		
	Type	Amount	Type	Amount	Type	Amount	
	Type	Amount	Type	Amount	Type	Amount	
Compa- rative Example	1	Polyoxymethylene copolymer	90	Nylon 12	10	-	-
	2	Polyoxymethylene copolymer	80	Polyether- amide	20	-	-
	3	Polyoxymethylene copolymer	40	Nylon 12	60	Hexamethoxy- methylmelamine	1
	4	Polyoxymethylene copolymer	90	Nylon 12	10	Melamine	1
	5	Polyoxymethylene copolymer	90	Nylon 66	10	Hexamethoxymethyl- melamine	1
	6	Polyoxymethylene copolymer	100	-	-	Hexamethoxymethyl- melamine	1
	7	-	-	Nylon 12	100	Hexamethoxymethyl- melamine	1

Table 2 (cont'd)

Filler (C)	Flexural strength	Flexural modulus		Average frictional coefficient	Particle diameter			
		(kg/cm ²)	(kg/cm ²)		Mean particle diameter	Maximum aspect ratio		
Type	Amount	23°C	80°C		(μm)			
Glass fiber	10	900	500	40,000	23,000	0.39	80	20
Plate-form talc	8	880	450	35,000	19,000	0.37	100	23
Glass fiber	10	600	280	20,000	12,000	0.32	Unmeasurable	
Glass fiber	10	900	500	40,000	23,000	0.39	70	19
Glass fiber	10	Impossible to melt and knead						
Glass fiber	10	1,100	610	44,000	27,000	2.5	-	-
Glass fiber	35	400	270	32,000	19,000	2.0	-	-

1 * In Comparative Examples 1, 2 and 4, thrust abrasion
was measured with an apparatus according to JIS
K-7218.

5 The coupled material used in the test was the same as
the material to be tested. Under a surface pressure
of 2 kg/cm² and at a line speed of 6 cm/sec at a
running distance of 50 km, an abrasion test was
carried out and thereafter the abrasion loss was
measured. Abrasion loss in Example 1 was 5.0 x
10⁻⁶ g/m, while in Comparative Example 1 using no
dispersant and in Comparative Example 4 using
melamine as a dispersant, the losses were 7.2 x
10⁻⁴ g/m and 6.8 x 10⁻⁴ g/m, respectively,
demonstrating an explicit increase in abrasion loss
in these comparative examples. Abrasion loss in
Example 8 was 5.6 x 10⁻⁶ g/m, while in Comparative
Example 2 using no dispersant, the loss was 7.8 x
10⁻⁴ g/m, demonstrating an explicit increase in
abrasion loss.

20 The thermoplastic resin composition of the
present invention is a polyacetal resin composition
comprising a polyacetal resin, a polyamide resin, a
dispersant and a filler. Unlike prior polyacetal resin
compositions, it simultaneously has excellent high-
25 temperature stiffness and lubricity and has a good color
tone.

CLAIMS

1. A polyacetal resin composition comprising 0.05-20 parts by weight of a dispersant (B) and 5-40 parts by weight of a filler (C), and 100 parts by weight of a resin ingredient (A) being a mixture of 90-50% by weight of polyacetal resin (a) and 10-50% by weight of polyamide resin (b), the % amounts of (a) and (b) being based on the combined amount of (a) and (b), said polyamide resin (b) having a melting point of up to 230°C, a maximum particle diameter of 0.03-10 μm and a maximum aspect ratio of up to 2, and being dispersed in a matrix of said polyacetal resin (a).

2. The polyacetal resin composition according to Claim 1, wherein said polyamide resin (b) is at least one resin selected from

- i) a nylon;
- ii) a polyamide resin containing in its molecular chain 0.1 to 50% by weight of straight chain alkylene oxide units having 1 to 10 carbon atoms;
- iii) a polyamide resin containing in its molecular chain 0.1 to 50% by weight of straight chain alkyl ester units having 1 to 10 carbon atoms; and
- iv) a polyamide resin wherein a hydrogen in amide bond of the main chain is partially substituted by an alkoxymethyl group.

3. The polyacetal resin composition according to Claim 2, wherein said polyamide resin (b) is a nylon selected from nylon 11, nylon 12, nylon 6, nylon 610 and nylon 612.

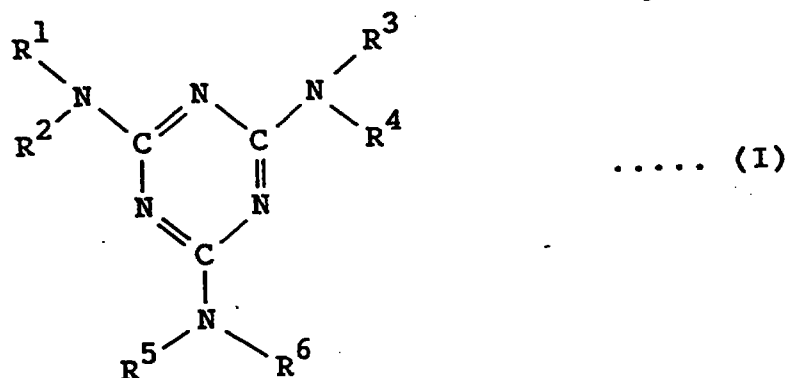




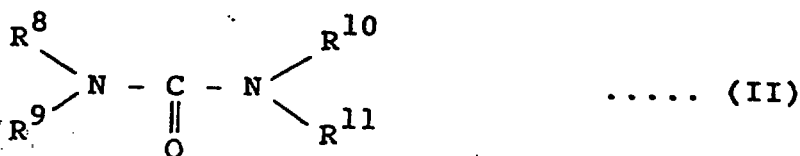
4. The polyacetal resin composition according to Claim 2, wherein said alkoxymethyl group is a methoxy methyl group.

5. The polyacetal resin composition according to Claim 1, wherein said polyamide resin (b) is a copolymer comprising at least one resin selected from i), ii), iii) and iv) as defined in Claim 2.

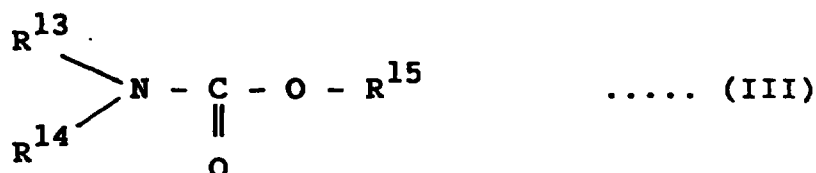
6. The polyacetal resin composition accordingly to Claim 1, wherein said dispersant (B) is at least one member selected from the group consisting of a melamine derivative represented by the following general formula (I):



wherein R^1 to R^6 each represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms, cycloalkyl group having 3 to 30 carbon atoms, aryl group or $-(\text{CH}_2)_m-\text{OR}^7$ (R^7 represents a straight chain alkyl group having 1 to 5 carbon atoms and m represents an integer of 1 to 4), wherein at least one of R^1 to R^4 is $-(\text{CH}_2)_m-\text{OR}^7$, a derivative represented by the following general formula (II):

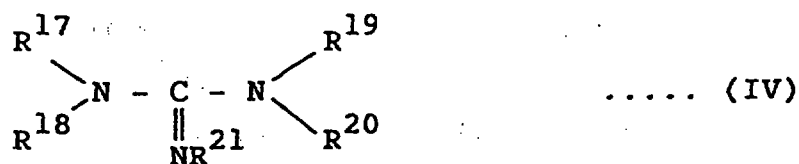


wherein R^8 to R^{11} each represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms, cycloalkyl group having 3 to 30 carbon atoms, aryl group or $-(CH_2)_n-OR^{12}$ (R^{12} represents straight chain alkyl group having 1 to 5 carbon atoms and n represents an integer of 1 to 4), wherein at least one of R^8 to R^{11} is $-(CH_2)_n-CR^{12}$, an aminoformic acid derivative represented by the following general formula (III):



wherein R^{13} and R^{14} each represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms, cycloalkyl group having 3 to 30 carbon atoms, aryl group or $-(CH_2)_p-OR^{16}$ (R^{16} represents straight chain alkyl group having 1 to 5 carbon atoms and p represents an integer of 1 to 4), wherein at least one of R^{13} and R^{14} is $-(CH_2)_p-OR^{16}$, and R^{15} represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms, cycloalkyl group having 3 to 30 carbon atoms or aryl group, and a guanidine derivative represented by the following general formula (IV):





wherein R^{17} to R^{20} each represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms, cycloalkyl group having 3 to 30 carbon atoms, aryl group or $-(CH_2)_q-OR^{22}$ (R^{22} represents straight chain alkyl group having 1 to 5 carbon atoms and q represents an integer of 1 to 4), wherein at least one of R^{17} to R^{20} is $-(CH_2)_q-OR^{22m}$, and R^{21} represents hydrogen atom, straight or branched chain alkyl group having 1 to 30 carbon atoms or aryl group.

7. The polyacetal resin composition according to Claim 1, wherein said dispersant (B) is selected from hexamethylene diisocyanate (HMDI), dicyclohexylmethane diisocyanate, isophorone diisocyanate, diphenylmethane diisocyanate (MDI), phenylene diisocyanate or tolylene diisocyanate (TDI).

8. The polyacetal resin composition according to Claim 1, wherein said dispersant (B) is a carbodiimide compound obtained by releasing CO_2 from a diisocyanate compound selected from hexamethylene diisocyanate (HMDI), dicyclohexylmethane diisocyanate, diphenylmethane diisocyanate (MDI), phenylene diisocyanate and tolylene diisocyanate (TDI);

a compound obtained by modifying with an alcohol a diisocyanate compound selected from hexamethylene diisocyanate (HMDI), dicyclohexylmethane diisocyanate, diphenylmethane diisocyanate (MDI), phenylene diisocyanate and tolylene diisocyanate (TDI);

an isocyanate oligomer compound; or

a compound having two or more functional groups reactive with alcoholic hydroxyl groups.

9. The polyacetal resin composition according to claim 8, wherein said compound having two or more functional groups reactive with alcoholic hydroxyl groups is a compound having two or more anhydride units in one molecule.

10. The polyacetal resin composition according to Claim 1, wherein said filler (C) is at least one member selected from the group consisting of silica, carbon black, talc, wollastonite, calcium carbonate, potassium titanate whisker, carbon whisker, clay, glass beads, glass fiber, carbon fiber and organic fiber.

11. The polyacetal resin composition according to Claim 1, wherein said resin ingredient (A) comprises 90-60% by weight of polyacetal resin (a) and 10-40% by weight of polyamide resin (b)

12. The polyacetal resin composition according to Claim 1, which comprises 0.1-10 parts by weight of said dispersant (B).

13. The polyacetal resin composition according to Claim 1, which comprises 7-35 parts by weight of said filler (C).

14. The polyacetal resin composition according to Claim 1, wherein said dispersant (B) is at least one member selected from the group consisting of a hexaalkoxymethyl melamine, a tetraalkoxy methyl urea, a methyl N-alkoxymethylaminoformate and a tetraalkoxyalkylguanidine.



15. The polyacetal resin composition according to Claim 1, wherein said filler (C) is coated with said polyamide resin (b).

16. A polyacetal resin composition according to Claim 1 substantially as described in any one of the Examples.

17. A shaped or molded article produced from a composition as claimed in any one of Claims 1 to 16.

