Title: RESIN COMPOSITION FOR FILAMENT, FILAMENT AND PROCESS FOR PRODUCING THE FILAMENT

Abstract: A resin composition for a filament, which comprises an ethylene homopolymer or ethylene-propylene copolymer having a density of 935 to 965 kg/m³, and a pesticide of 0.1 to 10 parts by weight per 100 parts by weight of the ethylene homopolymer, wherein the composition has a melt flow rate of 0.3 to 7 g/10 minutes and a melt flow rate ratio of 10 to 50 and a density of 935 to 980 kg/cm³.
DESCRIPTION

RESIN COMPOSITION FOR FILAMENT, FILAMENT AND PROCESS FOR PRODUCING THE FILAMENT

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a resin composition for a filament, the filament made of the resin composition and a process for producing the filament.

DESCRIPTION OF THE RELATED ARTS

A composition obtained by compounding a pesticide to an olefin-based resin such as polypropylene, polyethylene or the like, is processed into various moldings and used as a material for prophylaxis against pests such as ticks, louses, mosquitoes, flies and the like. For example, JP-A-04-065509 discloses a filament obtained by melt-spinning a composition of a polypropylene resin and a pesticide. Further, JP-A-06-315332 discloses a composition of a linear low density polyethylene and pesticide, and a collar made of the composition. Furthermore, JP 08-A-302080 discloses a composition of a high density polyethylene, a low density polyethylene and a pesticide, and an inflation film made of the composition.

However, when the conventional resin composition of the polyolefin resin and the pesticide is molded into a filament, a melt-spinning property and heat stretchability were not sufficiently satisfied.
DISCLOSURE OF THE INVENTION

Under such situations, an object of the present invention is to provide a resin composition containing a polyolefin resin and a pesticide, which provides a filament excellent in heat stretchability and is good in melt spinning property, and a filament made of the composition, and a process for producing the filament using the composition.

Namely, a first aspect of the present invention relates to a resin composition for a filament, which comprises an ethylene homopolymer having a density of 935 to 965 kg/m³, and a pesticide of 0.1 to 10 parts by weight per 100 parts by weight of the ethylene homopolymer, wherein the composition has a melt flow rate (MFR) of 0.3 to 7 g/10 minutes and a melt flow rate ratio (MFRR) of 10 to 50 and a density of 935 to 980 kg/cm³.

Further, a second aspect of the present invention relates to a resin composition for a filament comprising an ethylene-propylene copolymer having a density of 935 to 965 kg/m³ and a pesticide of 0.1 to 10 parts by weight per 100 parts by weight of the ethylene-propylene copolymer, wherein the composition has a melt flow rate (MFR) of 0.3 to 7 g/10 minutes and a melt flow rate ratio (MFRR) of 10 to 50 and a density of 935 to 980 kg/cm³.

Still further, a third aspect of the present invention relates to a filament made of the resin composition described above.

Still further, a fourth aspect of the present invention relates to a process for producing a filament, which comprises
melt-extruding the resin composition in strand-like, taking off the strand-like composition, and subjecting the strand-like composition taken off to heat stretching under a heating of 70 to 120°C.

DETAILED DESCRIPTION OF THE INVENTION

The resin composition of the first aspect of the present invention contains an ethylene homopolymer having a density of 935 to 965 kg/cm³ and a pesticide. The content of the pesticide is 0.1 to 10 parts by weight per 100 parts by weight of the ethylene homopolymer. The resin composition of the second aspect of the present invention contains an ethylene-propylene copolymer having a density of 935 to 965 kg/cm³ and a pesticide. The content of the pesticide is 0.1 to 10 parts by weight per 100 parts by weight of the ethylene-propylene copolymer.

The content of the pesticide is preferably 5 parts by weight or less, more preferably 3 parts by weight or less from the viewpoint of preventing from stickiness, in contrast, preferably 0.5 parts by weight or more, more preferably 1 part by weight or more from the viewpoint of heightening a pesticidal property.

The melt flow rate (MFR) of the resin composition in the first and second aspects is 0.3 to 7 g/10 minutes. When the MFR is below 0.3 g/10 minutes, a melt-extrudability may deteriorate because an extrusion load during molding of the filament becomes high. The MFR is preferably 0.5 g/10 minutes or more, more preferably 0.7 g/10 minutes or more.

In contrast, when the MFR is over 7 g/10 minutes, a heat
stretchability and mechanical strength may deteriorate. Furthermore, the MFR is preferably 5 g/10 minutes or less, more preferably 3 g/10 minutes or less. The MFR is measured by a method according to JIS K7210-1995, under a load of 21.18 N at a temperature of 190°C.

The melt flow rate ratio (MFRR) of the resin composition in the first and second aspects is 10 to 50. When the MFRR is over 50, a melt-spinning ability may deteriorate. The MFRR is preferably 45 or less, more preferably 40 or less.

Further, when the MFRR is below 10, the melt-extrudability may deteriorate. Furthermore, the MFRR is preferably 15 or more, more preferably 20 or more. The MFRR is a value obtained by dividing a melt flow rate value measured at 190°C under a load of 211.83 N (MFR-H, unit: g/10 minute) according to JIS K7210-1995 by an MFR measured at 190°C under a load of 21.18 N according to JIS K7210-1995.

The density of the resin composition in the first and second aspects of the present invention is 935 to 980 kg/m³. When the density is over 980 kg/m³, a heat stretchchability may deteriorate. The density is preferably 975 kg/m³ or less, more preferably 970 kg/m³ or less, further preferably 966 kg/m³ or less. On the other hand, when the density is below 935 kg/m³, the heat stretchchability may deteriorate. The density is preferably 940 kg/m³ or more, more preferably 945 kg/m³ or more.

The density of the composition is measured according to A-method in JIS K7112-1980 after annealed according to a method of low density polyethylene described in JIS K6760-1995.

A swelling ratio (SR) of the resin composition in the first
and second aspects of the present invention is preferably 1.40 or less, more preferably 1.30 or less, further preferably 1.25 or less from the viewpoint of heightening the heat stretchability. On the other hand, the SR is preferably 1.10 or more, more preferably 1.13 or more, further preferably 1.16 or more from the viewpoint of heightening the melt-extrudability.

A diameter of a strand extruded from an orifice having a diameter of $D_0$ under a load of 21.18N at 190°C according to JIS K7210-1995, was measured, and the swelling ratio (SR) was defined as a ratio $(D/D_0)$ of the diameter of the strand (D) to a diameter of the orifice $(D_0)$.

The resin composition of the present invention contains an ethylene homopolymer or ethylene-propylene copolymer.

Hereinafter, these polymers may be referred to as "ethylene-based polymer".

The density of the ethylene homopolymer is 965 kg/m$^3$ or less from the viewpoint of heightening a heat stretchability, and is preferably 960 kg/m$^3$ or less, further preferably 955 kg/m$^3$ or less. On the other hand, the density is 935 kg/m$^3$ or more from the viewpoint of the heat stretchability, and is preferably 950 kg/m$^3$ or more, more preferably 952 kg/m$^3$ or more, further preferably 954 kg/m$^3$ or more. The density is measured according to A-method in JIS K7112-1980 after annealed according to a method of low density polyethylene described in JIS K6760-1995.

The density of the ethylene-propylene copolymer is 965 kg/m$^3$ or less from the viewpoint of heightening a heat stretchability, and is preferably 960 kg/m$^3$ or less, further
preferably 955 kg/m³ or less. On the other hand, the density is 935 kg/m³ or more from the viewpoint of the heat stretchability, and is preferably 940 kg/m³ or more, more preferably 945 kg/m³ or more. The density is measured according to A-method in JIS K7112-1980 after annealed according to a method of low density polyethylene described in JIS K6760-1995.

The content of monomer units based on ethylene in the ethylene-propylene copolymer is usually 90 % by weight or more based on the total of the ethylene-propylene copolymer (100 % by weight). The content of monomer units based on propylene in the copolymer is usually 10 % by weight or less based on the total of the copolymer (100 % by weight).

The MFR of the ethylene-based polymer is preferably 0.1 or more, more preferably 0.3 g/10 minutes, further preferably 0.6 g/10 minutes or more from the viewpoint of heightening melt-extrudability.

Further, the MFR is preferably 6 g/10 minutes or less, more preferably 4 g/10 minutes or less, further preferably 2 g/10 minutes or less from the viewpoint of heightening a heat stretchability and mechanical strength.

The MFR is measured by a method according to JIS K7210-1995, under a load of 21.18 N at a temperature of 190°C.

The melt flow rate ratio (MFRR) of the ethylene-based polymer is preferably 50 or less, more preferably 45 or less, most preferably 40 or less, from the viewpoint of heightening a melt-spinning property. On the other hand, the MFRR is preferably 10 or more, more preferably 15 or more, most preferably 20 or more from the viewpoint of heightening the
melt-extrudability. The MFRR is a value obtained by dividing a melt flow rate value measured at 190°C under a load of 211.83 N (MFR-H, unit: g/10 minute) according to JIS K7210-1995 by an MFR measured at 190°C under a load of 21.18 N according to JIS K7210-1995.

A maximum take-off velocity (MTV) of the ethylene-based polymer is preferably 70 m/minute or more, more preferably 100 m/minute or more, most preferably 130 m/minute from the viewpoint of heightening a melt-spinning property. On the other hand, the MTV is preferably 500 m/minute or less, more preferably 400 m/minute or less, most preferably 300 m/minute from the viewpoint of heightening the mechanical strength.

The MTV means a take-up velocity at which a melt resin is broken, when the melt resin filled in a barrel of 9.5 mm φ is extruded from an orifice having a diameter of 2.09 mm and a length of 8 mm under conditions of a temperature of 190°C and a piston decent velocity of 5.5 m/minute and the extruded resin is wound at an ascent take-up velocity of 40 rpm using a wind roll of 150 mm in diameter.

As producing methods of the ethylene-based polymer, there can be illustrated known polymerization methods such as a solution polymerization method, slurry polymerization method, gas phase polymerization method and high-pressure ionic polymerization method with a known polymerization catalyst such as a Ziegler-Natta catalyst, a chromium-based catalyst or a metalloocene catalyst.

Further, the polymerization methods may be a batch polymerization method or a continuous polymerization method,
further a multi-stage polymerization method may be also adopted.

The Ziegler-Natta catalyst described above includes, for example, the following catalysts (1) and (2):

1. a catalyst obtained by combining a component prepared by supporting at least one selected from the group consisting of titanium trichloride, vanadium trichloride, titanium tetrachloride and haloalcalolate of titanium on a magnesium compound-based support with, as a co-catalyst, an organometallic compound, and

2. a catalyst obtained by combining a co-precipitate or co-crystallization product of a magnesium compound and a titanium compound support with, as a co-catalyst, an organometallic compound.

The chromium-based catalyst includes, for example, a catalyst obtained by combining a component prepared by supporting a chromium compound on silica or silica-alumina with an organometallic compound as a co-catalyst.

The metalloocene catalysts include, for example, the following catalysts (1) to (4):

1. a catalyst obtained by combining a component containing a transition metal compound having a group containing a cyclopentadiene skeleton with a component containing an alumoxane compound,

2. a catalyst obtained by combining a component containing the transition metal compound described above with a component containing an ionic compound such as tolytlyborate or anilinium borate,
(3) a catalyst obtained by combining a component containing the transition metal compound described above and a component containing the ionic compound described above with an organoaluminum compound,

(4) a catalyst obtained by supporting or immersing the respective components described above on an inorganic particulate support such as SiO₂ or Al₂O₃ or a polymer particulate support such as a polymer of an olefin (e.g. ethylene, styrene) polymer.

As a production process of the ethylene-based polymer, the process using the Ziegler-Natta catalyst or the metallocene catalyst as the polymerization catalyst is preferable.

Further, from the viewpoint of heightening a melt-spinning property, it is preferable to shorten a residence time distribution of polymer produced during polymerization, and, for shortening the residence time distribution, a single-stage polymerization is preferable, further, in a process using a plurality of reaction vessels, it is preferable to operate the polymerization using the reaction vessels connected in parallel.

The pesticide used in the present invention includes compounds having a pesticidal activity such as pesticides, insect growth controlling agents, pest repellants and the like.

Pesticides include pyrethroid compounds,
organophosphorus compounds, carbamate compounds, phenyl pyrazole compounds and the like. Examples of the pyrethroid compounds include permethrin, allethrin, d-allethrin, dd-allethrin, d-tetramethrin, prallethrin, d-phenothrin,
d-resmethrin, empenthrin, fenvalerate, esfenvalerate,
fenpropathrin, cyhalothrin, etofenprox, tralomethrin,
esbiothrin, benfulthrin, terallethrin, deltamethrin,
phenothrin, tefluthrin, bifenthrin, cyfluthrin, cyphenothrin,
cypermethrin and α-cypermethrin. Examples of the
organophosphorus compounds include phenitrothion, dichlorobos,
dichlorvos, naled, fenthion, cyanophos, chloropyrifos,
diazinon, calchlophos and salithion.

Examples of the carbamate compounds include methoxydiazon,
propoxur, fenobucarb and carbaryl. Examples of the
phenylpyrazole compounds include fipronil.

Examples of the insect growth controlling agents include
pyriproxyfen, methoprene, hydropropene, diflubenzuron,
cyromazine, phenoxy carb and lufenuron (CGA184599).

Examples of the insect repellants include diethyltolamide
and dibutylphthalate.

These pesticides can be used alone or as a mixture of two
kinds or more. A combination of two kinds or more of the
pesticides of which the mechanisms different each other makes
the expression of resistance against pesticides of insects
carrying an infection, difficult. As pesticides, insecticides
are preferable, pyrethroid compounds are more preferable, and
pyrethroid compounds having a vapor pressure of less than 1 x
10⁻⁶ mmHg at 25°C are further preferable. Examples of the
pyrethroid compounds having a vapor pressure of less than 1 x
10⁻⁶ mmHg at 25°C include resmethrin and d-permethrin.

A compound having a role of heightening of a pest proof
activity, may be compounded to the resin composition of the
present invention. Examples of the compound includes piperonyl butoxide, MGK264 and octachloropropylether.

Further, a supporting material retaining the pesticide may be added to the resin composition of the present invention. As the supporting material, a material which can retain, support, absorb, adsorb, immerse, permeate, or inject the pesticide, is used, and examples thereof include silica-based compounds, zeolites, clay minerals, metal oxides, micas, hydrotalcites, and organic supports. Examples of the silica-based compounds include non-crystalline (amorphous) silica and crystalline silica, for example, powdery silicic acid, fine powdery silisic acid, acidic white clay, diatom earth, quartz and white carbon. Examples of the zeolites include A-type Zeolite and mordenite. Example of the clay minerals include montmorillonite, saponite, beidellite, bentonite, kaolinite, halloysite, nacrite, dickite, anauxite, illite and sericite. Examples of the metal oxides include zinc oxide, magnesium oxide, aluminum oxide, iron oxide, copper oxide and titanium oxide. Examples of the micas include mica and vermiculite. Examples of the hydrotalcites include hydrotalcite and smectite. As organic supports, coals (e.g. charcoal, peat, glass peat), polymer beads (e.g. fine crystallized cellulose, polystyrene beads, polyacrylate-based beads, polymethacrylate-based beads, polyvinylalcohol-based beads) and crosslinked polymer beads thereof are listed. Further, pearlite, plaster, ceramics and volcanic rock are listed.

As the pesticide support, non-crystalline inorganic supports are preferable, and amorphous silica is more preferable.
When the pesticide support is used, the content of the pesticide support in the resin composition is usually 0.1 to 20 parts by weight per 100 parts by weight of the ethylene-based polymer. From the viewpoint of heightening mechanical strength, it is preferably 10 parts by weight or less, more preferably 5 parts by weight or less. In contrast, from the viewpoint of enhancement of a performance of pest-control, it is preferably 0.5 parts by weight or more, more preferably 1 part by weight or less.

Additives such as antioxidants, antiblocking agents, fillers, lubricants, antistatic agents, weathering agents, pigments, processing improving agents and metal soaps; and polymer components other than olefin-based polymers, may be added to the resin composition of the present invention.

Two or more of the additives and the polymer components may be added, respectively.

The resin composition of the present invention can be obtained by melt-kneading the ethylene-based polymer, the pesticide and optionally other components by a publicly known method. For example, there are exemplified a method of mixing previously the ethylene-based polymer with the pesticide, then melt-kneading a mixture obtained with an extruder, roll molding machine, kneader or the like, a method of feeding separately the ethylene-based polymer and the pesticide to an extruder or the like followed by melt-kneading them. In melt-kneading by an extruder, the pesticide may be fed from the middle of the extruder by an adding device such as a side extruder or a feeder.

In the production of the resin composition, the pesticide
after which the pesticide was subjected to treatment such as retaining, supporting, immersing, permeating, injecting, adsorbing or absorbing on or in the support for the pesticide, may be used, further, the above-treated pesticide or non-treated pesticide may be used as a master batch by adding the pesticide to a resin.

Examples of the resin used as a base of the master batch, include olefin-based resins such as ethylene-based resins, propylene-based resins, butene-based resins, 4-methyl-1-pentene-based resins and modified products, saponified products and hydrogenated products of these resins. As a preferable resin, ethylene-based resins such as high density polyethylenes, linear low density polyethylenes, linear very low density polyethylenes, linear ultra low density polyethylenes, high pressure process low density polyethylenes and ethylene-vinyl acetate copolymers; and hydrogenation products of butadiene-based polymers are listed.

When the master batch is used in the production of the resin composition, an amount of the master batch is usually less than 50% by weight of the resin composition (100 % by weight), and from the viewpoint of improving economic efficiency, preferably 20% by weight or less, more preferably 10% by weight or less.

As the resin composition of the present invention is excellent in melt-spinning property and has a good melt-extrudability, it is molded into a filament such as a multi-filament or monofilament and used. Further, the filament made of the resin composition is excellent in heat
stretchability and good in mechanical strength. Furthermore, a production process of filament using the resin composition is advantageous in cost because it is possible to discharge the resin composition at a high speed from a nozzle of an extruder thereby carrying out filament spinning and to stretch the filament at high degree by one step stretching operation.

As a method of molding the resin composition of the present invention into a filament, there are exemplified a melt-spinning method, and (direct) spinning-stretching method, for example, a method of (1) melting the resin composition and discharging the composition from a die/nozzle via a gear pump or the like in strand-like, (2) drawing the strand melt-discharged followed by spinning while cooling the strand using a cooling medium such as water or air, thereafter, (3) subjecting to treatment such as heat stretching, heat treatment, oil application or the like, if necessary, and winding the filament.

In a method of obtaining the filament to subject a molding obtained by spinning to heat stretching to prepare a filament, a heat stretching temperature is preferably 70 to 120°C, and from the viewpoint of heightening heat stretchability, more preferably 75 to 115°C, further preferably 80 to 110°C, most preferably 90 to 105°C.

A cross sectional shape of the filament includes circle, ellipse, triangle, square, hexagon, star shape and the like.

A use of the filament made of the resin composition of the present invention, includes as a mono-filament, nets such as mosquito nets, window and door screens, insect nets; lopes;
yarns; filters; and the like, and as a multi-filament, lopes; nets; carpets; non-woven clothes; filters; shoes; clothes; and the like. Especially, uses for which a insect proof is required, for example, window or door screens, insect nets, mosquito nets, filters, carpets, shoes, clothes and the like are suitable.

Pests to be controlled by the filament of the resin composition of the present invention, include arthropods such as spiders, mites and insects. Further, these are described in detail below.

Arachnida includes, for example, Acarinia (e.g. Ornithonyssus sylviarum, Panonychus citri, Tyrophagus putrescentiae); and Araneae (e.g. Atypus karschi, Pholcus phalangioides). Chilopoda includes, for example, Scutigeromorpha (e.g. Thereuonema tuberculate); and Lithobiomorpha (e.g. Bothropolys rugosus). Diplopoda includes, for example, Polydesmoidea (e.g. Oxidus gracilis, Nedyopus tambanus).

Furthermore, examples of INSECTA include Thysanura (e.g. Ctenolepisma); Orthoptera (e.g. Diestrammena japonica, Atractyloides japonica, Locusta migratoria, Schitocerca gregaria, Oxya yezoensis; Dermaptera (e.g. Forficula auricularia); blattaria (e.g. blatella germanica, periplaneta fuliginosa, periplaneta japonica, Periplaneta americana); Isoptera (e.g. Reticulitermes, Coptptermes formosanus, Incistermes minor); Psocoptera (e.g. Liposcelis entomophilus, Lipicepselis bostrychophilus); Mallophaga (e.g. Trichodectes canis; Felicola subrostratus); Anoplura (e.g. Pediculus corporis, Pthirus pubis, Pediculus humanus); Hemiptera (e.g.
nilaparvata lugens, Nephotettix cincticeps, Trialeurodes vaporariorum, Myzus persicae, Cimex lectularius, Halyomorpha mista); Coleoptera (e.g. Attagenus japonicus, Authrenus verbasci, Aulacophora femoralis, Sitophilus zeamais, Lyctus brunneus, Gibbium aequinoctiale, Ptinus japonicus, Popillia japonica); Siphonaptera (e.g. Ctenocephalides felis, Ctenocephalides canis, Pulex irritans); Diptera (e.g. Culex pipienspallens, Aedes aegypti, Anoheles spp., maringouin, Chironomus yoshimatsui, Clogmia albipunctatus, Musca domestica, Fannia canicularis, Tabanus trigonus, Allograpta iavana); and Hymenoptera (e.g. Vespa mandarinia japonica, Polistes hebraeus, Nesodiprion japonicus, Dryocosmum kuriphilus, Sclerodermus nipponicus, Monomorium nipponensis).

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EXAMPLE

The present invention is described by Examples and Comparative Examples below.

Physical properties in Examples and Comparative Examples were measured by the following methods:

20 (1) Melt flow rate (MFR, unit: g/10 minutes)

It was measured by a method under conditions of 190°C and a load of 21.18N according to JIS K7210-1995.

(2) Melt flow rate ratio (MFRR)

The melt flow rate ratio (MFRR) is a value obtained by dividing a melt flow rate value measured at 190°C under a load of 211.83 N (21.60 kg) by a melt flow rate value measured under a load of 21.18 N (2.16 kg) according to JIS K7210-1995.

(3) Density (unit: kg/m³)
The density of a resin composition was measured according to a method in JIS K7112-1980 after annealed according to a method of low density polyethylene described in JIS K6760-1995.

(4) Swelling ratio (SR)

A diameter of a strand extruded from an orifice at the time of measurement of a melt flow rate under a load of 21.18N at 190°C according to JIS K7210-1995, was measured, and a ratio of the diameter of strand (D) to a diameter of the orifice (D₀) was defined as a value of the SR.

(5) Maximum take-off velocity (MTV, Unit: m/minute)

A melt resin filled in a barrel of 9.5 mm φ at a temperature of 190°C was extruded from an orifice of 2.09 mm in diameter and 8 mm in length at a fall velocity of 5.5 mm/minute using a melt tension tester manufactured by Toyo Seiki Seisaku-sho Ltd., then the extruded melt resin was wound at take-up rise velocity of 40 rpm with a wind roll of 150 mm φ in diameter, and a take-up velocity at which the melt resin was broken was measured. When this value is larger, it is shown that the melt spinning property is higher.

(6) Heat stretchability of filament

A heat stretching of a filament was carried out in a method described in (i) to (v), and a length between marked lines after the stretching was measured followed by calculating an elongation of the length between marked lines. When this elongation is larger, it is shown that the heat stretchability is more excellent.

(i) A filament was cut to a length of 70 cm and marked up with two lines at an interval of 40 mm along the length direction.
(ii) The one side of the filament prepared in (1) was fixed.

(iii) A hot-air heater was set so that the distance between the outlet of the heater and the filament was 50 mm, and the filament was heated between the lines for 15 seconds or 30 seconds with the hot-air heater. A filament temperature after heating for 15 seconds and 30 seconds was respectively 85°C and 98°C.

(iv) After the heating, the end of the filament not fixed was stretched at a rate of 100 m/minute.

(v) The length (mm) between the marked lines was measured after the stretching, and an elongation of the length between the marked lines was calculated by the following equation. Besides, when the filament was broken during the stretching, the lengths between the marked line and the broken point of the respective broken filaments were measured and the total of the lengths was defined as the length between the marked lines.

Elongation of length between marked lines = (Length between marked lines after stretching - Length between marked lines before stretching)/(Length between marked lines before stretching) X 100 (%)

Length between marked lines before stretching = 40 mm

(7) Mechanical strength of filament

A filament was subjected to tensile test under conditions of a chuck distance of 20 mm and a tensile velocity of 500 mm/minute to determine a tensile strength at break (unit: MPa) and a nominal tensile strain at break (unit: %). These values larger are, the mechanical strength more excellent is.

Example 1
(1) Preparation of resin composition

51 parts by weight of permethrin (manufactured by Sumitomo Chemical Co., Ltd., trade name: Eksmin®), 47.5 parts by weight of amorphous silica (manufactured by Fuji Silysia Chemical Ltd., Trade name: Sylysia®) and 1.5 parts by weight of an antioxidant (butylhydroxy toluene) were mixed with stirring to prepare a pesticide support. 60.3 parts by weight of pellets of linear low density polyethylene [manufactured by Sumitomo Chemical Co., Ltd., trade name: Sumikathene®-L GA807 (MFR: 25 g/10 minutes, density: 913 kg/m³), ethylene-1-butene copolymer], 34.2 parts by weight of the pesticide support and 5.5 parts by weight of zinc stearate were melt-kneaded for 10 minutes under conditions of a set temperature of 160°C and a rotation speed of 60 rpm with a Labo Plastmill (manufactured by Toyo Seiki Seisaku-sho, Ltd.) to obtain a pesticide master batch. Next, 100 parts by weight of pellets of a high density polyethylene [GF7750M2 (herein-after referred to as “HD-1”, physical properties of HD-1 are shown in Table 1), manufactured by Basell Polyolefin Co., Ltd.], 14.7 parts by weight of the pesticide master batch and 0.8 parts by weight of zinc stearate were melt-kneaded for 10 minutes under conditions of a set temperature of 160°C and a rotation speed of 60 rpm with a Labo Plastmill (manufactured by Toyo Seiki Seisaku-sho, Ltd.) to obtain a resin composition (herein-after, referred to as “Composition-1”). Evaluation results of physical properties of the obtained Composition-3 were shown in Table 2.

(2) Preparation of filament

Composition-1 was melt-extruded under conditions of a
temperature of 190°C and a piston fall speed of 10 mm/minute using Capirograph manufactured by Toyo Seiki Seisaku-sho, Ltd. and an orifice (L/D:40/1 mm, flow angle: 90°) to obtain a strand, the strand melt-extruded was taken off at a speed of about 3 m/minute with a take up device included with the Capirograph to obtain a filament of 450 μm in diameter. Evaluation results of physical properties of the obtained filament were shown in Table 2.

Example 2

A resin composition and filament were prepared in the same manner as in Example 1 except that a high density polyethylene (Hizex® 5000S manufactured by Prime Polymer Co., Ltd.) (herein-after, referred to as "HD-2", physical properties of HD-2 are shown in Table 1) was used in place of HD-1. Evaluation results of physical properties of the composition and filament obtained were shown in Table 2.

Example 3

A resin composition and filament were prepared in the same manner as in Example 1 except that a high density polyethylene (Hizex® 3300F manufactured by Prime Polymer Co., Ltd.) (herein-after, referred to as "HD-3", physical properties of HD-3 are shown in Table 1) was used in place of HD-1. Evaluation results of physical properties of the composition and filament obtained were shown in Table 2.

Example 4

A resin composition and filament were prepared in the same manner as in Example 1 except that a high density polyethylene (Hizex® 445M manufactured by Prime Polymer Co., Ltd.)
(herein-after, referred to as “HD-4”, physical properties of HD-4 are shown in Table 1) was used in place of HD-1. Evaluation results of physical properties of the composition and filament obtained were shown in Table 2.

Comparative Example 1

(1) Preparation of resin composition

100 parts by weight of pellets of a high density polyethylene (HYA-800 manufactured by Exxon-Mobil Co., Ltd.) (herein-after, referred to as “HD-5”, physical properties of HD-5 are shown in Table 1) and 2.6 parts by weight of permethrin (manufactured by Sumitomo Chemical Co., Ltd., trade name: Eksmin®,) were melt-kneaded for 10 minutes under conditions of a set temperature of 160°C and a rotation speed of 60 rpm with a Labo Plastmill (manufactured by Toyo Seiki Seisaku-sho, Ltd.) to obtain a resin composition (herein-after, referred to as “Composition-5”). Evaluation results of physical properties of the obtained Composition-5 were shown in Table 3.

(2) Preparation of filament

The resin composition-5 was molded into a filament of 450 μm in diameter in the same manner as in Preparation of filament of Example 1. Evaluation results of physical properties of the obtained filament were shown in Table 3.

Comparative Example 2

(1) Preparation of resin composition)

48 parts by weight of permethrin (manufactured by Sumitomo Chemical Co., Ltd., trade name: Eksmin®) and 52 parts by weight of amorphous silica (manufactured by Fuji Silysia Chemical,
Ltd., Trade name: Sylisia® 530) were mixed with stirring to prepare a pesticide support. Next, 100 parts by weight of pellets of HD-5 and 4.9 parts by weight of the pesticide support were melt-kneaded for 10 minutes under conditions of a set temperature of 160°C and a rotation speed of 60 rpm with a Labo Plastmill (manufactured by Toyo Seiki Seisaku-sho, Ltd.) to obtain a resin composition (herein-after, referred to as "Composition-6"). Evaluation results of physical properties of the obtained Composition-6 were shown in Table 3.

(2) Preparation of filament

The resin composition-6 was molded into a filament of 450 μm in diameter in the same manner as in Preparation of filament of Example 1. Evaluation results of physical properties of the obtained filament were shown in Table 3.

Comparative Example 3

A resin composition and filament were prepared in the same manner as in Example 1 except that HD-1 was changed to HD-5. Evaluation results of physical properties of the obtained resin composition and filament were shown in Table 3.

Comparative Example 4

A resin composition and filament were prepared in the same manner as in Example 1 except that HD-1 was changed to a high density polyethylene GC7260 (manufactured by Basell Polyolefin Co., Ltd.) (herein-after, referred to as "HD-6", physical properties of HD-6 are shown in Table 1). Evaluation results of physical properties of the obtained resin composition and filament were shown in Table 3.
<table>
<thead>
<tr>
<th>Polymer</th>
<th>Comonomer Content (wt%)</th>
<th>Density (kg/m³)</th>
<th>MFR (g/10 min.)</th>
<th>MFRR</th>
<th>MTV (m/min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD-1 Ethylene homopolymer</td>
<td>-</td>
<td>955</td>
<td>1.1</td>
<td>32</td>
<td>164</td>
</tr>
<tr>
<td>HD-2 Ethylene-propylene copolymer</td>
<td>0.9</td>
<td>948</td>
<td>0.8</td>
<td>35</td>
<td>119</td>
</tr>
<tr>
<td>HD-3 Ethylene-propylene copolymer</td>
<td>1.1</td>
<td>947</td>
<td>1.1</td>
<td>33</td>
<td>144</td>
</tr>
<tr>
<td>HD-4 Ethylene-propylene copolymer</td>
<td>-</td>
<td>947</td>
<td>0.9</td>
<td>35</td>
<td>66</td>
</tr>
<tr>
<td>HD-5 Ethylene homopolymer</td>
<td>-</td>
<td>957</td>
<td>0.7</td>
<td>67</td>
<td>44</td>
</tr>
<tr>
<td>HD-6 Ethylene-1-butene copolymer</td>
<td>0.6</td>
<td>957</td>
<td>7.8</td>
<td>30</td>
<td>492</td>
</tr>
</tbody>
</table>

*1: Content of monomer units based on comonomer (propylene or 1-butene) in ethylene-propylene copolymer or ethylene-1-butene copolymer.
## Table 2

<table>
<thead>
<tr>
<th>Physical property of resin composition</th>
<th>Example 1</th>
<th>Example 2</th>
<th>Example 3</th>
<th>Example 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFR (g/10 min.)</td>
<td>1.4</td>
<td>1.0</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>MFRR</td>
<td>33</td>
<td>36</td>
<td>37</td>
<td>40</td>
</tr>
<tr>
<td>SR</td>
<td>1.19</td>
<td>1.24</td>
<td>1.25</td>
<td>1.27</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>970</td>
<td>962</td>
<td>963</td>
<td>963</td>
</tr>
<tr>
<td>MTV (m/min.)</td>
<td>135</td>
<td>83</td>
<td>96</td>
<td>96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical property of filament</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat stretchability 85°C</td>
<td>%</td>
<td>89</td>
<td>124</td>
<td>97</td>
</tr>
<tr>
<td>Tensile strength at break</td>
<td>MPa</td>
<td>40.3</td>
<td>36.7</td>
<td>38.4</td>
</tr>
<tr>
<td>Nominal tensile strain at break</td>
<td>%</td>
<td>2978</td>
<td>2550</td>
<td>2928</td>
</tr>
<tr>
<td></td>
<td>Comparative Example 1</td>
<td>Comparative Example 2</td>
<td>Comparative Example 3</td>
<td>Comparative Example 4</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Physical property of resin composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFR g/10 min.</td>
<td>0.8</td>
<td>0.8</td>
<td>1.0</td>
<td>8.4</td>
</tr>
<tr>
<td>MFRR</td>
<td>66</td>
<td>68</td>
<td>60</td>
<td>31</td>
</tr>
<tr>
<td>SR</td>
<td>1.50</td>
<td>1.44</td>
<td>1.50</td>
<td>1.13</td>
</tr>
<tr>
<td>Density kg/m$^3$</td>
<td>963</td>
<td>974</td>
<td>972</td>
<td>971</td>
</tr>
<tr>
<td>MTV m/min.</td>
<td>42</td>
<td>37</td>
<td>43</td>
<td>430</td>
</tr>
<tr>
<td>Physical property of filament</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat stretchability 85°C</td>
<td>%</td>
<td>64</td>
<td>49</td>
<td>73</td>
</tr>
<tr>
<td>98°C</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Tensile strength at break</td>
<td>MPa</td>
<td>43.0</td>
<td>40.6</td>
<td>38.4</td>
</tr>
<tr>
<td>Nominal tensile strain at break</td>
<td>%</td>
<td>2593</td>
<td>2540</td>
<td>2775</td>
</tr>
</tbody>
</table>
According to the present invention, there can be provided a resin composition containing an ethylene-based resin and a pesticide, which gives a filament excellent in heat stretchability and is good in melt spinning property, and a filament made of the composition, and a process for producing the filament using the composition. Further, the resin composition containing the pesticide is excellent in extrudability, the filament made of the resin composition is good in mechanical strength, and the process for producing the filament using the resin composition, is advantageous in cost.
CLAIMS

1. A resin composition for a filament, which comprises an ethylene homopolymer having a density of 935 to 965 kg/m³, and a pesticide of 0.1 to 10 parts by weight per 100 parts by weight of the ethylene homopolymer, wherein the composition has a melt flow rate of 0.3 to 7 g/10 minutes and a melt flow rate ratio of 10 to 50 and a density of 935 to 980 kg/cm³.

2. The resin composition according to claim 1, wherein the ethylene homopolymer has a melt flow rate of 0.1 to 6 g/10 minutes and a melt flow rate ratio of 10 to 50.

3. A resin composition for a filament, which comprises an ethylene-propylene copolymer having a density of 935 to 965 kg/m³, and a pesticide of 0.1 to 10 parts by weight per 100 parts by weight of the ethylene-propylene copolymer, wherein the composition has a melt flow rate of 0.3 to 7 g/10 minutes and a melt flow rate ratio of 10 to 50 and a density of 935 to 980 kg/cm³.

4. The resin composition according to claim 3, wherein the ethylene-propylene copolymer has a melt flow rate of 0.1 to 6 g/10 minutes and a melt flow rate ratio of 10 to 50.

5. A filament obtained from the resin composition of any one of claims 1 to 4.

6. A process for producing a filament, which comprises melt-extruding the resin composition of any one of claims 1 to 4 in strand-like, taking off the strand-like composition, and subjecting the strand-like composition taken off to heat
stretching under a heating of 70 to 120°C.